



***Polyaromatic Hydrocarbon Emissions
from Asphalt Processing and Roofing Manufacturing
Operations***

***Submitted by
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Environmental Task Force
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Abstract

The Clean Air Act of 1990 Section 112(c)(6) requires EPA to identify and regulate 90% of the sources of Polycyclic Organic Matter (POM). The Roofing Manufacturing and Asphalt Processing industry segments of the Asphalt Roofing Industry have been identified in EPA's emission inventory as sources of POM's. EPA utilizes Polyaromatic Hyrdocarbons (PAH) as a surrogate for POM's. EPA's estimate of PAH emissions overstates the industry production and their emission factors are based on limited data. This resulted in significant overestimation of the industry PAH emissions. This paper presents revised emission estimates for these industry segments. The industry estimate suggests that the PAH emissions for the Asphalt Roofing Industry are less then 3% of those estimated by EPA.

Background

The reduction of emissions of Hazardous Air Pollutants (HAP) in the United States has been mandated by Section 112 of the Clean Air Act, as amended in 1990. This section of the Clean Air Act contains the original listing of 189 HAP's in Section 112-(b) (1). The Administrator of the EPA published the list of industry sources of Hazardous Air Pollutants pursuant to section 112(c) of the act and EPA is required to establish Maximum Achievable Control Technology (MACT) standards for the major Sources of HAPs in the identified industry segments. A major source is defined as any facility source that has the potential to emit 10 tons per year of any individual HAP or 25 tons per year in the aggregate of all HAPs. The Asphalt Roofing Industry was included in EPA's list of the industrial sources of HAPs⁽¹⁾. The timing for the Asphalt Roofing Industry MACT standards is the year 2000.⁽²⁾ The Asphalt Roofing Manufacturers Association (ARMA) is currently working with EPA in the development of these MACT standards.

In addition to the above sections, Section 112(c)(6) of the Clean Air Act identifies seven pollutants as being subject to special provisions for MACT standards. EPA is required to list the sources of these pollutants and assure that sources accounting for at least 90% of the emissions are subject to standards under Section 112(d)(2) or Section 112(d)(4).

Table 1

Section 112(c)(6) Pollutants
Alkylated lead compounds
Polycyclic Organic Matter
Hexachlorobenzene
Mercury
Polychlorinated Biphenyls
2,3,7,8-tetrachlorodibenzfurans
2,3,7,8- Tetrachlorodibenzo-p-dioxin

EPA prepared an emission inventory of section 112(c)(6) pollutants as required by the act. This emission inventory was issued on June 11, 1997.⁽³⁾ In the emission inventory, EPA used PAH as a surrogate for POM. The Asphalt Roofing Industry is included in this emissions inventory as a source of PAH's. Inclusion in this listing opens the door for further regulation of industry sources.

EPA's mandate to control 90% of the emissions of Section 112(c)(6) sources allows EPA to include area (non-major) sources of these pollutants in the MACT regulations for each industry. EPA has recently utilized the same emission inventory prepared for section 112(c)(6) as input to their inventory of 40 pollutants subject to possible regulation under section 112(k). Section 112(k) requires EPA to regulate area sources to insure that at least 90% of the emissions of 30 HAPS presenting health threats to urban population are regulated.

The ARMA Environmental Task force, faced with the possibility of MACT regulation on area sources of the Asphalt Roofing Industry, and the inconsistencies in the EPA estimates, utilized recent industry data to prepare a more accurate estimate of PAH emissions.

EPA 1990 Baseline Emission Estimate

The EPA 1990 Baseline Emission Estimate of 112(c)(6) Pollutants make several significant assumptions. EPA redefines the family of compounds to be regulated from Polycyclic Organic Matter to Polynuclear Aromatic Hydrocarbons. PAH's are a narrower subset of the POM group. EPA suggests the use of PAH 7 and PAH 16 groups as possible surrogates for total POM emissions. EPA states that the species that make up the PAH 7 group are probable human carcinogens. The PAH 16 group are those species measured by EPA Method 610. The members of the PAH7 and PAH 16 groups are listed in the Table 2.

