

The Regulation and Manufacture of Brake Pads: The Feasibility of Reformulation to Reduce the Copper Load to the San Francisco Bay

Catherine C. Engberg

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1. BACKGROUND

1.1 Water Quality Criteria

The San Francisco Bay recurrently fails to meet water quality objectives for copper, lead, and other heavy metals. Due to the adverse water quality impacts related to high concentrations of copper and other metals, the U.S. Environmental Protection Agency (US EPA) has designated the southern reach of the San Francisco Bay (south of the Dumbarton Bridge) an impaired water body under Section 304 (l) of the Clean Water Act.

Local and regional agencies are reducing copper mass loads to the South San Francisco Bay in accordance with Cease and Desist Orders (CDO) issued by the San Francisco Regional Water Quality Control Board. The Regional Water Quality Control Board Basin Plan requires that the amount of copper discharged into the Bay be reduced by 57,000 lbs/yr. This reduction will come from riverine, sanitary sewer, and stormwater sources.

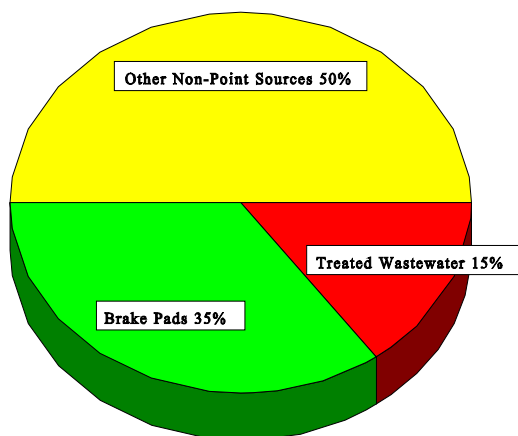
Storm drain discharges from Santa Clara County to the Bay contain more than five times the amount of copper discharged by the three sewage treatment plants (POTWs) in the South Bay. The POTWs have focused some attention on reducing sources of heavy metals to stormwater because they feel they can achieve greater reductions by preventing pollution from large non-point sources of copper.

1.2 Source Identification

The Santa Clara Valley Nonpoint Source Pollution Control Program has identified vehicle brake pads as a major contributor of copper in stormwater. A significant fraction of brake pads currently in use contain copper. When disc brakes are applied to a moving vehicle, a portion of the pad rubs off in the form of dust and enters the environment. The copper-containing dust can enter the Bay via either stormwater or airborne particle deposition. The fate of copper in disc brake pads is described schematically in Appendix 1. It has been estimated that approximately one half of the copper in brake pads eventually reaches the Bay (Santa Clara Valley NPS Program, 1994). The second half reaches other destinations in the environment and on the car.

In order to determine the contribution of brake pads to copper loading to the San Francisco Bay, the Santa Clara Valley Nonpoint Source Pollution Control Program performed a study which was published a study in February 1994 entitled the *Contribution of Heavy Metals to Storm Water from Automotive Disc Brake Pad Wear*. The purpose of the study was to determine the copper content of brake pads and to model the stormwater load from these results. Its authors were unable to obtain information on brake pad composition and wear rates voluntarily from automobile and brake pad manufacturers. Instead, they conducted laboratory tests to analyze disc brake composition. From the results of stormwater load models, the Program estimated that dust from disc brake pad wear contributes over 40 percent of the non-point source copper loading to the Bay, or approximately 35 percent of the total copper load. Figure 1 shows the contribution of brake pads to the total copper load to the Bay. Brake pads are the largest single source of copper discharge to the Bay that has been identified thus far.

Figure 1: South Bay Copper Sources



2. RESEARCH GOALS

The Santa Clara Valley study served as a basis for the Palo Alto Regional Water Quality Control Plant's (RWQCP) research on the manufacture and regulation of brake pads. As part of an internship with the RWQCP, I researched the players involved and the regulatory and economic forces at work in determining brake pad formulation. Ultimately, the RWQCP plans to work cooperatively with regulators and manufacturers to conduct a pollution prevention program which would lead to a reduction in the copper content of brake pads.

I contacted a number of companies within the brake pad industry including manufacturers and trade associations to understand which group is responsible for determining brake pad formulation. This group would be targeted for discussions regarding brake pad reformulation. Secondly, I wanted to request brake pad composition information from manufacturers not previously contacted in the Santa Clara Valley Study. A final goal of these contacts was to understand the properties of copper in brake pads and the available alternatives. The RWQCP wanted to learn if there were any safety or performance tradeoffs associated with reducing the copper content of brake pads.

