



Siemens We Can Change The World Challenge

Dead Weight's Application Details

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• Step 1: Choose It!

Lead wheel weights are used to balance tires on vehicles with little thought about the metal used to make the weight. Lead is one of the top three hazardous waste materials listed by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) <<http://www.atsdr.cdc.gov/cxcx3.html>>. Lead adversely affects the environment and humans. The US EPA estimates that 10% of lead wheel weights fall off during normal driving conditions (U.S. Geological Survey. USA Today, August 28, 2008). They remain in the environment and are exposed to all types of environmental conditions. Lead compounds may then be distributed in the environment through run-off. The lead may also be brought into the garage on tires of vehicles and bicycles and into the house on shoes where lead dust can be ingested unknowingly by children or pets. In addition, citizens of our community who handle lead wheel weights have a higher chance of developing health problems.

We found an article about California phasing out the use of lead in wheel weights. We recommend using the California model as an example to help our community and state achieve the goal of phasing out the lead in wheel weights.

Everyone in our community will benefit from the phase out of lead wheel weights. Children will especially benefit from our efforts because exposure to lead detrimentally affects the development of the brain. Adults who work in tire service centers will benefit because they will have less occupational exposure to lead.

• Step 2: Research It!

Wheel weights are metal clips that are attached to tire rims to balance tires. Since the 1930's, lead has been the preferred substance for wheel weights. Lead affects the nervous, circulatory and reproductive systems <www.atsdr.cdc.gov>. People who work with large amounts of lead are 3 times more likely to develop Alzheimer's disease (www.ehponline.org). Lead can decrease a person's IQ by up to 3 points for every microgram of lead per deciliter of blood <www.mass.gov>.

Lead accumulates in soil and sediment and slows growth and reproduction rates of plants and animals. Lead bioaccumulates in fish, which can work its way up the food chain.

We read an article by Dr. Robert Root: "Lead Loading of Urban Streets by Motor Vehicle Wheel Weights". This article and our correspondence with Dr. Root helped us understand the significant problem that lead wheel weights pose to the environment. Dr. Root's study shows how easily discarded wheel weights abrade and disintegrate into particles or dust that can be then picked up by tires and shoes or be washed away by rain into sewers. Lead particles picked up by tires, shoes, etc can be brought into the garage and homes. This led us to wonder why little was done to regulate the entry of lead into the environment from using lead wheel weights to balance tires.

Through our communications with Linda Barr, US EPA, we learned that the EPA launched the National Lead-Free Wheel Weight Initiative (NLFWWI) on Aug. 29, 2008. The purpose of the NLFWWI is to encourage the voluntary transition from the use of lead in wheel weights. We learned that there are alternative metals (steel, copper, and aluminum) that can be used in place of lead for wheel weights. We also contacted Theresa Stiner, Iowa DNR, to inquire about current regulations that exist regarding lead wheel weights. We learned there are no specific regulations in Iowa. She stated, "The IDNR is not planning on conducting any studies in the near future."

According to a survey conducted by the Ecology Center in 2006, half of all new vehicles sold in the US have lead-free wheel weights. Tires only remain balanced for about a year, but this can vary drastically due to driving conditions. Once out of balance, tires need to be taken to a tire service center to be rebalanced. Most tires are balanced with lead wheel weights because there are no state regulations on the use of lead to balance tires. In 2005, the European Union banned the sale and use of lead wheel

weights.

Through our research we learned that annually about 65,000 tons of lead wheel weights are used in the United States (Green Living Tips, 8/24/08). Ten percent of these wheel weights fall off resulting in over 6,500 tons of lead being deposited on roadways from lead wheel weights (www.leadfreewheels.com). When visiting automotive tire centers we learned that workers are exposed to lead while installing wheel weights. We also learned that lead in wheel weights are one of the last unregulated sources of lead in the United States.