Table 2

PAH 7 Group	PAH 16 Group
Benz(a)anthracene	Acenaphthene
Benzo(a)pyrene	Acenaphthylene
Benzo(b)fluoranthene	Anthracene
Benzo(k)fluoranthene	Benz(a)anthracene
Chrysene	Benzo(a)pyrene
Dibenz(a,h)anthracene	Benzo(b)fluoranthene
Indeno(1,2,3-cd)pyrene	Benzo(ghi)perylene
	Benzo(k)fluoranthene
	Chrysene
	Dibenz(a,h)anthracene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-cd)pyrene
	Naphthalene
	Phenanthrene
	Pyrene

EPA's estimate of Asphalt Roofing Industry 1990 PAH emissions was 1.68 tons of PAH 7 per year and 43.6 tons of PAH 16 per Year.

These estimates combined PAH emissions for both Asphalt Processing and Roofing Manufacturing segments. The estimates are presented on page B-47 of the "1990 Emission Inventory of Section 112(c)(6) Pollutants" Final Report June 1997, Distributed by the Emission Factor and Inventory Group (MD-14), Emissions, Monitoring and Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Due to several errors in input data, these EPA estimates are many times higher than the more detailed estimates described in the remainder of this paper. EPA does not document the source of their emission factors for both Asphalt Processing and Roofing Manufacturing. The Asphalt Processing emission factor is several orders of magnitude above industry experience. The Roofing Manufacturing emission factor does not differentiate between organic and inorganic substrates. In addition, EPA's estimate of industry production is flawed by a units error in reporting the industry shingle production and an overestimate of the asphalt content in roofing to determine the asphalt production.

ARMA Industry Estimate

The ARMA estimate of industry PAH emissions was prepared from data collected from an ARMA study conducted at a member company's manufacturing plant during an ARMA sponsored sampling event in August 1995. Additional data was provided by Owens Corning. This Owens Corning data had been collected to prepare Title V permit applications. Both the ARMA and Owens Corning data has presented in tables 3 and 4. This data is presented as pounds of pollutants emitted per ton of product produced. The emissions factors for asphalt processing are **controlled** emissions. Controlled emissions are representative of the Asphalt Processing segment as incinerators or afterburners are in place on 100% of all manufacturing facilities.

The emission factors presented for the Roofing Manufacturing portion of the business are uncontrolled emissions. There is no representative control scheme for this industry segment. The Roofing Manufacturing segment includes, no control on many fiberglass coaters, numerous methods of particulate control and in some instances incineration of coater or saturator fumes. Since the control efficiency for PAH's is unknown for these devices, the uncontrolled emissions for the Roofing Manufacturing segment were used.

Table 3

PAH Emission Factors- Asphalt Air Blowing ⁽⁷⁾

PAH Compound	PAH 7/16	1990 Baseline	OC Plant C	OC Plant L Ferric	OC Plant L No Ferric	OC Plant Q Cutter	OC Plant Q #5 Fuel
Acenaphthene	16	x	0	3.60E-05	2.50E-06	2.70E-07	8.40E-08
Acenaphthylene	16		6.70E-09			2.50E-08	6.70E-09
Anthracene	16		0			2.50E-09	5.60E-08
Benz(a)anthracene	7	x	0			8.00E-09	6.20E-09
Benzo(a)pyrene	7		0				
Benzo(b)fluoranthene	7		0			7.1 0E-09	7.90E-09
Benzo(ghi)perylene	16		0				
Benzo(k)fluoranthene	7		0				
Chrysene	7	x	0			1 .00E-08	1.40E-08
Dibenz(a,h)anthracene	7		0				
Fluoranthene	16	x	0	1.30E-05	2.50E-06	6.50E-09	2.00E-08
Fluorene	16						
Indeno(1,2,3-cd)pyrene	7		0				
Naphthalene	16		5.90E-06	5.30E-05	2.50E-05	8.90E-07	9.90E-07
Phenanthrene	16	x	0	8.00E-05	6.90E-06	6.40E-08	6.40E-07
Pyrene	16		0	7.30E-06	2.50E-06	7.80E-09	1.80E-08
PAH 7 Factor		0	0	0	0	2.5 1E-08	2.81E-08
PAH 16 Factor		5.10E-03	5.91E-06	1.89E-04	3.94E-05	1.2909E-06	1.8428E-06
			Average	Maximum			
PAH 7 Factor			1.06E-08	2.66E-08			
PAH 16 Factor			4.75E-05	1.89E-04			

