Brake Pad Partnership Project

Copper Use Monitoring Program

Results for Model Years 1998 - 2002

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Introduction and Purpose

This report contains data on copper use in original equipment[1] automotive friction materials[2] for the model years 1998 to 2002, which are presented in Table 1. "Friction materials" include disc brake pads (on front and rear brakes) and drum brake linings (on rear brakes only). The Brake Manufacturers Council's Product Environmental Committee (BMC/PEC) reports annually on the amount of copper in friction materials as a part of its members' participation in the Brake Pad Partnership.[3, 4]

These data are important to the Brake Pad Partnership for the purposes of:

(1) monitoring trends in copper use over the course of the Partnership, and monitoring the industry's voluntary reduction in use of copper in the event the Partnership determines that copper from friction materials is a significant cause of water quality impairment; and

(2) providing inputs for modeling studies of the environmental fate and transport of automotive friction material wear debris in the environment.

Data Strengths and Limitations

- **Best available data set.** These are the most comprehensive and reliable data available regarding the copper content of automotive friction materials in the United States. They are reported voluntarily by the BMC/PEC as a part of its members' participation in the Brake Pad Partnership, and would not be collected and made publicly available without the Partnership's cooperative approach.
- **Data are for 40% of new automobiles.** The data for model years 1998 to 2001 are reported for the copper content of vehicle friction materials for the top 20 best selling vehicles, which comprise approximately 40% of the new cars and light trucks sold in the United States. For model year 2002, data were not available for all of the top 20 selling vehicles. The sample used for model year 2002 includes 19 of the top 25 selling vehicles for which data were available, which comprises 39% of the new cars and light trucks sold in the United States for that model year.
- **Trend indicator.** The data indicate the industry trend in use of copper in friction materials. The data do not provide the total amount of copper used in friction materials in the vehicle fleet.

[1] "Original equipment" refers to equipment that comes on new vehicles, and does not include "aftermarket" or replacement parts.

[2] "Automotive friction materials" refers to friction materials used in cars and light trucks, and does not include friction materials used on heavy-duty trucks, off-road vehicles, or motorcycles.

[3] The Brake Pad Partnership is a collaborative effort to understand the impacts on the environment that may arise from brake pad wear debris generated in the use of passenger vehicles. Working together, manufacturers, regulators, stormwater management agencies, and environmentalists are developing an approach for evaluating potential impacts on water quality, using copper in the South San Francisco Bay as an example. Friction material manufacturers have committed to adding this evaluation approach to their existing practices for designing products that are safe for the environment while still meeting the performance requirements demanded of these important safety-related products.

[4] The data reported herein were originally reported in: Lawrence, Jim. "Friction Material Content Monitoring: A Project of the BMC Product Environmental Committee. Motor and Equipment Manufacturers Association, Research Triangle Park, North Carolina. October 15, 2003.

TABLE 1. Friction Material Copper Content Monitoring Results[4]

Model Year:	1998	1999	2000	2001	2002
Top Selling Vehicle Samples[5]					
Total vehicle sales (vehicles)	15,540,765	16,890,536	17,349,760	17,122,368	16,816,368
Top 20 vehicle sales (vehicles)	6,659,538	6,931,931	6,810,814	6,799,008	--
Sample vehicle sales	--	--	--	--	6,633,977
Percent of total vehicle sales	42.8%	41.0%	39.3%	39.7%	39.4%
Friction material in Top 20 (kg)	9,366,940	9,109,322	8,556,864	8,416,727	--
Friction material in Sample 20 (kg)	--	--	--	--	7,850,371
Friction material per vehicle (kg)	1.406	1.314	1.256	1.238	1.183
Cu in Top 20 (kg)	267,462	358,541	384,145	381,507	--
Cu in Sample 20	--	--	--	--	507,938
Cu per vehicle (kg)	0.0402	0.0517	0.0564	0.0561	0.0766
Alternative 20 Sample[6]					
Friction material per vehicle (kg)	--	--	0.9460		
Cu per vehicle (kg)	--	--	0.0542		

- **Data are not designed for mass load calculations.** These data are not intended nor are they appropriate for calculating total copper loadings to the environment from friction materials on a national, regional, or local scale. While the data represent a significant sample of new vehicles, they encompass less than half of the friction materials in new vehicles. Copper use in other vehicles and vehicle sectors, and in the aftermarket is likely to differ significantly from that reported here for the top selling new vehicles. Within a region or watershed, variations in fleet mix and vehicle use patterns also contribute to differences in copper content and amounts of wear debris released to the environment. It is important to note that not all of the copper in friction materials is released to the environment. Friction material ingredients can wear out of a pad or lining at different rates, and brake pads and linings are normally replaced with a considerable amount of the friction material still intact.
- **Actual copper content.** The data are based on manufacturers' reporting of the actual copper content of their products. These data are collected and made available by the BMC/PEC in a manner that protects manufacturers' confidential business information, including the copper content of friction materials on specific new vehicles and the name of the manufacturer that supplies the friction materials.
- **Actual vehicle sales data.** The data reflect actual sales for each model year.