Government agencies were contacted to determine which agencies have the authority to request composition information from manufacturers and to regulate brake pad formulation. Specifically, the RWQCP wanted to learn how transportation agencies regulate brake pads for safety, performance, and composition. Environmental agencies were also contacted regarding their data collection and regulatory authority on brake pad composition for the protection of human health and the environment.

The information acquired by this research will help agencies determine what approach would be most effective to influence manufacturers to reduce the copper content of brake pads.

3. BRAKE PAD FORMULATION AND MECHANICS

In order to understand why brake pads are a problem for the San Francisco Bay, it is necessary to understand how they work and which materials are used in brake pad formulation.

3.1 Types of Brakes

Automobiles use either drum brakes, disc brakes or a combination of the two. In drum brakes, two semicircular brake pads (also called brake shoes) are located inside a drum. When the brakes are applied, the brake shoes are forced outward and press against the drum. The drum, shaped like a covered cylinder, “catches” much of the brake pad dust that is worn during braking.

Disc brakes consist of two brake pads located on either side of a rotor. When the brakes are applied, the two pads squeeze against the rotor. Disc brakes are more exposed to the environment than drum brakes. Dust generated by disc brakes that does not temporarily affix to the car falls to the road or becomes suspended in the air.

Disc brakes tend to have better braking performance than drum brakes. Most cars today use disc front - drum rear braking systems. Some vehicles use disc brakes on all four wheels while few, if any, use only drum brakes. This report is primarily concerned with disc brakes because they are more common in newer vehicles and pose a greater risk to water quality than drum brakes.

3.2 Brake Materials

Brake materials generally fall into the category of organics or semi-metallics. Other categories have also been cited such as metallic (Toboldt et al, 1989) and low-metallic (Delgado, 1994) but these may be variations on the semi-metallic pad.¹ However, all auto repair shops and parts stores contacted offered only organic or semi-metallic brake pads (Johnson, Mountain View Auto Parts, Sherba's Auto Stores, Walden, 1995).

The different formulations have varying wear rates, braking properties, and noise levels. Semi-metallic brake pads are visibly different from organics. Semi-metallic pads are a darker color with visible metallic fibers and have a rough texture. Organic pads are a lighter shade of gray and have a smoother texture.

¹ Delgado's contact to Dr. David Patten of Prattville Manufacturing Inc., indicates that semi-metallic formulations are predominantly iron and steel while other metals (such as copper) are substituted for iron in low-metallic formulations.

Organic formulations often contain polymers such as kevlar, resins, and sometimes asbestos fibers. Organic brake pads may also contain copper. In the past, asbestos was used extensively in organic formulations before it was discovered that breathing dust containing asbestos fibers can cause serious bodily harm (Toboldt, 1989). Today, although use of asbestos is still legal, manufacturers are generally moving towards non-asbestos organic formulations for safety reasons (Dougherty, 1995).

Semi-metallic generally refers to the presence of iron and steel in the formulation (Delgado, 1994). Semi-metallic brake pads are composed of finely powdered iron or copper, graphite, and lesser amounts of inorganic fillers and friction modifiers (Toboldt, 1989). Manufacturers have voluntarily phased out lead in brake pad formulations to protect human health (Dougherty, 1995).

From the results of this research on brake pad materials it cannot be concluded whether organic or semi-metallic brake pads contain more copper. Both organic and semi-metallic may contain copper although specific amounts will depend on the manufacturer.

3.3 Performance Characteristics

Brake pads are designed for friction stability, durability, and minimization of noise and vibration. “Friction stability” means that the brake pad’s friction coefficient remains high under hot, cold, wet and dry conditions at various braking speeds. Automotive engineers use a variety of materials to maximize performance in all areas, often combining five to twenty different material ingredients to form complex composite friction materials (Rhee et al., 1990).

Metals, such as copper, tend to be good friction materials because they are good at dissipating heat generated during braking. Metallic formulations generally have high “hot” friction coefficients making them perform well under extreme braking conditions (Dougherty, 1995). Larger cars and cars that need to stop quickly generally require semi-metallic pads while organic pads are fine for light and medium weight vehicles (Walden, 1995). Asbestos is a highly versatile friction material, providing consistent braking performance at a variety of speeds and weather conditions. Researchers are constantly testing new materials for braking performance, often in response potential upcoming regulations. The technical literature suggests that polymer friction materials have been developed as alternatives to asbestos and metals in organic brake pads (Yamaguchi, 1991).

