Dear Safer Products for Washington Team:

I applaud the work you have done to date in tackling the restriction of toxic chemicals in consumer products. Your ongoing effort is vital and much appreciated.

This document contains my comments regarding the Draft Identification of Priority Consumer Products Report to the Legislature [1], part of Safer Products for Washington Cycle 2 Implementation Phase 2, and is organized as follows:

- Priority product evaluation approach detailed in [1].
- Notes on my Listing of Consumer Products containing lead
- My Recommendations for Cycle 2 Priority Products containing lead
- Future Work

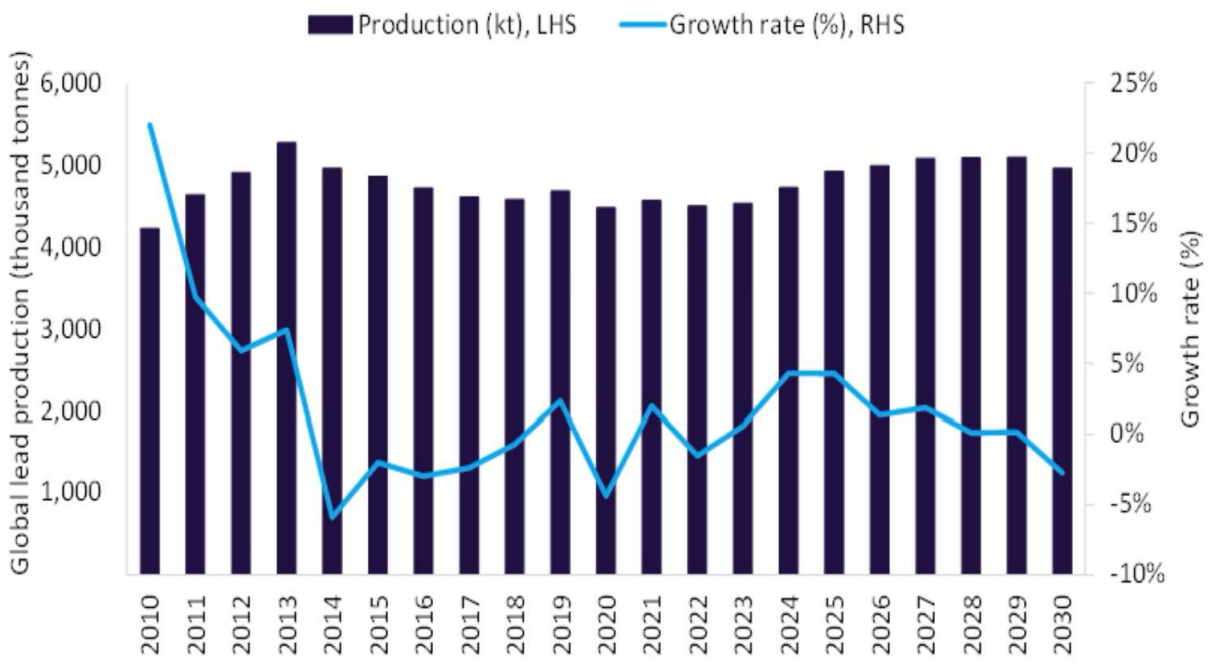
Priority product evaluation by Ecology Washington

I support the factors listed in [1] that Ecology Washington is using to identify priority products.

However, the absence of a safe level of lead exposure, the widespread usage of lead, the persistent nature of lead, and the complex nature of variable exposure pathways that are cumulative over a lifetime, require that broad restrictions are placed on lead in consumer products. There simply isn't publicly available data to quantify exactly how much volume of lead is used in each of the consumer products nor are there studies to quantify every exposure pathway for every sensitive population. However good engineering and scientific judgement based on updated scientific knowledge about the toxicity of lead, along with restrictions already enacted, or in process of being enacted, by agencies in other jurisdictions, such as ECHA, give powerful support to the need for broad restrictions of lead in consumer goods.

Millions of tons of lead are used every year. Once released from the ground, lead becomes a permanent problem of containment and humanity is collectively adding to this every year. As an element, it will never dissipate or disappear.

Worldwide lead production has stayed steady over the last decade, after appreciating sharply in the years before. Worldwide lead production was forecast to grow 4.3% from 2023 to 2024 and to have a compound annual growth rate of 0.8% from 2024 to 2030, as seen in the following figure:



Global lead production is set to grow at a CAGR of 0.8% from 2024 to 2030. Credit: GlobalData.

Source: https://www.mining-technology.com/analyst-comment/global-lead-production-2024/

Even though the dangers of lead were already suspected in antiquity, an estimated 1 million deaths are still caused by lead every year, according to the WHO [2]. Many millions more are affected by, often long-term low-level lead poisoning, that results in lifelong health problems such as anemia, high blood pressure, immunotoxicity, toxicity to the reproductive organs, intellectual disability, and possibly irreversible neurological and behavioral effects.

Knowledge of the harms of lead exposure have only gone in one direction in recent decades, specifically that lower and lower amounts of lead, considered 'safe' in the past are now known to cause large scale morbidity, disability, and mortality.