[5] A list of the Top 20 vehicles for each model years 1998 to 2001 is included in Table 2, a list of the top selling vehicles sampled for model year 2002 is included in Table 3.

[6] A list of the Alternative 20 vehicles for model year 2000 is included in Table 4. Alternative 20 sample data were collected only for model year 2000.

- **Vehicle fleet mixes vary.** The data do not reflect regional variations in vehicle fleet mixes.

- **Aftermarket (replacement) brake pads and linings are not included.** The data are for "original equipment" friction materials only. "Original equipment" refers to parts that are installed on new vehicles. It does not include "aftermarket" or replacement parts. The BMC/PEC has stated that the copper content of aftermarket friction materials is small, but no public data are available to confirm that statement.

- **Heavy-duty trucks, off-road vehicles, and motorcycles are not included.** These data are for friction materials used in cars and light trucks. The data do not include friction materials used on heavy-duty trucks, off-road vehicles, or motorcycles. Manufacturers of these other friction material types are not currently participating in the Brake Pad Partnership.

Data Collection and Reporting Process

The Brake Manufacturers Council's Product Environmental Committee (BMC/PEC) consists of the majority of companies that manufacture original equipment friction materials for automotive vehicles manufactured in the United States, Canada, and Mexico for sale in the United States. The BMC/PEC has developed a process for collecting and reporting these data that produces accurate information while maintaining the confidentiality of its member companies' proprietary business information.

The data reported here represent the amount of copper and friction material used on samples of the most popular vehicles sold in the United States, by model year, comprising approximately 40% of the total U.S. sales of domestic automobiles.

Sample Selection

The samples selected for data collection were from the top best selling domestic cars and light trucks for each model year. All data on actual vehicle sales were obtained from the *Ward's Automotive Yearbook*s.[7] For model years 1998 to 2001, the top 20 best selling vehicles were selected comprising about 40% of the total vehicle sales for each year. The list of the Top 20 best selling vehicles for model years 1998 through 2001 and their sales volumes are shown in Table 2.

For model year 2002, data were not available for some of the top 20 best selling vehicles, and the sampling method was modified to include available data on the top 25 best selling vehicles to obtain a sample comprising approximately 40% of the total vehicle sales for the year. Table 3 lists the vehicles sampled for model year 2002. Those vehicles for which volumes are listed in the "processed" column are the ones for which copper use data were available. Those vehicles for which check marks appear in the "calculated" column are ones that may be purchased with a choice of different brake systems. The sample includes only those vehicles having disc brake systems.

[7] 1999 Ward's Automotive Yearbook, 61st Edition. Ward's Communications, Detroit. Pp. 246-248.
2000 Ward's Automotive Yearbook, 62nd Edition. Ward's Communications, Detroit. Pp. 244-246.
2001 Ward's Automotive Yearbook, 63rd Edition. Ward's Communications, Detroit. Pp. 249-251.
2002 Ward's Automotive Yearbook, 64th Edition. Ward's Communications, Detroit. Pp. 243-245.
2003 Ward's Automotive Yearbook, 65th Edition. Ward's Communications, Detroit. Pp. 234-236.

For model year 2000, an alternative sampling method was used in addition to the Top 20 sampling method to provide some insight on the representativeness in regard to copper use of the Top 20 sample relative to the total domestic vehicle sales. First, all vehicles with annual sales of more than 20,000 units were identified based on sales information provided in *Ward's Automotive Yearbooks*. The vehicles were listed in the same order as they appear in *Ward's*—*i.e.*, by segment (*e.g.*, small car, van, large pickup, etc.)[8]—and then by manufacturer and model within each segment. Next, starting with the first vehicle on the list, every eleventh vehicle was selected generating a list of more than 30 vehicles. Then all vehicles that also appeared on the Top 20 list were eliminated, along with two models for which data were not available because the models were not supplied by BMC/PEC companies. The result of this process was the Alternative Sample 20 list of vehicles that appears in Table 3. Table 3 also includes information on the sales volumes for the Top 20 and Alternative samples for the year 2000 for comparison purposes.