The effect of metals on durability and noise characteristics is unclear at this point. Some automobile technicians indicated that semi-metallic pads are more durable than organics allowing longer replacement intervals (Walden, 1995). However, it was also noted that driving style is generally more important than brake pad formulation in determining the frequency of replacement (Johnson, 1995). Some varieties of organic pads may tend to squeal more than semi-metallic pads (*ibid*).

The Santa Clara Valley study found that copper is used less, if used at all, in the brake pads used in domestic cars than in Japanese and European vehicles. Copper is used more extensively in brake pads in European and Japanese vehicles (Dougherty, 1995). There are many possible explanations for the lower copper content in domestic vehicles including cost and driving conditions. The use of copper in domestic brake pad formulations is limited by cost since copper is more expensive than organic materials (*ibid*). Another

possible explanation is driving style; lower metal formulations may be more appropriate for American drivers who brake slowly and steadily rather than European drivers who tend to brake more quickly (*ibid*).

The results of the Santa Clara Valley study also indicate that zero or low-copper formulations are used in many in light and medium weight vehicles. The study did not indicate whether the brake pads tested were semi-metallic or organic formulations since either type may contain copper. Since their study did not focus on performance characteristics of the brake pads, it is not possible to draw conclusions on the durability or noise characteristics of the different models tested.

3.4 Safety Considerations

It is possible to draw conclusions on safety and friction stability based on the results of the study. As will be discussed in Section 5, federal regulations relating to brake pads are safety performance-based, using friction stability as a criteria. It is therefore possible to conclude that zero and low-copper brake pad formulations perform well enough on the basis of friction stability to pass federal safety standards.

Because zero-copper products are currently used safely and in accordance with federal vehicle safety standards, it appears that the presence of copper is not necessary for brake pads to function safely. Therefore, it should be technically feasible to reduce or eliminate the presence of copper in brake pads in most types of vehicles. Manufacturers, particularly those involved in the development of friction materials, are probably knowledgeable about the correlation between the presence of copper and brake pad performance. Although I was unable to obtain technical information during this study, it is likely that friction material, brake pad, and vehicle manufacturers could provide specific information concerning the safety of low and zero-copper brake pads.

3.5 Replacement Brake Pads

Brake pads must be replaced every 10,000 to 50,000 miles depending on the type of pad and driving terrain. The car owner can replace the pads with either original manufacturer equipment (OEM) or after-market (replacement) pads.

Automobile manufacturers recommend that owners purchase OEM pads from the dealer. These pads will be designed for the specific model and year of car. The OEM pad will not have exactly the same composition as the original because brake pads are composite materials and different batches will vary slightly in their chemical composition.

Replacement and OEM brake pads are usually manufactured by the same friction material/brake pad manufacturer. Replacement pads are labeled with the name of the brake pad manufacturer while OEM pads are labeled with the automobile manufacturer. With replacement pads, the car owner has the option to install semi-metallic or organic pads. Organic replacement pads are often less expensive but may also be less durable than semi-metallics. The auto parts store or repair shop will usually recommend a size and formulation of brake pad for the specific vehicle.

The two replacement pads tested in the Santa Clara Valley study contain low amounts of copper. It is

unclear whether these two pads are representative of replacement pad composition.

4. THE BRAKE PAD INDUSTRY

I contacted automobile, friction material, and brake pad manufacturers to better understand the organization of the industry and to obtain information about brake pad composition. The RWQCP wanted to determine which group of manufacturers is responsible for determining brake pad formulation. A second goal of these contacts was to confirm the Santa Clara Valley Study's findings that manufacturers are unwilling to provide information on brake pad composition to local governments. Automobile trade associations were also contacted regarding their role in setting standards for brake pads.

4.1 Manufacturers

The brake pad industry consists of friction material, brake pad, and automobile manufacturers. These industry groups are closely linked and appear to work together to develop new materials. Friction material manufacturers produce the composite materials used in brake pads. Brake pad manufacturers shape the composite material into individual pads and attach them to disc brake shoes. Oftentimes, the same company manufactures both friction materials and brake pads.

Appendix 2 includes a list of brake pad manufacturers that have registered their products with the American Manufacturers Equipment Compliance Agency (AMECA), a trade association that will be further discussed in Section 4.2. Some of the larger companies such as ABEX, Bendix, and Allied Signal (recently merged as Bendix-Allied Signal) are also friction material manufacturers. Larger companies may also have more than one line of brake pads. There may be other brake pad manufacturers that have not registered their products with AMECA but this is the most complete list of friction material and brake pad manufacturers obtained to date.