As a result, lead exposure limits have been continuously lowered in recent years, playing 'catch-up' with scientific knowledge.:

- On January 17, 2024, the U.S. Environmental Protection Agency issued updated guidance lowering residential soil lead (RSL) from 400 to 200 parts per million (ppm). [3]
- Additionally, RSL was reduced even lower to 100 ppm if an additional source of lead is identified. [3]

The EPA updated the guidance because "The science on lead has evolved to demonstrate that lead exposure is harmful to children's health at lower levels than we previously understood. "

Or consider the lead dust level standards established by the EPA starting in 2001, and the significant revisions downwards in several steps through to 2024, as seen below [4]:

2001 LBP Hazards Rule			2019 Rule	2021 Rule	2024 Reconsideration Rule	
µg/ft²	DLHS	DLCL	DLHS	DLCL	DLRL	DLAL
Floors	40	40	10	10	Any reportable level by an EPA-recognized laboratory	5
Sills	250	250	100	100		40
Troughs	no standard	400	no standard	400	no standard	100

Note: DLHS is Dust Level Hazards Standards, DLCL is Dust Level Clearance Level, DLRL is Dust-Lead Reportable Level and DLAL stands for "Dust-Lead Action Level.

The WHO states that “there is no safe level of exposure to lead, which harms health, particularly children’s health.” [2] In other words, lead is toxic to adults and children at any dosage.

If consumers try to reduce their exposure to lead from consumer products, they are faced with a complex patchwork of mostly narrow lead regulations, and companies that often do not want to disclose how much lead is in their products, if not required by the law (which they often are not). Other consumers believe that lead has already been removed from most consumer products. In my experience, even when speaking with generally well-informed people, they often erroneously believe that lead is already restricted in many of the consumer products where it is still used; in general, they state that it’s ‘obvious’ to them that no one would continue to use lead in those products when it’s common knowledge that lead is toxic. Unfortunately, that is not always the case.

Part of the problem is that the complex patchwork of regulations means that there are many consumer products that have been overlooked in terms of lead restrictions. Average consumers may have reduced lead exposure with restrictions that target products that are used in the greatest volume in aggregate, but without broad restrictions that capture all unnecessary uses of lead, it may do little to nothing for sensitive populations who are disproportionately affected by less common or niche products.

These broad loopholes also result in regrettable new lead products. If lead is finally restricted in one product, then lead suppliers can simply find new markets to sell to, resulting in continued and increasing lead demand, and continued pathways to exposure for the public. I was amazed how quickly manufacturers began selling lead tape marketed specifically to pickleball players, as soon as pickleball picked up in popularity. These regrettable new uses of lead (and other priority chemicals) is something that needs to be addressed so there is not a game of whack-a-mole when trying to reduce exposure to toxic chemicals.

The solution to this is to enact broad and simple lead restrictions with these objectives:

- Make it extremely easy to understand, for consumers, producers, sellers, and regulators alike, where lead is restricted and where it continues to be allowed. For example, [1] states there are existing Washington state restrictions on lead (and cadmium) in children's jewelry, RCW 70A.430 Children's Safe Products Act. The Cycle 2 proposal in [1] is to extend lead restrictions to all jewelry. From now on partial and complex regulations such as lead applied only to children's jewelry need to be avoided – who is to decide what exactly is 'children's jewelry' and why does every stakeholder need to invest time and money to understand and track this distinction? Simply restrict lead in jewelry, period, and there is then no uncertainty when the restriction applies. And even though the health benefits are the greatest for children, everyone who uses, sells, and produces jewelry will benefit.
- Broad restrictions will discourage regrettable new uses of lead. If for example, there is a restriction on lead in sports products, then restricting the use of lead tape for golf means you then don't need to make another restriction on lead tape for tennis or pickleball. Or restricting lead in the wettable surfaces of a faucet means you then don't need to make another restriction to restrict the use of lead as a counterweight for the faucet – you simply restrict lead in the entire faucet and all its parts and attachments.
- Capture the complex variations in lead exposure as opposed to the mean exposures that tend to leave out sensitive populations. There are so many consumers products with lead still being used, with varying exposure pathways, that it would be technically difficult and costly to tease apart which products are leading to which health outcomes in various sub-populations. We are well past the time of trying to argue which uses of lead are safe, when the real world use of products often deviates from the ideal uses envision by defenders of lead usage, and when the WHO and other health agencies state there is no safe level of lead exposure. The only uses of lead going forward should be those where there truly is no alternative, and where the lead is not for some frivolous use.

ECHA (European Chemicals Agency, a regulator like the U.S. EPA) has now come to a similar conclusion. Lead was listed as a substance of very high concern by the ECHA in 2018. Then, April 2023, ECHA recommended to the European Commission (the Executive Body of the EU) to add lead to Annex XIV of REACH, meaning lead use in the EEA (the European Economic Area, that includes the EU and several other countries) would be subject to authorization. [5] Substances on the authorization list may only be placed on the EEA market or further used in the EEA if an authorization has been granted or applied for. It is currently waiting for a final decision from the European Commission on whether to be included in the authorization list.