Data Collection

Each year, data are requested from each of the BMC/PEC member companies on the friction materials supplied for each of the vehicle makes and models on the list of top selling vehicles. Specifically, information is requested for the make and model to which the manufacturers supplied in January of the model year. For model year 2000, data were also requested for the vehicles on the Alternative sample list.

A copy of the information request form used is contained in Appendix B. The specific information requested of and reported by the manufacturers included:

- the weight of the friction material for one axle set (front and rear reported separately),
- the total copper by weight in the friction material for one axle set, and
- the percentage of the model production for which the data are applicable.

Data Aggregation

The BMC/PEC process for collecting and reporting these data is designed to provide high-quality, accurate information while maintaining the confidentiality of its member companies' proprietary business information. Several checks are built into the process. At least two individuals review and confirm the annual list of top selling vehicles. Data are entered into an electronic spreadsheet from the reporting forms submitted by the manufacturers, and then checked for accuracy by two other individuals. Once the data have been recorded and checked, the spreadsheet is locked so that it cannot be altered accidentally, and the original information is destroyed to protect the manufacturers' proprietary business information.

The data are analyzed using calculation formulas on the spreadsheet that are also locked to prevent accidental errors. Upon completion of the data analysis, it is checked by one other individual, and the entire spreadsheet is locked to prevent further changes.

The resultant aggregated data, combined with the actual annual sales volume numbers from *Ward's Automotive Reports*, contains information on the total friction material and copper use for the sample for each model year. These data are reported in Table 1.

[8] Appendix A contains definitions of the vehicle segments used by *Ward's Automotive Yearbook*.

TABLE 2. Top Selling Vehicles and Actual Sales for Model Years 1998 through 2001.[9]

Segment, Make and Model[10]	Actual Sales			
	1998	**1999**	**2000**	**2001**
Small Car	***5.1%***	***4.6%***	***7.1%***	***7.1%***
Chevrolet Cavalier	256,099	272,122	236,803	233,298
Ford Escort	291,936	260,486	--	--
Ford Focus	--	--	286,166	264,414
Saturn	--	--	177,355	162,110
Toyota Corolla	250,500	249,128	230,156	245,023
Honda Civic	--	--	306,748	311,314
Segment total	**798,535**	**781,736**	**1,237,228**	**1,216,159**
Middle Car	***11.3%***	***10.5%***	***8.2%***	***9.2%***
Chevrolet Malibu	223,703	218,540	207,376	176,583
Honda Civic	317,134	308,807	--	--
Pontiac Grand Am/Oldsmobile Alero[9]	180,428	234,936	214,923	291,348
Ford Taurus/Mercury Sable[10]	371,074	368,327	382,035	456,206
Honda Accord	370,984	316,339	317,483	350,090
Toyota Camry	295,108	320,156	298,123	303,436
Segment total	**1,758,431**	**1,767,105**	**1,419,940**	**1,577,663**
Sport Utility Vehicle (SUV)	***7.4%***	***7.4%***	***7.3%***	***5.2%***
Chevrolet Blazer	219,710	232,140	255,948	--
Ford Explorer/Mercury Mountaineer	479,083	478,003	491,704	461,495
Jeep Grand Cherokee	229,135	300,031	271,723	223,612
Ford Expedition/Lincoln Navigator	225,703	233,125	251,406	209,804
Segment total	**1,153,631**	**1,243,299**	**1,270,781**	**894,911**
Van/Small Pickup	***6.8%***	***6.3%***	***5.6%***	***5.8%***
Dodge Caravan/Plymouth Voyager/Chrysler Voyager	450,790	431,744	384,561	287,481
GMC Sonoma/S10	282,912	291,661	262,680	204,243
Ford Ranger/Mazda[11]	328,136	348,358	330,125	298,591
Ford Windstar/Mercury Voyager	--	--	--	201,641
Segment total	**1,061,838**	**1,071,763**	**977,366**	**991,956**
Large Pickup	***12.1%***	***12.2%***	***11.2%***	***12.4%***
Chevrolet Silverado/GMC Sierra	235,110	734,234	734,377	908,629
Chevrolet and GMC C/K	454,311	98,285	--	--
Dodge Ram	410,130	428,930	380,874	344,538
Ford F-series	787,552	806,579	820,248	865,152
Segment total	**1,887,103**	**2,068,028**	**1,935,499**	**2,118,319**
Total Top 20 vehicle sales	**6,659,538**	**6,931,931**	**6,810,814**	**6,799,008**
Percent of total vehicle sales	***42.8%***	***41.0%***	***39.3%***	***39.7%***
Total vehicle sales	**15,540,765**	**16,890,536**	**17,349,760**	**17,122,368**

[9] Starting 2001 includes Oldsmobile Alero.
[10] Starting 2001 includes Mercury Sable.
[11] Starting 2001 includes Mazda.