As part of their study, the Santa Clara Valley Program contacted several automobile manufacturers as well as two of the largest friction material/brake pad manufacturers requesting information on the composition of their brake pads. The following automobile companies were contacted as part of the manufacturers survey: Chrysler, Ford, General Motors, Honda, Mercedes Benz, Nissan, Toyota, and Volkswagen. ABEX and Bendix-Allied Signal were also contacted. In all but one case, specific information on the composition of brake pads was either unknown or could not be disclosed for legal reasons. The one exception was Mercedes Benz which provided a range of 12 to 22% copper for their brake pads. I was advised that further attempts to contact automobile manufacturers would probably yield no further data (Armstrong, 1994).

As a follow-up attempt to obtain composition information, Uribe & Associates, environmental consultants, contacted Prattville Manufacturing Inc. (PMI), a friction material/brake pad manufacturer (Delgado, 1994). PMI was not willing to divulge composition information. Raylock Corp., a brake pad manufacturer, was also contacted with similar results (Harms, 1995).

Automobile manufacturers usually purchase brake pads from one of several large companies that manufacture both friction materials and brake pads. Dr. David Patten of Prattville Manufacturing Inc.

estimated that there are approximately six or seven friction material/brake pad manufacturers that supply brake pads to automobile manufacturers (Delgado, 1994). These pads are either installed in the automobile or are packaged as OEM replacement pads. In the past, automobile manufacturers have set the trend for materials used in brake pad formulations. Dr. Patten stated that asbestos was not phased out of brake pads until automakers insisted that they would not use asbestos materials on their products (*ibid*).

Friction material manufacturers may have little input on the copper content of OEM specification brake pads since they are under contract with the automobile manufacturers (Armstrong, 1994). However, they probably have greater control over the formulation of replacement pads which are not under contract with automobile manufacturers. Friction material and automobile manufacturers appear to be leaders in the research and development of brake pad formulations (Rhee, 1990; Wycliffe, 1993; Yamaguchi, 1991). Brake pad manufacturers may be involved to a lesser extent in research efforts.²

The results of this research indicate that the automobile manufacturers may have the most leverage in determining the copper content of OEM brake pads. Friction material and, to a lesser extent, brake pad manufacturers may have the greatest influence in determining the copper content of after-market pads.

4.2 Trade Associations

I contacted trade associations to determine whether they use performance or composition-based criteria to set brake pad standards. The RWQCP was also interested to learn whether the associations make recommendations on composition based on environmental criteria.

I identified two associations that set standards for brake pads: the Society of Automotive Engineers (SAE) Brake Forum and the Automotive Manufacturers Equipment and Compliance Agency (AMECA). The Association for Standard Test Methods (ASTM) and the American Automobile Manufacturing Association (AAMA) were also contacted but do not set standards for brake pads (Barr, 1995 and Edmunds, 1995).

The SAE Brake Forum represents companies involved in the research, development and manufacture of brake pads. SAE publishes recommended procedures to find specific gravity and friction coefficients of friction materials in the SAE Handbook. The SAE Brake Forum does not collect any information on product composition from industry members. However, SAE may make recommendations to industry members based on upcoming regulations or concerns about worker health. For example, SAE concerns itself with materials regulated by OSHA which may represent a worker safety hazard. The brake pad industry has voluntarily limited the use of phosphate fibers, asbestos, and lead because these materials represent a health hazard to workers who manufacture friction materials (Dougherty, 1995).

² Companies that only manufacture brake pads, purchasing friction materials from other companies, may not be directly involved in the development of new formulations but may instead use the same research arms as the friction material manufacturer. For example, Brake Parts, Inc., a brake pad manufacturer, purchases materials from and uses the same research organization as PMI, a friction material/brake pad manufacturer (Delgado, 1994).

AMECA is a private association of state transportation administrators and industry members, recently separated from the American Association of Motor Vehicles Agency. States have the option of creating state-specific brake pad performance standards or of adopting federal standards. AMECA has developed the Vehicle Equipment Safety Standard V-3 which provides state administrators with equipment approval guidelines for brake pads by setting minimum coefficient of friction requirements and uniform test procedures (AMECA, 1982). Eight states, not including California, have adopted AMECA standards.

AMECA also registers brake pads with its coding system. All registered brake pads are stamped with a code on back of the brake shoe. For example, the back of a brake shoe may read AK NS 123 EE, specifying the manufacturer (Akebono Brake Industry), the formulation code, and the normal and hot friction coefficient code letters (EE). For a fee, AMECA can provide a list of all registered brake pads and their registration codes (Walton 1995). A partial list of these codes is attached as Appendix 3.

4.3 Summary of Findings

Automobile manufacturers and the large companies that manufacture both friction materials and brake pads should be contacted regarding reformulating brake pads to reduce their copper content.