The Washington State Toxic Pollution Law (Chapter 70A.350 RCW) of course isn't identical to REACH but the same goal of restricting lead in a wide breadth of consumer products should be pursued, to the maximum extent possible.

Notes on Listing of Products containing Lead

Attached at the end of this report is a listing of consumer products that contain lead. It is organized into categories based on general use: Sporting Goods, Household Renovations/Construction Products, Arts & Crafts products, Vehicle Accessories, Ammunition, and Radiation Shielding.

The categories should be viewed as a reference list of products that can be combined in numerous ways for Cycle 2 priority product categories (and future cycles as well).

Some of the products could be in more than one category (for example lead acid batteries aren't just for motor vehicles as they are also used in UPS (Uninterruptible Power Supplies), golf carts and other recreational vehicles, boats, and more). Also, some of the products have applications that are covered by the Toxic Pollution Law (Chapter 70A.350 RCW), such as lead-acid batteries used in UPS or replacement batteries for various vehicles and watercraft, while other applications are exempt from the Toxic Pollution Law, such as original lead acid batteries in new vehicles.

There are additional consumer goods that need to eventually be added to the list, such as:

- Ceramic Dishware and Cookware that contains lead
- Cable sheathing lined with lead
- Lead crystal used in drinkware, art, décor, and industrial uses (electronics)
- Permanent tattoo ink
- Perhaps others…

I have focused on sensitive populations for each product that are straightforward. It could also be useful to think of more nuanced sensitive populations, such as people with certain pre-existing conditions. For example, the American Heart Association states that chronic low-level lead exposure is linked to vascular (heart) damage and atherosclerotic disease and contributes a significant risk factor for CVD, including ischemic heart disease, stroke, and PAD (Peripheral Artery Disease) [6]. Therefore, another sensitive population could be people who are already at higher risk to develop CVD, stroke, and PAD due to other risk factors. Cumulative low level lead exposure may be even more damaging to people with existing risk factors, such as obesity and diabetes. The precautionary principle would argue for including sensitive populations of people with existing health conditions that overlap with diseases linked to lead exposure.

My Recommendations for Cycle 2 Priority Products

1. Add a priority product category in Cycle 2 in [1], based on the functional use of lead as a weight, including:
    a. lead fishing tackle (lures, sinkers, lines, and more), lead powder, lead shaft weights, lead tape, filling for weighted vests and other weighted fitness clothing, any other sports and fitness equipment.
    b. kitchen counterweights
    c. piano key weights, curtain/drapery hem weights
    d. ballast (for boats, other watercraft, on-road and off-road vehicles, other uses)
    e. any other use of lead where at least one function of the lead is as a weight or ballast.
    f. In all the products above, limit lead content to 0.1% by weight of every component of the product. The 0.1% upper limit on lead should be high enough to account for lead impurities that are not intentionally added. Raw materials reclaimed from recycled materials with higher lead content would be restricted – the longer-term goal would be to establish the removal of lead from recycled materials as standard practice in industry, so that lead isn't unintentionally added to new products. Also, for simplicity and to benefit from the economics of scale, the maximum level of lead should be consistent with other lead regulations (such as REACH and RoHS) so that suppliers can clear the same 'lead-free' material destined for a variety of uses and states/countries.
2. Expand Jewelry and Accessories in [1] to Arts, Crafts, Jewelry and Accessories, including:
    a. jewelry and accessories, as described in [1].
    b. lead came, typically used for stained glass.
    c. lead tin/solder used for a variety of consumer goods.
    d. For a. through c., limit lead content to 0.1% by weight for any part, except those that are worn, such as all jewelry and accessories, in which case a lower lead limit of either 0.05% to be consistent with ECHA or the lower 100 ppm as defined in the US Consumer Product Safety Improvement Act.
    e. Art paints (pigments) would fall under this general category. Pigments in art paints that contain lead should be restricted, similar to that proposed by ECHA, with an exception for the use of such pigments by professionals performing restorations of historical art. Because a. through c. are all various alloys containing lead, they may form a more natural grouping with art paint being moved to a separate group, possibly together with permanent tattoo ink. I don't cover tattoo ink in this report, however a friend of mine had acute lead poisoning, requiring chelation treatment, and a long recovery time, and the doctors believed the lead primarily came from a tattoo.