TABLE 3. Sample Selection for Model Year 2002

Segment/Vehicle	Volume		
	Selected[12]	Processed[13]	Calculated[14]
Small Cars:			
Honda Civic	283,173	283,173	
Chevrolet Cavalier	238,225	--	
Ford Focus	243,199	243,199	
Toyota Corolla	222,017	222,017	✓
Middle Cars:			
Toyota Camry	343,796	343,796	
Ford Taurus/Mercury Sable	431,688	431,688	
Honda Accord	330,692	330,692	
Pontiac Grand Am/Oldsmobile Alero	245,103	--	
Chevrolet Impala	198,918	--	
Nissan Altima	201,822	201,822	✓
Chevrolet Malibu	169,377	--	
CUVs:			
PT Cruiser/Dodge Neon/Plymouth Neon	264,817	264,817	
SUVs:			
Large GMC SUV's (e.g. Tahoe/Suburban)	540,981	540,981	
Ford Explorer/Mercury Mountaineer	481,991	481,991	
Chevrolet TrailBlazer/Oldsmobile Bravada/GMC Envoy	374,625	374,625	
Jeep Grand Cherokee	224,233	224,233	
Ford Escape/Mazda Tribute	190,460	--	
Ford Expedition/Lincoln Navigator	194,067	194,067	✓
Van/Small Pickup:			
DC Minivans (e.g. Caravan/Voyager/Town & County)	408,681	408,681	✓
Ford Ranger/Mazda Pickup	246,359	246,359	
Chevrolet S10/GMC Sonoma	192,092	192,092	
Ford Windstar/Mercury Villager	165,317	165,317	✓
Large Pickup:			
Chevrolet Silverado/GMC Sierra	847,894	847,894	
Ford F-Series	774,037	774,037	
Dodge Ram Pickup	396,934	396,934	✓
Total Volume of Sample:	***8,210,498***	***7,168,415***	***6,633,977***
Total 2002 Volume:	***16,816,368***	***16,816,368***	***16,816,368***
Percentage:	***49%***	***43%***	***39%***

[12] Includes all of the top 25 best selling vehicles for model year 2002.
[13] Includes the top 25 best selling vehicles for which copper use data are available for model year 2002.
[14] Indicates vehicles available with different brake systems. Includes only vehicles having disc brake systems.

TABLE 4. Top 20 and Alternative 20 Vehicles and Actual Sales for Model Year 2000.[15]

	Top 20 Sample		Alternative 20 Sample	
Vehicle Segment[9]	**Make and Model**	**Actual Sales**	**Make and Model**	**Actual Sales**
Small Car		***7.1%***		***1.32%***
	Chevrolet Cavalier	236,803	Dodge Neon	113,381
	Ford Focus	286,166	Mazda Protégé	62,851
	Saturn	177,355	Chevrolet Prizm	52,116
	Toyota Corolla	230,156		
	Honda Civic	306,748		
Segment total		**1,237,228**		**228,348**
Middle Car		***8.2%***		***1.05%***
	Chevrolet Malibu	207,376	Nissan Maxima	--[16]
	Pontiac Grand Am	214,923	Oldsmobile Intrigue	64,109
	Ford Taurus	382,035	Mazda 626	71,046
	Honda Accord	317,483	Chevrolet Lumina	46,573
	Toyota Camry	298,123		
Segment total		**1,419,940**		**181,728**
Luxury/Large Car		***0%***		***1.63%***
			Ford Crown Victoria	92,047
			Chrysler Concorde	50,206
			Lincoln LS	51,039
			Buick Park Avenue	47,669
			Lexus ES300	41,320
Segment total		**0**		**282,281**
Sport Utility Vehicle (SUV)		***7.3%***		***1.97%***
	Chevrolet Blazer	255,948	Jeep Cherokee	141,457
	Ford Explorer/Mercury Mountaineer	491,704	Toyota 4Runner	111,797
	Jeep Grand Cherokee	271,723	Nissan Xterra	88,578
	Ford Expedition/Lincoln Navigator	251,406		
Segment total		**1,270,781**		**341,832**
Van/Small Pickup		***5.6%***		***1.89%***
	Dodge Caravan/Plymouth Voyager/Chrysler Voyager	384,561	Nissan Frontier	--[11]
	GMC Sonoma/S10	262,680	Toyota Sienna	103,137
	Ford Ranger	330,125	Chevrolet Venture	97,450
			Honda Odyssey	126,686
Segment total		**977,366**		**327,273**
Large Pickup		***11.1%***		***0.58%***
	Chevrolet Silverado/GMC Sierra	734,587	Toyota Tundra	100,445
	Dodge Ram	380,874		
	Ford F-series	819,686		
Segment total		**1,935,147**		**100,445**
Total vehicle sales for each sample		**6,840,462**		**1,461,907**
Percent of total vehicle sales		***39.4%***		***8.4%***