There is a growing number of Asphalt Industry sampling events where the PAH 7 group and certain members of the PAH 16 organics have not been detected. Results below detection limit from these sampling events were set at zero when calculating the industry average emission factors. A second set of emission factors were derived using the worst case sampling event and adding in the non detect compounds at the level of detection. These are particularly conservative estimates, considering that the EPA estimates were based on only five species with the remaining compounds set at zero ⁽⁴⁾. These numbers are shown as the industry maximum numbers for both fiberglass and organic roofing manufacture.

Table 4

PAH Emission Factors- Roofing Manufacturing (10) (11)

PAH Compound	PAH 7/16	EPA 1990 Base	OC Plant Fiberglas	ARMA Fiberglas @Detection	ARMA Fiberglas	ARMA Organic@ Detection	ARMA Organic
Acenaphthene	16	x	0.00E+00	2.56E-06	2.56E-06	2.28E-05	2.28E-05
Acenaphthylene	16		0.00E+00	1.605E-06	0	1.03E-05	0.00E+00
Anthracene	16		0.00E+00	2.476E-06	2.476E-06	4.35E-05	4.35E-05
Benz(a)anthracene	7	x	0.00E+00	5.384E-06	0	4.81E-05	0.00E+00
Benzo(a)pyrene	7		0.00E+00	9.687E-06	0	8.00E-05	0.00E+00
Benzo(b)fluoranthene	7		0.00E+00	8.257E-06	0	6.65E-05	0.00E+00
Benzo(ghi)perylene	16		0.00E+00	1.193E-05	0	9.85E-05	0.00E+00
Benzo(k)fluoranthene	7		0.00E+00	8.672E-06	0	7.16E-05	0.00E+00
Chrysene	7	x	5.55E-06	5.873E-06	0	6.23E-05	0.00E+00
Dibenz(a,h)anthracene	7		0.00E+00	1.284E-05	0	1.07E-04	0.00E+00
Fluoranthene	16	x	0.00E+00	3.421E-06	3.421E-06	2.76E-05	2.76E-05
Fluorene	16		6.35E-06	1.261E-05	1.261E-05	1.29E-04	1.29E-04
Indeno(1,2,3-cd)pyrene	7		0.00E+00	9.924E-06	0	8.19E-05	0.00E+00
Naphthalene	16		5.55E-06	1.268E-05	1.268E-05	9.32E-05	9.32E-05
Phenanthrene	16	x	6.18E-06	1.589E-05	1.589E-05	2.52E-04	2.52E-04
Pyrene	16		1.05E-06	4.266E-06	4.266E-06	5.28E-05	5.28E-05
PAH 7 Factor		1.10E-04	0.00000555	6.064E-05	0	0.0005171	0
PAH 16 Factor		3.17E-04	0.00002468	0.0001281	5.39E-05	0.00124656	0.00062064
		Max	Average				
Fiberglas PAH 7		6.0638E-05	2.775E-06	lb/ton			
Fiberglas PAH 16		0.00012807	3.929E-05	lb/ton			
Organic PAH 7		0.0005171	0	lb/ton			
Organic PAH 16		0.00124656	0.00062064	lb/ton			

Since emission factors were derived for asphalt processing, fiberglass roofing and organic roofing, production estimates for each industry segment were required to obtain a comprehensive industry emissions estimate. The Asphalt Processing segment production data was obtained from the industry estimates of asphalt oxidation₍₈₎. These estimates include not only saturant and coating asphalt for roofing manufacturing, but Built Up Roofing Asphalts and Industrial Specialties produced by the industry. The Roofing Manufacturing Segment production data were taken from the Asphalt Roofing Manufacturers reports of industry shipments.