Future Work

Due to resource limitations at Ecology Washington, there is a need to request a special round of Safer Products for Washington to address the wide range of products that use lead, like the standalone Cycle 1.5 for PFAS. This special cycle should also be broadened to include all heavy metals such as cadmium and mercury. I request that a section is added in [1], or a separate report sent to the legislature, to request a special round 2.5 of Safer Products for Washington, to enact broad restrictions of lead and other heavy metals for all consumer products that can't be addressed in Cycle 2

Best regards,

David Krizan,
M. Engineering,
M. Applied Data Science

Listing of Consumer Products Containing Lead

A) Sporting Goods

Product	Lead Content	Available Alternatives
Lead Fishing Tackle	~ 100%	Bismuth/tin, steel, Tin, tungsten, glass
Lead Powder	~ 100%	Tungsten powder or switch to non-lead shaft weights
Lead Shaft Weights	~ 100%	Brass, copper, steel, tungsten
Lead Tape	~ 100%	Tungsten tape, copper tape, high density thermoplastic (EcoMass)
Weighted Vests, Ankle & Hand Weights	Note 1	Lead-free iron sand, steel pellets, steel plates
Lead Diving Weights	~ 100%	Bismuth, stainless steel, and tungsten, high density thermoplastic (EcoMass)
Lead Ballast for Watercraft	~ 100%	Steel, Concrete, Sand, Iron Sand

Note 1: An XRF test done on an 8 lb. weighted vest I purchased on Amazon showed 0.81% lead in iron sand. I expect other weighted fillings could vary in lead content. In the absence of publicly available information on weighted fitness products this is at least a first data point that shows a concerning level of lead content. Also, there is no regulation preventing a company from selling solid lead weights in various fitness products.

A. 1. Lead Fishing Tackle

Weights, lures, and fishing lines are weighted to keep bait below the water surface or the lake/river/sea bottom.

Source : https://www.oceandefenders.org/news-and-media/toxic-lead-fishing-weights-removed-from-oahu-waters.html

Sensitive Populations: Fishing enthusiasts, especially children, pregnant women, women of childbearing age, manufacturing workers, retail employees, and people who make fishing tackle at home can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: Exposure pathways include touching lead lures, lead sinker, or lead lines before eating, smoking, or putting hands in the mouth, accidental ingestion of products, or inhaling vapors during manufacturing, especially those doing so at home. Areas where lead tackle is stored can become contaminated with lead dust, particularly when tackle is moved and rubs against other objects, leading to further pathways for exposure.

Exposure to Sensitive Species and Environmental Release: Lead tackle lost in lakes and other bodies of water can lead to increases in environmental lead levels and be swallowed by certain animals, such as loons, swans, and fish. Additionally, animals that eat fish, such as eagles and

bears, can be exposed to lead when eating fish that have ingested lead. Lead tackle may also not be properly disposed of as hazardous waste and instead end up in landfills and leach lead into soil and groundwater.

Additional Info: It is unlawful to use lead weights or lead jigs measuring 1 1/2" or less along the longest axis in about a dozen lakes in Washington State [7]. This was a step in the right direction but it's past time to ban lead fishing tackle entirely, including lead fishing lines. The ECHA (European Chemicals Agency) has proposed a rule to accomplish this [8]. A similar approach could be used (ideally with a more accelerated timeline as it's not clear why this was deemed necessary by ECHA):

1. ban on the sale and use of lead sinkers and lures (with transition periods depending on weight: ⩽ 50 g three years; > 50 g five years);
2. immediate ban on the sale and use of lead fishing wire; and
3. immediate ban on the use of lead sinkers when the sinker is deliberately released (lead 'drop off' techniques).

A. 2. Lead Powder

Used to change the balance of a golf club or racquet, by adding lead powder inside the handle of a racquet or shaft of a golf club.

Source: https://www.golfworks.com/powdered-lead-1lb/p/lp/?srsltid=AfmBOop01HwNNeuWu7F2M_iicc2cqMbQ7HnUitay8FT8lfr_bNbLxWVX

Sensitive Populations: Tennis, golf, pickleball, and other racquet sports enthusiasts, especially children, pregnant women, women of childbearing age, manufacturing workers, retail employees, and pro shop technicians can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: Exposure pathways include touching the lead powder, or areas contaminated by the lead powder, before eating, smoking, or putting hands in the mouth. Additionally, lead powder may be inhaled if the powder is disturbed.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of, whether in the original container or along with discarded clubs and racquets, as solid waste in landfills, where the lead can leach into soil and groundwater.

A. 3. Lead Shaft Weights

These are typically used to change the balance of a golf club or racquet, by adding weight inside the handle of a racquet or shaft of a golf club.

Source: https://www.golfworks.com/lead-counterweights/p/cwssh/

Sensitive Populations: Tennis, golf, pickleball, and other racquet sports enthusiasts, especially children, pregnant women, women of childbearing age, manufacturing workers, retail employees, and pro shop technicians can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: Exposure pathways include touching the lead weights, or areas contaminated by the lead weights, before eating, smoking, or putting hands in the mouth. The weighs may also contaminate areas where they are stored if the weights rub against each other or other objects when they are moved.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of, along with discarded clubs and racquets, as solid waste in landfills, where the lead can leach into soil and groundwater.

A. 4. Lead Tape

Typically, a ¼" or ½" wide tape made of solid lead with an adhesive backing. Used to change balance and add weight to tennis, racquetball, squash, and other racquets as well as golf clubs. Lead tape usually comes in a roll or precut strips of set weights. Lead tape has also been traditionally used in electroplating (although safer alternatives are available for these applications as well). The tape is typically added at various locations around the head of a racquet, to the handle of a racquet, or to the head of a golf club.