We looked into the California policy that is banning the sale and use of lead in wheel weights. We corresponded with Charles Margulis, Center for Environmental Health (CEH), about the CEH's lawsuit against lead wheel weight manufacturers and distributors. As a result of the CEH lawsuit, California implemented a policy that will require companies to stop producing and using lead wheel weights by the end of 2009. This act prevents 500,000 pounds of lead from entering the environment in California each year (Green Living Tips, 8/24/08).

We called organizations in order to become knowledgeable about conducting lead testing. Dr. Michael Wichman from the University Hygienic Laboratory (UHL) invited us to tour the UHL lab in Ankeny, IA. We visited on Nov. 14, 2008 to learn how hazardous materials are tested.

Our hypothesis is: If the public becomes more aware of the environmental dangers of lead wheel weights and is given alternative wheel balancing choices then there will be a decrease in lead entering the environment.

In our town there are approximately 1,700 vehicles. Each vehicle has about 127 grams (4.5 ounces) of lead wheel weights on their tires. Approximately 10% of the lead wheel weights fall off during normal driving conditions (U.S. Geological Survey. USA Today, August 28, 2008), resulting in about 2.2 kg (5 pounds) of lead being deposited on the streets. Groundwater and surface water may be contaminated through street water runoff and children may come in contact with lead carried into homes on shoes and tires.

Therefore, if our hypothesis is correct, our community will be safer because groundwater contamination from lead wheel weights will be eliminated. The risk of lead poisoning by touching lead wheel weights will also be eliminated.

• Step 3: Plan It!

Our team met to identify and distribute tasks. We developed a timeline. We communicated through email and weekly meetings. We worked before and after school on the project. We met 1-2 times each week for most of the project.

In August 2008, team members did background research on wheel weights and lead. Justin studied the history, Brennan studied the health effects of lead, and Jathan studied the environmental effects. Our next step was to visit car dealers and tire centers. At the tire centers their lead wheel weight trays tested positive for the presence of lead.

In October 2008, the team worked on organizing the testing. Lead wheel weight testing kits and procedures were researched. Our team devised a testing protocol. Preliminary lead testing was conducted by all team members. The University Hygienic Lab was contacted concerning the wheel weight lead testing protocol. The team worked on organizing community education and legislative lobbying. Display posters were designed and created. We created a brochure recommending why lead wheel weights should be phased out. Each member wrote letters to interested community members and state legislators. Brennan emailed and phoned legislators Kaufman, Bolkcom and Willems. Justin corresponded with Charles Margulis (CEH). Jathan communicated with Dr. Root.

Team members participated in five Lead Wheel Weight Community Awareness presentations held between November and January. The team gave presentations to the City Council, the Community School District and other civic organizations. As a result, the city and school district agreed to phase out lead wheel weights on all city and school district owned vehicles.

In November the team members created surveys to learn what individuals and tire store employees knew about lead wheel weights. Team members distributed surveys and evaluated the responses. We created a website <www.leadzero.org> to inform a larger population about the hazards of lead wheel weights.

On January 3, 2009 we participated in the annual Environmental Summit held at our school. Five state legislators and a Department of Transportation representative attended. As a result we worked with Representative Kaufmann and Willems to craft three bills that were presented to the Iowa Legislature recommending the phasing out of lead as the metal used in wheel weights.

We distributed brochures to parents. We visited tire service centers and provided educational materials for employees and

customers. After our educational efforts, we administered our survey to see if our educational efforts had an effect. The results are in Section 4.

On March 4, 2009 we presented information to legislators and environmental committees at the State Capitol about the hazards of lead wheel weights. We lobbied for support to pass the three bills we initiated.

• **Step 4: Do It!**

We experimented with lead wheel weights in four different solutions. Rainwater simulated precipitation; dilute .5% acetic acid vinegar solution simulated landfill conditions; salt-sand/rainwater simulated winter road conditions; and distilled water which can be naturally occurring. Twelve plastic bottles were provided by UHL.