These reports cover production for the years 1995-1997. The industry production estimates and subsequent PAH emissions are provided in Tables 5 & 6. The comparison of these estimates to the EPA 1990 baseline is shown in Figures 1-3. The ARMA emissions estimates were not revised downward for 1990 even though the total production output of the industry has increased by 10% from 1990 to the 1995-1997 period.

Table 5
Asphalt Processing Emissions

1997 Built-up Roofing Asphalt Production-Tons ⁽⁹⁾	1,100,000
1997 Roofing Saturant and Coating Asphalts- Tons ⁽⁹⁾	4,200,000
1997 Industrial Specialty Asphalts- Tons ⁽⁹⁾	500,000
 1997 Total Asphalt Processing Tons	 5800000

Emissions Factors- Lb. per Ton of Product	Average	Maximum
PAH - 7	1.064E-08	2.66E-08
PAH - 16	4.74881E-05	1.89E-04

1997 Asphalt Processing Emissions- Tons Emitted		
PAH - 7	3.086E-05	7.7 14E-05
PAH - 16	1.377E-01	5.481E-01

Table 6
Roofing Manufacturing Emissions

Annual Roofing Production- Tons ⁽⁸⁾	Inorganic 1.28E+07		Organic 2.5 1E+06	
Emission Factors - Lbs/Ton	Inorganic Average	Inorganic Maximum	Organic Average	Organic Maximum
PAH - 7	2.78E-06	6.06E-05	0.00E+00	5.17E-04
PAH - 16	3.93E-05	1.28E-04	6.21E-04	1.25E-03
Annual Roofing Production Emissions-Tons				
PAH - 7	0.02	0.39	0.00	0.65
PAH - 16	0.25	0.82	0.78	1.56

Discussion

The total emissions from the Asphalt Roofing Industry Manufacture and Asphalt Processing Industry are less than 3% of the emissions estimated by EPA. The key difference between the ARMA estimate of PAH emissions and the EPA baseline was the estimate of emissions attributable to Asphalt Processing. The EPA baseline differs from the industry estimate in both magnitude of the emission factor and industry throughput. The basis for the EPA emission factors was not documented.

EPA has stated both in the baseline emission estimate⁽⁴⁾ document and in their discussion of comments on the April 10, 1998 Federal Register publication ⁽²⁾ of the final recommendations that their emission estimates were derived from sparse and questionable data. EPA also acknowledges that the data collected for MACT standard development will be of higher quality and more

representative. This is apparently the case for the Asphalt Roofing Industry POM emission estimates also.

In the EPA estimate, the total industry asphalt processing production was estimated as one half the total roofing production. This was based on the erroneous assumption that asphalt makes up 50% of the weight of roofing products. Offsetting somewhat the over estimate of asphalt going into roofing, is the failure to count any asphalt production to other products such as BURA and Industrial Specialties. The ARMA estimate of controlled emissions, based on actual industry data, for the Asphalt Processing Segment is a fraction of a ton annually for even the worst case maximum (as shown in Tables 5 & 6).

The EPA estimate for Roofing Manufacturing Segment was skewed by an apparent conversion error from roofing squares to production tons. The EPA estimate of 1990 roofing production exceeds the Industry estimate of annual production for the 1995-1997 period. ARMA estimates that the PAH 16 emissions from uncontrolled coater and saturator sources is 1 ton annually, based on the average PAH 16 emissions in Table 6.

The generation of PAH 7 is negligible for the industry as a whole. Additionally, PAH emissions from the roofing manufacturing segments are uncontrolled emissions. These numbers will be further reduced by the control measures currently in place and future MACT standards for major sources in the industry. Further reductions by controlling area sources will have no measurable impact on the aggregate emissions of PAH's in the United States. Thus, there is no reason to regulate the Asphalt Roofing Industry for POM's.

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