Source: https://www.golfworks.com/high-density-lead-foil-tape/p/hdlt/?sku=HDLT&gad_source=1

Sensitive Populations: Tennis, golf, pickleball, and other racquet sports enthusiasts, especially children, pregnant women, women of childbearing age, manufacturing workers, retail employees, and pro shop technicians can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: Exposure pathways include touching the lead tape, or areas contaminated by the lead tape, before eating, smoking, or putting hands in the mouth.

When used on tennis (or other) racquets for example, the tape is used on the exterior frame of the racquet head or under the grip tape on the handle. The tape is eventually subject to sweat from the tennis player, water from spilled water bottles, and rain when used in outdoor courts. Furthermore, the tape, particularly on the racquet head or golf club head, is fully exposed to abrasion from striking a tennis ball or if the racquet falls to the ground or is stored where it can rub against other material, such as other gear in a tennis bag or backpack while it's carried or moved in and out of storage areas. I've even seen people carry these racquets onto an airplane and store them in an overhead compartment where they get significantly jostled around with all the other luggage during turbulence, landing, and luggage handling. Lead tape on golf club heads are also prone to contact on and off the course and you can see the result in the following pictures:

ANDREW TURSKY

Source: https://golf.com/gear/lead-tape-101-scott-piercy-golf-clubs/

I spoke with a tech at a tennis pro shop in Seattle and he indicated he really doesn't like working with lead tape, as it needs to be cut and handled extensively when installing, but unfortunately some people still ask for it instead of the safer alternatives.

Exposure to Sensitive Species and Environmental Release: The lead tape is rubbed off and falls off over time and needs to be continually replaced. This may cause contamination around courts and golf courses. The product may be improperly disposed of, along with discarded clubs and racquets, as solid waste in landfills, where the lead can leach into soil and groundwater.

A. 5. Weighted Vests and other weighted sports products

Used to add weight to workouts. Weights are also now used in rucking (hiking with a weighted backpack).

Source: Amazon - ProsourceFit Exercise Weighted Training Vest

Sensitive Populations: Fitness participants, especially children, pregnant women, women of childbearing age, manufacturing worker, and retail employees, can be exposed during product manufacturing, use, and disposal.

Exposure Pathways: My one XRF test of a vest I purchased showed the filling to be 0.81% lead. This percentage is high enough to be a concern as the vests don't appear to be dustproof. Additionally, a search of online reviews shows these vests tear, allowing the lead-containing filling to escape. The amount of filling can be 20 lb. or more so even at 0.81%, the total amount of lead is significant; and, there may be vests that are sold with even higher lead content in the filling. As a result, anyone wearing or handling the vest (or other weighted fitness product) could be exposed to lead dust which they then ingest when eating, smoking, or placing hands in the mouth.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

A. 6. Lead Diving Weights

Used to balance the buoyancy of the diver. Typically, a diver needs about 10% of their body weight in these diving weights, so it is a large point source of lead.

Source: https://www.walmart.com/ip/Scuba-Choice-Diving-Soft-Mesh-Lead-Shot-Weight-5lb-Made-in-USA/453677883

Source: https://www.houseofscuba.com/collections/weights/products/wbelt74

Sensitive Populations: Divers, manufacturing workers, people making diving weights at home, and retail employees can be exposed during product manufacturing, sale, use, and disposal. Family members of divers may also be exposed depending on the care taken in safeguarding against lead contamination and exposure of household and vehicle surfaces.

Exposure Pathways: Lead shot has a high surface area to volume ratio. The soft bag that contains the lead shot conforms to the shape of the diver's equipment and body and whenever they move, there is some contact between the faying surfaces of the pellets of lead. In online forums, I've read that divers report seeing visible clouds of lead dust from bags of lead shot when they enter the water or wash their equipment. There is logically then dust present so whenever the weights are moved there is the possibility to contaminate surrounding objects and surfaces. Solid weights have less surface area to volume, but they are very large point sources of lead. Some amount of lead rubs off every time the weights are handled, and the frequent exposure to water will cause leaching, increasing the amount of lead available to be transferred to hands or surrounding surfaces. Also, due to their weight and because they are typically uncovered, solid diving weights are prone to abrasion, which would release additional lead to surrounding areas.

Exposure to Sensitive Species and Environmental Release: Divers lose their diving weights from time to time so these large point sources of lead will leach into the water. Some leaching into the water is expected form regular use as well, as noted above, regarding visible clouds of lead dust in the water. Additionally, the lead weights may be improperly disposed of and end up in landfills where they leach lead into soil and groundwater.

Additional Info: I couldn't find any well-designed largescale studies that quantify lead exposure in divers. A pilot study in 2014 [9] was conducted but the sample size of 20 was not representative of divers in general and more concerningly, the blood samples were taken an average of 4.8 weeks after the last dive (with a range of 1-18 weeks). Since lead has a half-life of 30 days in blood, this is a significant source of potential bias in the results. Nonetheless the study found an average BLL (Blood Lead Level) of 2.65 µg/dL after 4.8 weeks, with a range of 1.17 to 4.48 µg/dL. The study then mysteriously concluded that these were not elevated BLLs since the average BLL in the divers was less than the top of the BLL range found in the general German public. If you consider that according to the CDC the average BLL of American adults in 2015-16 was 0.92 µg/dL then the study number looks more concerning, particularly due to the limitations of the study noted above. The authors however concluded that the study could not be generalized to conclude that divers do not have elevated blood lead levels.