Some trade associations set standards for brake pad performance but none set standards based on composition. Nevertheless, trade associations should be included in discussions of reformulation. SAE would be an important player in discussions of regarding brake pad composition because it is closely linked with research and development efforts of brake pad formulations. AAMA may not be involved in brake pad formulation or manufacture but it represents automobile manufacturers who decide which formulations to use. AMECA registration codes may be useful in tracking formulations.

5. GOVERNMENT AGENCY REGULATORY AUTHORITY AND VOLUNTARY PROGRAMS

I investigated the regulatory and data collection authority of federal and state agencies over brake pads. Specifically, I researched whether any transportation agency sets standards for brake pad composition in addition to setting standards for braking safety and performance. I also contacted environmental agencies regarding their authority to regulate brake pad composition to protect human health and the environment.

I found that the only agencies which may have authority to collect information on brake pad composition are the U.S. Environmental Protection Agency (US EPA) and possibly the California State Water Resources Control Board (State Water Board, part of Cal EPA). Both US EPA and the State Water Board may also have authority to regulate brake pad composition. The Occupational Safety and Health Administration has authority to collect product composition information but its authority is limited by its powers of enforcement. I found that transportation agencies do not have the authority to regulate brake pad composition.

I believe there is potential for a voluntary approach to brake pad reformulation by creating partnerships between government agencies and brake pad/vehicle manufacturers. Both the US EPA and Cal EPA have programs to facilitate the formation of voluntary partnerships between government and industry groups.

5.1 Regulation of Braking Safety

Federal and state transportation agencies set and enforce standards for vehicle braking systems based on braking performance. Neither agency sets standards based on brake pad composition. For example, their standards specify the maximum stopping distance for passenger vehicles traveling at a certain speed.

By setting braking standards based on performance, transportation agencies regulate brake pads only indirectly. The brake pads installed in a new car must stop the car in accordance with the braking standards. However, no regulation applies directly to the brake pads themselves. Once the brake pads are replaced, the safety standards no longer apply. This means that the safety standards do not apply to replacement pads.

The federal agency responsible for vehicle safety is the National Highway Traffic Safety Administration (NHTSA) within the Department of Transportation. Each state has a transportation agency to enforce highway safety standards. The responsible agency for the State of California is the California Highway Patrol (CHP).

National Highway Traffic Safety Administration (NHTSA)

NHTSA regulates braking safety by the Federal Motor Vehicle Safety Standards (FMVSS). FMVSS No. 105 specifies braking performance for braking materials in new passenger vehicles. The standards apply only to new vehicles installed with original equipment manufacturer (OEM) brake pads (Carter, 1995).

NHTSA standards do not apply to after-market (i.e. replacement) brake pads. Transportation agencies do not regulate replacement brake pads despite estimates by the Society of Automotive Engineers that replacement pads outnumber original equipment pads in cars five to one (Dougherty, 1995).

NHTSA recently issued a rule intended to “harmonize” the differences in automotive brake system standards between the United States and other countries that have already adopted a universal safety standard (*Federal Register*, 1995). The new standards (FMVSS No. 135), which go into effect September 1, 2000, amend a number of items including the definitions, testing procedures, and stopping distance requirements. There was some concern that a “harmonized” standard would implicitly drive the American automotive parts industry towards increasing the metal content of brake pads to be comparable to those of foreign automakers. Richard Carter at NHTSA stated that the new rule should not either directly or implicitly drive the automotive parts industry towards increasing the metal content of brake pads (Cook, 1994).

California Highway Patrol (CHP)

States may set their own standards for brake materials or may adopt federal standards (Droneburg, 1995). The State of California does not set its own standards for brake pad composition or performance (CHP, 1995). The CHP follows the performance-based Federal Motor Vehicle Safety Standards.

5.2 Regulation of Brake Pads to Protect Human Health and the Environment

The Palo Alto RWQCP have not identified any federal agency or department within Cal EPA that has obtained information about or regulated brake pad composition in order to protect water quality. However, in recent past cases, several agencies have collected product composition information for products that pose a risk to human health. It is not certain whether this authority would apply when the product poses a threat to environmental quality and only indirectly to human health. In a case such as brake pads (for which human health is not of primary concern) it could be difficult to make a case under the current environmental regulatory framework.

The federal environmental agencies contacted include the U.S. Environmental Protection Agency (US EPA) and the Occupational Safety and Health Administration (OSHA). The Federal Highway Administration (FHWA) was also contacted. While the FHWA has no specific authorities relating to brake pads, it has identified brake pads as a source of copper and has performed extensive studies on the relationship of highway-related sources and water pollution (FHWA, 1987, 1987, 1987, 1988, 1990).