Three bottles contained 500 ml of distilled water. Three contained 500 ml of rainwater (5.5 pH). Three contained 500 ml of vinegar solution (2.9–3.0 pH). Three contained 500 ml of rainwater with 43 grams of salt/sand mixture (5.5 pH). Four of the 12 bottles were used as controls, one of each solution with no wheel weights. We placed one 7 gram steel wheel weight in each of four individual solution bottles. Finally, we placed one 14 gram lead wheel weight in each of the remaining individual plastic bottles of solution. After 24 hours we used lead indicator kits to test for the presence of lead. The rainwater, vinegar, and salt/sand solutions with lead wheel weights tested positive.

Test results for the presence of lead			
Solutions	Control (no weights)	Lead wheel weight	Steel wheel weight
Distilled water (7 pH)	Negative	Negative	Negative
Rainwater (5.5 pH)	Negative	Positive	Negative
Vinegar (3.0 pH)	Negative	Positive	Negative
Salt/sand/rainwater	Negative	Positive	Negative

We met with Dr. Michael Wichman, UHL, who agreed to replicate our experiment in his laboratory and to quantify the results. We prepared the experiment the same as our initial tests. The 12 plastic bottles were placed on a “shaker” that rotated for 18 hours according to EPA Toxic Characteristic Leaching Protocol Test (TCLP).

UHL Lab test results for Total Lead (mg/L) or part per million (ppm)				
	Distilled Water	Rainwater	Dilute Vinegar formulated by TCLP Protocol	Salt/Sand Rainwater
Control	<.001	.002	.022	.006
Lead	.856	.189	385	2.19
Steel	.050	.004	.037	.003

The UHL test results show significant amounts of lead compounds present in the experimental solutions. The lead wheel weight experiment simulating landfill leachate conditions, as defined by TCLP standards established by the US EPA, yielded an astonishing 385 mg/Liter (385 ppm) lead concentration in solution. The dilute acetic acid solution dissolved more than 0.3 grams from the lead in wheel weights!

We surveyed 109 families and 21 tire centers to test our hypothesis that educating the public and tire center owners results in fewer lead wheel weights being used on vehicles. We distributed brochures and Fact sheets. Post survey results showed an increase in awareness of lead wheel weights.

Pre and Post Surveys of local citizens					
Knowledge of wheel weight.		Metal contained by majority of wheel weights.		Knowledge of wheel weights impact on the environment.	
Pre	Post	Pre	Post	Pre	Post
Yes: 71.56%	Yes: 92.47%	Aluminum: 11.54%	Aluminum: 0%	Positively: 15.38%	Positively: 3.19%
No: 28.44%	No: 7.53%	Lead: 70.19%	Lead: 91.4%	Negatively: 65.38%	Negatively: 92.55%
		Mercury: 3.85%	Mercury: 0%	No Effect: 19.23%	No Effect: 4.26%
		Steel: 14.42%	Steel: 8.6%		

Tire centers were provided with a brochure, fact sheet, and safety posters and later were resurveyed. Their knowledge and willingness to use non-lead metals in wheel weights increased by 33%. There was a 52% increase in knowledge of environmental issues associated with lead wheel weights.

Pre and Post Surveys of Tire Service Centers									
Metal used in wheel weights:		Knowledge of non-lead weights to balance tires.		Use of non-lead weights to balance tires.		Awareness of environmental or health problems associated with lead wheel weights		Willingness to switch to non-lead wheel weights.	
Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Lead: 85.71%	Lead: 100%	Yes: 47.62%	Yes: 81.81%	Yes: 28.57%	Yes: 27.27%	Yes: 47.62%	Yes: 100%	Yes: 71.43%	Yes: 81.81%

Zinc: 4.76%	Zinc: 0%	No: 52.38%	No: 19.19%	No: 71.43%	No: 72.72%	No: 38.1%	No: 0%	No: 14.29%	No: 19.19%
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• Step 5: Analyze It!