A. 7. Lead Ballast for Watercraft

Uses include improving boat stability (both motorboat and sailboats) and creating a larger wake for water skiing and wakeboarding (as the boat will displace more water if it is heavier).

This is 50 lbs (2 bags at 25 pounds each) of raw reclaimed lead that has not been washed It is also great for making scuba weights, for use as ballast weight or a cheap lead source for other projects. Please be aware that these BB's may still have a small amount of foreign objects, i.e. pebbles or dirt in it. The bag will contain a mix of all sizes - mainly around 7.5 and 8. Our reclaimed lead averages about 5% Antimony Lead. Bulk orders of this product are available. This is the *best* value for inexpensive ballast weight.

Source: https://www.rotometals.com/ballast-weight-reclaimed-lead-2-25-lbs-bags-50-pounds-w-free-freight/

Sensitive Populations: Boaters, boat maintenance workers, ship breakers, manufacturing workers, and retail employees can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: As with the diving weighs, lead shot pellets rub against each other whenever there is movement and result in the release of lead dust. The bags that lead shot is packaged in typically don't appear to be well sealed (and even if it was, the sealing may break down over time) so dust will be continually released from the bags whenever the bag is moved (such as manufacturing, handling, and in use on a boat going over waves). Exposure pathways include touching these products before eating, smoking, or putting hands in the mouth, or inhaling dust during manufacturing and installation or breaking (recycling) old boats. Additional exposure can occur by touching areas contaminated by lead dust from the lead shot bags.

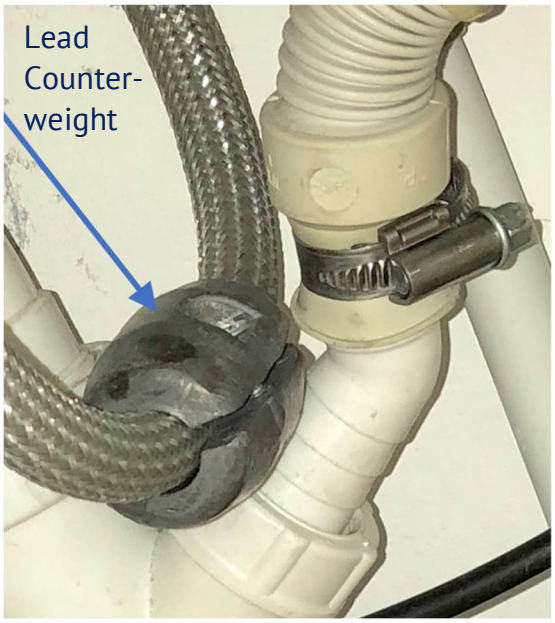
Exposure to Sensitive Species and Environmental Release: Some companies now advertise lead ballast that isn't actually lead, so there can be confusion about what is and isn't lead. This can increase the chance that this ballast, when no longer needed, is not disposed of as hazardous waste and ends up in a landfill where it can leach lead into the soil and groundwater. Boating accidents that release this ballast into water would result in a large source of lead that would break down over time and be eaten by various animals, including birds and fish.

B) Household Renovation/Construction Products

Product	Lead Content	Available Alternatives
Lead Faucet Counterweights	~ 100%	Iron, steel, zinc, iron sand, high density thermoplastic, non-counterweight design using springs
Other Plumbing Components (that do not contact drinking water)	Up to 8% for pipes and pipe fittings and 4% for plumbing fittings and fixtures (California DSTC)	Lead-free brass coupling and fittings, lead-free aluminum fittings (less than 0.25% lead is definition of lead-free in section 1417 of the Safe Drinking Water Act)
Brass keys	~2.5 %	Aluminum, steel, lead-free brass
Lead Roofing Materials (Flashing)	~ 100%	Copper, aluminum, stainless steel, pliable polymer rubber with aluminum mesh embedded inside.
Lead Planters, Sculptures, Ornaments	~ 100%	Wide variety of metal, wood, concrete, and plastic alternatives
Lead Anchors/Plugs	~ 100%	Zamac, zinc plated steel, stainless steel, zinc alloy, plastic, and more
Lead Press Seals	~ 100%	Aluminum, plastic
Garden Hoses	As high as 68,000 ppm for PVC hoses. Brass fittings can contain 8% lead.	Non-PVC hose, lead-free PVC hose, lead-free brass coupling and fittings, lead-free aluminum fittings

B. 1. Lead Kitchen faucet counterweights

These are typically 3 to 5 lb. lead weights that attach to a faucet water hose (under the sink) to help the faucet head retract after it is pulled it out. Here is an example of a lead weight (confirmed by the manufacturer) that I photographed:



Sensitive Populations: Plumbers, construction workers, home do-it-yourselfers, children, pregnant women, women of childbearing age, manufacturing workers, and retail employees can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: include touching products before eating, smoking, or putting hands in the mouth, accidental ingestion of products, or inhaling vapors during manufacturing.