[15] 2001 Ward's Automotive Yearbook, 63rd Edition. Ward's Communications, Detroit. Pp. 249-251.
[16] Model year 2000 copper content data are not available for the Nissan Maxima and Frontier.

APPENDIX A

Vehicle Segment Definitions Used in *Ward's Automotive Yearbook*

Segment	Typical Price range	Typical Length
Small Cars		
Lower Small Car	$11,500 and under	Under 175 inches
Upper Small Car	$11,501 to $17,999	Under 180 inches
Small Specialty Car	Under $18,000	Under 180 inches
Middle Cars		
Lower Middle Car	$14,500 to $18,499	180 to 190 inches
Upper Middle Car	$18,500 to $24,999	180 to 190 inches
Middle Specialty Car	$14,500 to $24,900	180 to 199 inches
Large Cars		
Large Car	Under $25,000	Over 200 inches
Luxury Cars		
Lower Luxury Car	$25,000 to $32,999	-
Middle Luxury Car	$33,000 to $43,999	-
Upper Luxury Car	$44,000 plus	-
Luxury Specialty Car	$25,000 plus	-
Luxury Sport Car	$25,000 plus	-
Cross Utility Vehicles (CUV)		
Small CUV	Under $20,000	Under 180 inches
Medium CUV	$20,000 to $30,000	180 to 190 inches
Large CUV	$30,000 plus	Over 190 inches
Sport Utility Vehicles (SUV)		
Small SUV	Under $20,000	Under 170 inches
Middle SUV	Under $30,000	170 to 192 inches
Middle Luxury SUV	$30,000 plus	170 to 192 inches
Large SUV	Under $40,000	Over 192 inches
Large Luxury SUV	$40,000 plus	Over 192 inches
Vans		
Small Van	Under $26,000	Under 210 inches
Large Van	Under $26,000	210 inches plus
Luxury Van	$26,000 plus	-
Pickup Trucks		
Small Pickups	$14,000 and under	Under 200 inches
Large Pickups	Above $14,000	200 inches plus

APPENDIX B

Sample Information Request Form

Product Environmental Committee
Friction Material Monitoring

CONFIDENTIAL

This information is for the exclusive use of the Brake Manufacturers Council

Directions: 1. Identify brake manufacturer, e.g., Delphi.
2. Check the model year(s) applicable to the data.
3.List the make and model. (Example: Ford Ranger)
4.Report the axle set weights in gms.
Friction material weight is without steel, etc.
Copper content is for the axle set *[See instructions]*.
2. Please fill in *all* blanks (use NA for "not applicable").
3. Return by fax, mail, or e-mail.

Manufacturer: _____

Model year (s): 02 03

Make & Model: _____

Front axle: ***Friction*** _____ **gms.** ***Copper*** _____ **gms. {Note 1}**

Percentage of model _____ **Example: May be different materials with or without ABS**

Rear axle: ***Friction*** _____ **gms.** ***Copper*** _____ **gms. {Note 1}**

Percentage of model _____

***PERCENTAGE OF MODEL MUST BE FILLED IN FOR FRONT AND/OR REAR AXLES!**

Note 1. The copper level in storm water is determined by atomic adsorption on unfiltered storm water. The water sample is treated with nitric acid to digest all forms of copper.

Factors for calculating net copper content in various copper containing additives are:

- Brass: Typical copper content is 70.0 wt%, but may vary with the type of brass.
- Copper oxide (Cu_2O): 88.8 wt% copper
- Copper oxide (CuO): 79.9 wt% copper
- Copper sulfide (Cu_2S): 79.9 wt% copper
- Copper sulfide (CuS): 66.5 wt% copper

REPORT THE NET %

(Same process as used for 2000 and 2001)

Return to: Brake Council Project Administrator
10 Laboratory Drive
Research Triangle Park, NC 27709-3966

FAX: 919-406-1306

E-mail: pbecoat@mema.org