We learned what wheel weights are, how they are used and why lead is the preferred metal for wheel weights. We learned about potential hazards lead poses to humans and the environment. We learned that citizens in our community had little awareness of hazards from lead wheel weights. Our research verified landfills contain acetic acid producing bacteria <www.atsdr.cdc.gov/hac/landfill/html/ch2.html>. Our experiments suggest that lead in wheel weights readily react with acetic acid present in our test solutions and dilute acid present in rainwater (pH=5.5) producing toxic highly mobile soluble lead compounds. <www.silver-colloids.com/Tables/Solubility_Rules.html>.

The UHL test results verified and quantified our team's preliminary testing for the presence of lead using home lead test kits.

Upon completion of the experiments using EPA protocol, Dr. Wichman stated, "Based on these results one can determine that various conditions could result in leaching of lead from wheel weights. How that models into contamination of groundwater and/or surface water requires more research." The lead wheel weight testing to determine the solubility of lead under various conditions is a logical step to enhance the understanding of how hazardous lead could be released into the environment.

Our experiment results suggest that minute amounts of measurable lead can react under environmental conditions forming water soluble lead compounds. If lead becomes mobile under natural environmental conditions then it could potentially enter the environment and our drinking water reserves through leaching and surface water runoff. Because the accidental deposition of unregulated lead wheel weights is occurring on our nation's highways, our test results lead us to believe that environmental levels of lead could increase due to the formation of soluble lead compounds. *Our test results are important because discarded and road deposited lead wheel weights can end up in landfills or are abraded on roadways by precipitation and salt. Our UHL test results suggest lead in wheel weights can potentially form soluble lead compounds that are carried off by street water runoff.* Lead contamination should not be tolerated.

It is exciting to know that because of our project and Environmental Summit, three bills have been introduced in the State Legislature and that our city has begun phasing out the use of lead wheel weights on its vehicles. The tire centers surveyed have expressed a willingness to offer lead free wheel weight alternatives and one dealer has switched to offering only steel.

• Step 6: Share It!

Our project has impacted and made a difference in our community! There has been an increase in the awareness of the hazards of lead wheel weights. Employees of local tire service centers are aware of potential health hazards when installing lead wheel weights. Dodge Street Tire announced, "We care about the environment! That is why we are the first in town to offer steel wheel weights". The police chief, mayor, and school superintendent have mandated phasing out lead wheel weights on police, city, and school vehicles. State legislators have introduced three bills to phase out the lead in wheel weights.

All communities benefit if lead in wheel weights is phased out. If a safe substance is used in wheel weights, lead is eliminated from entering the environment. There is a solution to the problem. Replicating our model in other communities can be accomplished: 1) through surveys, brochures and presentations to increase awareness of citizens, policy makers, and tire service owners about the hazards of lead wheel weights and the alternative of installing lead free wheel weights; 2) by crafting bills to phase out the installation of lead wheel weights; and 3) by working with legislators, the DNR, and environmental committees to encourage them to support the bills to become law.

Ultimately, our goal is to eliminate the lead in wheel weights. To accomplish this, we recommend replication by communities that share our vision. Our website, <www.leadzero.org>, informs the public about the hazards of lead wheel weights. For communities to proceed with the project, we recommend conducting research to learn of health problems associated with lead wheel weights. Success includes the need to: 1) establish partnerships with research facilities to complete lead solubility testing; 2) create educational materials to improve community awareness; 3) work cooperatively with community decision makers to phase out lead wheel weights on city vehicles; 4) contact state policy makers to craft a bill to present to legislative committees; and 5) know a significant difference can be made in the community.

We began working on our issue in August. The time required depends on: 1) establishing partnerships with scientists, tire centers, and policy makers; 2) making presentations to community citizens; 3) contacting legislators; and 4) once the legislative process begins, contacting policy makers. Commitment, dedication, and persistence are key components for success. Currently, California is the only state to take action phasing out the lead in wheel weights. Representative Kaufmann tells us that passage of our bill looks good. Our goal is to make Iowa a leader in addressing environmental issues. Change is coming to America. Policy makers are supportive. The time is right to phase out the use of lead in wheel weights!