These are very large potential single point sources of lead, in the range of 1 kg to 2 kg. Since lead exposure is measured in micro-grams, it is useful to think of it in terms of 1 billion to 2 billion micro-grams. The lead weight is subject to movement and impact against neighboring objects (plumbing fixtures and objects stored under the sink) every time the faucet head is pulled out and then retracted. I've observed some people are abrupt in the way they pull out and retract the faucet heads, imparting more contact force to any lead weight impact below the sink. You can see from the preceding picture that this relatively new lead weight, about 3 years old when I took the photo, was already showing noticeable signs of contact and abrasion. This abraded lead would have transferred onto neighboring objects.

This particular lead faucet weight was present in the home of someone I know with four small children. The area under the sink was used on a very regular basis as it had small bins for trash and recycling, as well as storage of paper products such as bags, and other often used items.

Ironically, no household cleaning chemicals were stored there to prevent any accidental exposure to the young children. In fact, they were 'training' the children on how to use the trash and recycling bins so it's very possible, being children, they ended up rummaging around whatever else was under the sink. The parents had no idea they had several pounds of pure lead there, as it was not labeled, and they reasonably assumed that lead was no longer allowed in plumbing products.

Exposure to Sensitive Species and Environmental Release: It is difficult for people to know when lead is used in these counterweights, especially when all new kitchen faucets are typically marketed as "lead-free" –the 'lead-free NSF/ANSI 61 regulations apply to the wetted surfaces of the fixtures that come into contact with drinking water. Additionally, the specifications provided for faucets rarely include the material of the weight (usually it's described as 'metal', if at all). Therefore, the product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

B. 2. Other plumbing components

As mentioned previously, NSF/ANSI 61 regulations apply to the wetted surfaces of the fixtures that come into contact with drinking water. Consumer plumbing components (faucets, spouts, knobs, fittings, etc.) used in areas considered not to have drinkable water include bathrooms, laundry rooms, outdoor faucets, and even parts of kitchen faucets that do not come into contact directly with the drinking water. Section 1417 of the Safe Drinking Water Act (SDWA) established the definition for "lead free" as a weighted average of 0.25% lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and 0.2% lead for solder and flux. Extending this to all consumer plumbing components would further reduce exposure pathways to sensitive populations and simplify regulations for manufacturers, retailers, and consumers alike.

A common criticism in the past has been that brass without lead is difficult to machine, but newer brass alloys with bismuth or silicon machine just as well and have the same corrosion resistance as lead brass alloys, according to peer-reviewed research out of Virginia Tech [10]. And clearly if plumbing components and fixtures that contact drinking water can be made with a maximum of 0.25% lead than the other plumbing components can as well.

Sensitive Populations: Children, pregnant women, women of childbearing age, plumbers, and home do-it-yourselfers can be exposed during product installation, use and disposal.

Exposure Pathways: include touching products before eating, smoking, or putting hands in the mouth. Drinking water, such as from a bathroom faucet or outdoor hose, and watering edible plants with an outdoor hose that has fittings or is attached to fittings that contain lead.

Exposure to Sensitive Species and Environmental Release The product may be improperly disposed of, particularly during renovations and teardowns, and end up as solid waste in landfills, where the lead can leach into soil and groundwater.

B. 3. Brass Keys

Brass keys typically contain up to 2.5% lead - the lead is traditionally added to make the brass alloy easier to machine (i.e. to cut the keys). Many house keys and almost all USPS mailbox keys are made with lead-containing brass. Some keys that appear silver, for example, are likely brass keys coated in nickel.

Source: https://mylennarhome.com/metal-corrosion-and-rusting-throughout-house

Sensitive Populations: Children, pregnant women, women of childbearing age, locksmiths, other workers who cut keys, and anyone that uses a large number of brass keys for their job (janitors, security guards, mail couriers, etc.) can be exposed during product manufacture and use.

Exposure Pathways: include touching products before eating, smoking, or putting hands in the mouth, or in the case of children, putting keys in their mouth. Another exposure pathway is breathing lead dust when cutting keys. Keys that can scrape against other keys can over time increase the amount of lead released to surrounding areas (hands, purses, etc.).

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

Additional Info on Safer Alternatives: As noted, keys can be made from aluminum or stainless steel. Additionally, lead-free brass exists and it's a myth that lead-free brass is too difficult to machine [11] (the same point was made in the previous section, regarding the machining of lead-free brass for plumbing components).