Several departments within the California Environmental Protection Agency (Cal EPA) were also contacted including the San Francisco Bay Regional Water Quality Control Board (RWQCB), Air Resources Board, and Department of Toxic Substances Control.

US Environmental Protection Agency (US EPA)

The US EPA has used its authority under the Toxic Substances Control Act (TSCA) to collect product composition information in order to protect human health. This authority was used specifically to regulate asbestos in brake pads under TSCA Section 6 (*Federal Register*, 1989). Following twelve years of research, US EPA's 1989 final ruling called for a ban of all asbestos brake friction material in original equipment manufacturer and after-market brake pads for light and medium weight vehicles. The rule was reversed by a court order before the 1993 phaseout date was reached.

Paul Susstone, at EPA's Office of Pollution Prevention and Toxics, said that the basis of the reversal was that EPA had not evaluated industry's alternatives before issuing the phaseout rule (Susstone, January 1995).

EPA did not contest the reversal because industry had already switched to non-asbestos materials.

Presently, few brake material formulations contain asbestos because OSHA requirements make it costly to manufacture materials containing asbestos.

TSCA appears to provide EPA with the authority to obtain composition information and to regulate specific chemical components of products. In the past, TSCA has been used primarily to protect human health and I have received several opinions from the US EPA regarding the applicability of TSCA to the protection of surface waters and the environment. Mr. Susstone said he did not believe TSCA applied to the protection of surface waters (Susstone, March 1995). However, in a meeting at the US EPA's Region IX office, Amy Zimpfer of the Office of Pollution Prevention, stated that she believes TSCA would grant the US EPA the authority to collect information on the chemical composition of brake pads and may also apply to their regulation (Zimpfer, 1995). The City of Palo Alto is researching TSCA's data collection and regulatory provisions.

EPA coordinates voluntary partnerships with companies to prevent pollution in a number of different industry sectors. For example, EPA's Green Lights program promotes switching to energy efficient lighting at a significant savings in energy costs to companies. EPA's 33/50 program encourages companies to reduce their hazardous waste generation by publicizing companies that are 33/50 partners. The RWQCP believes that voluntary reductions in the copper content of brake pads may be achieved by a voluntary partnership with vehicle/brake pad manufacturers. By reformulating brake pads to contain less copper, manufacturers can save on the cost of raw materials and can enhance their images as an environmentally responsible companies.

Occupational Safety and Health Administration (OSHA)

Copper is regulated by both Federal OSHA and Cal OSHA (Clanerman, 1995). The maximum permissible exposure limit (PEL) for copper dust 1 milligram/cubic meter. This standard would apply to all grinding activities in brake pad manufacture or servicing. The PEL for copper fumes is 0.1 mg/m³ which would apply to welding activities in brake pad manufacture. The health effects associated with breathing copper particles is that it disrupts the body's normal enzymatic activity.

OSHA collects product composition information via material safety data sheets (MSDSs). Manufacturers are required to submit MSDSs for all hazardous substances contained in the product. There is no set format for MSDSs and manufacturers are not required to submit percentage by weight information.

The maximum airborne PEL for copper is not ordinarily exceeded during proper brake pad use and

servicing. Auto repair shops are required to use the OSHA “wet method” to replace brake pads. Under this method, dust is washed into a catch container limiting worker exposure to airborne dust particles. Auto repair shops that do not follow OSHA requirements may use air guns to remove the dust that builds up around disc and drum brakes. The air gun method may cause worker exposure above the PEL when servicing semi-metallic brake pads.

OSHA’s collection authority appears limited by the discretion product manufacturers can exercise when reporting hazardous substances on MSDS forms. Brake pad manufacturers do not report percentage by weight of copper since it is in their best interest to retain this information as a trade secret.

California Environmental Protection Agency (Cal EPA)

Cal EPA is comprised of an Administrator’s Office and several agencies and departments including the ones contacted below. Cal EPA Administrator’s Office has been leading several public/private partnership efforts, such as the Environmental Technology Certification program. Under this program, companies that manufacture pollution preventing technologies receive recognition and certification that their equipment prevents pollution from Cal EPA.

State Water Resources Control Board

The State Water Resources Control Board has offices in each region of California. I contacted the San Francisco Regional Water Quality Control Board (RWQCB) which is responsible for the San Francisco Bay.

It is not clear whether the State Water Resources Control Board has the authority to request technical reports from brake pad manufacturers (Moghbel, 1994). Section 13267 of the Water Code allows the State Water Board to request technical reports from dischargers, which may or may not apply to brake pad manufacturers as indirect dischargers. The San Francisco RWQCB indicated plans to ask friction material and brake pad manufacturers for chemical composition information under their authority to evaluate discharge sources (Moghbel, 1994).

California Air Resources Board (ARB)

ARB regulates chemicals which have been identified as toxic air contaminants (TACs). ARB has authority to collect product composition information for products which contain these TACs. The airborne levels of copper dust generated during brake pad wear have not been identified as a threat to human health. ARB would probably not have authority to collect product composition information or to regulate copper in brake pads (Popejoy, 1995).

Department of Toxic Substances Control (DTSC)

Mike Shepard, a DTSC attorney, stated that DTSC does not have authority to collect product composition information or to require companies to change the chemical composition of their product or manufacturing process (Shepard, 1995). DTSC’s authority is derived from the Health and Safety Code and is related primarily to the transport, storage and disposal of hazardous waste. Under Section 25244.12 of the Health and Safety Code, DTSC can encourage companies to create economically efficient pollution prevention plans but the provisions do not require action on the part of the companies.

5.3 Summary of Findings

Preliminary research indicates that the US EPA (under TSCA) and the Cal EPA Water Board (under the Water Code) may have authority to collect composition information and to regulate the formulation of brake pads. Both US EPA and Cal EPA administer programs that encourage pollution prevention in voluntary public/private partnerships.

6. CONCLUSIONS

6.1 Evaluation of Research Goals

This section will evaluate the extent to which the findings met the research goals.

Safety and Performance Issues Related to Composition

I could not find any technical literature on the relationship between copper and the safety and performance of brake pads. The information acquired from manufacturers and auto shop technicians was often conflicting and perhaps too anecdotal to make any definitive conclusions on the safety and performance characteristics of different formulations. Overall, I learned that copper can appear in both organic and semi-metallic brake pads. None of the contacts knew or were willing to provide information on copper's relationship to durability, noise, and frictional coefficients.

It is unlikely that further independent research, without the assistance of manufacturers, will provide answers to questions of composition and performance. These questions are best directed to the automobile and friction material/brake pad manufacturers.

Composition Information Requests

The results of my contacts and those of the Santa Clara Valley indicate that no further information on composition can be attained by local government requests.

Organization of the Brake Pad Industry

Although I could not locate a complete list of friction material and brake pad manufacturers, AMECA provided a list of these companies which probably includes the majority of these companies. Some companies appear to have greater influence in determining brake pad formulations than others. Automakers usually specify formulations for OEM pads while friction material manufacturers have somewhat more autonomy in determining the formulation of after-market pads.

Trade Organizations

SAE and AAMA may be able to influence their members to favor certain formulations over others.

Government Authority and Voluntary Programs

Preliminary research indicates that the US EPA and the Cal EPA Water Board may have authority to collect composition information and to regulate the formulation of brake pads. Further research on the data collection and regulatory authority of these two agencies is currently being conducted. Both US EPA and Cal EPA administer programs that encourage pollution prevention in voluntary public/private partnerships.

6.2 Recommendations

This section will recommend actions steps and areas for further research.

Pursue a Dialogue with Manufacturers

Some technical questions cannot be answered with independent research and require the assistance and cooperation of manufacturers. Automobile and friction material manufacturers should be involved in discussions of the technical issues surrounding brake pad reformulation to reduce the copper content. These two industry groups appear to be the most knowledgeable about the relationship between chemical composition and safety and performance.

This dialogue should also include discussions of the feasibility of brake pad reformulation from an economic and environmental standpoint. Regulators must understand the alternatives to copper in brake pads and their impact on the environment. Manufacturers need to know the potential upcoming regulations that would affect brake pads.

Pursue a Voluntary Pollution Prevention Program

The results of this research suggest that a voluntary approach may be preferable to a regulatory one to achieve reductions in copper content of brake pads. It would probably take the government agencies several years to use their authority to collect product composition information and even longer to regulate brake pad composition. I recommend that government team with manufacturers to explore the possibility of a partnership agreement to achieve voluntary reductions in copper content.

A voluntary public/private partnership could mutually benefit manufacturers and the environment. Manufacturers benefit since copper is generally more expensive than its alternatives and because companies usually benefit from a positive environmental image. A reduction in the copper content of brake pads will help the San Francisco Bay, and other similarly affected water bodies, meet water quality objectives.

Determine Which Other Water Bodies are Affected by Copper from Brake Pads

Government agencies need to determine which other water bodies are adversely affected by copper and other metals from brake pads in order to better characterize the scope of the problem. The US EPA should have information on which water bodies are out of compliance for copper. The Federal Highway Administration may have access to information on water bodies that receive highway runoff of copper and other metals.

Update the Estimate of the Contribution of Brake Pads to the Copper Load to the Bay

A better estimate of the copper load from brake pads could be attained with composition and sales data for OEM and after-market brake pads. A large fraction of vehicles are installed with replacement brake pads but we do not know the respective fractions which are OEM or after-market pads. An updated load estimate would be helpful but would probably not change the conclusion that brake pads are the single largest contributor of copper to the San Francisco Bay.

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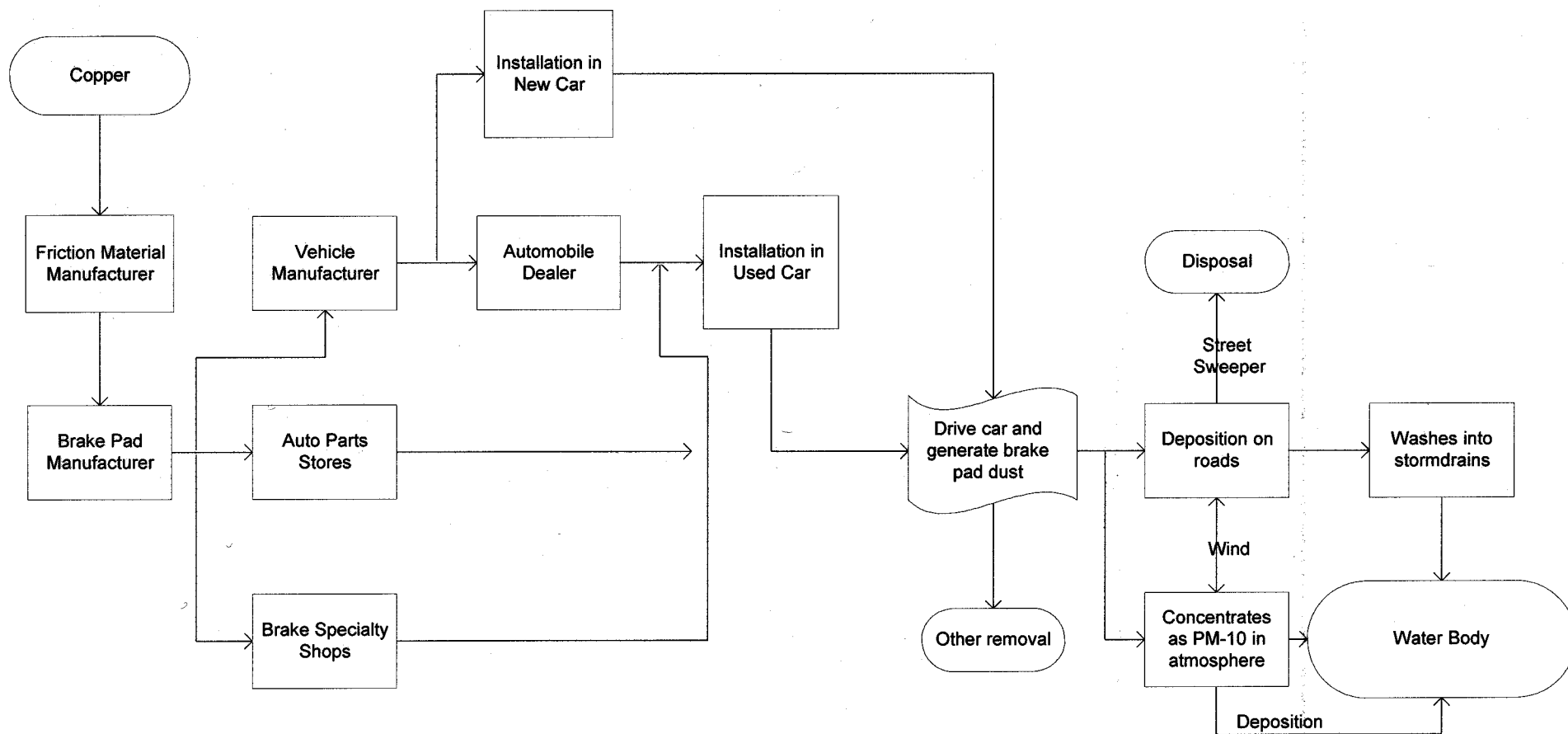
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**APPENDIX 1: THE FATE OF COPPER IN
BRAKE PADS**