Additional Info on Sensitive Populations and Exposure Pathways:

- A 2005 pilot study in [12] states that the odds ratio of increased hypertension (high blood pressure) in locksmiths is between 1.1 and 2.3.
- The Vermont Conservation & Housing Board provides some information on testing of brass keys around 2001 [13]:

  There are no Federal standards regarding how much lead is safe in keys. During the California trial [in 2001], it was found that minor handling of keys deposited lead on the hands during a normal task such as removing the key from your pocket and unlocking a door. The amount of lead found was compared to California's Proposition 65 "no significant risk level" of 0.5 micrograms of lead. It was found that handling some keys deposited lead on the hands as much as 80 times the "no significant risk level". The average of all keys tested was 19 times the "no significant risk level."

- It may seem obvious to not let small children play with keys as they may then put their hands or the keys themselves in their mouth. Furthermore, there are warnings such as this one below from the Vermont Housing & Conservation Board [13]:

  - *Don't let children handle any keys or give them to children to play with*
  - *Wash your hands thoroughly after handling any key.*
  - *Avoid mixing keys with gum, candy or food products that are commonly placed in a pocket or purse.*
  - *Use plastic or rubber covers for the head of keys.*
  - *Replace keys with worn plated finishes.*

  However, it's very optimistic to assume all parents are aware of this. While only an observation of one, I've seen small kids playing with keys in public and I would assume it does happen more than it should. A safer approach is to remove the lead from the keys such that they can't pose a lead hazard.

B. 4. Lead Roofing Materials (Flashing)

Flashing is a thin, usually metal sheet installed where the roof meets a wall, chimney, or valley, to direct water away from these junctions and prevent leaks by creating a waterproof seal. Lead is the traditional material for this and while there are more modern and safer alternatives available, lead flashing is still sold.

Source: https://evobuild.com.au/what-are-the-dangers-of-lead-flashing-and-what-are-the-best-alternatives/

Sensitive Populations: Construction workers, home do-it-yourselfers, manufacturing workers, and retail employees can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: include touching products before eating, smoking, or putting hands in the mouth, or inhaling vapors during manufacturing. As this is an outdoor product, rainwater will leach lead onto surrounding areas, including the soil and grass below the roof, such that they may become contaminated.

There don't appear to be many studies that quantify lead leaching from lead exposed to rainwater, such as lead flashing. But an interesting study was done in [14] where they estimate that 11 kg of lead runs off 1 square meter of lead plated roof over 800 years. While lead typically degrades slower than most other metals it still works out to 1375 µg/cm^2 per year. If you multiply that by the total surface area of lead flashing, a significant amount of lead will run off the lead flashing every year and contaminate the surfaces and ground below. Recall the

recently lowered residential soil limit (RSL) of 200 or 100 ppm [3] so the level of lead runoff may be significant.

Where the runoff lead ends up depends on the location of the lead flashing and what is below the roof edge of the building. If there is soil below, the leached lead will tend to stay in the top layers of the soil, where it can be picked up by people, particularly children.

Or the leached lead may end up draining into a sewer, eventually finding its way into local bodies of water. Or the leached lead can end up adhering to other surfaces.

Wherever the lead runs off there is the potential for buildup of lead and the creation of additional exposure pathways.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, during renovation or teardown, allowing the lead to leach into soil and groundwater. And as described above, rainwater will leach lead out of the lead flashing and deposit it in the soil below the roof or be washed into storm sewers, where it will eventually end up in a local body of water.

B. 5. Lead Planters, Sculptures, and Ornaments

Traditional English lead planters, sculptures, and garden ornaments were made of lead, due to their rust resistance and lower cost (at the time) than other materials such as bronze. While the vast majority of 'lead planters' sold now are made with other materials, there are still places that sell genuine ~100% lead planters.

Floral Box Lead Planters (~100% lead)
Source: https://detroitgardenworks.com/product/floral-window-box-lead-planter/

English Lead Lamb (~100% lead)
Source: https://detroitgardenworks.com/product/english-lead-lamb/

Sensitive Populations: Gardeners, landscapers, children, pregnant women, women of childbearing age, manufacturing workers, and retail employees can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: include touching products before eating or putting hands in the mouth, or inhaling vapors during manufacturing (casting lead). It also may be possible that lead is spread around from abrasion when these heavy planters and ornaments are moved. Additionally, rainwater will leach lead from the lead planters and ornaments to surrounding areas, such as gardens, grasses and soils, sidewalks, etc. See discussion in preceding section on lead flashing. Anyone working, or in the case of children, playing near these areas would have added exposure pathways, such as touching the lead contaminated soil and then eating, smoking, or putting hands in the mouth or tracking the soil on shoes into the home.

Exposure to Sensitive Species and Environmental Release: Animals, including birds and insects, may ingest lead from eating leaves or flowers from any plants in or near these lead pots and sculptures.

As mentioned above, the soil around these lead planters and sculptures may become contaminated with lead over time due to leaching. Keep in mind the recently lowered residential soil limit (RSL) of 200 or 100 ppm [3].

These products may also be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

B. 6. Lead Anchors/Plugs

Lead anchors are typically used together with a bolt to attach structural or non-structural objects to concrete or brick. The anchors transmit loads from the bolt into the concrete or brick. Lead plugs are also used to fill a hole, typically in concrete or brick, or for attaching a survey marker.

Source: https://www.fastenal.com/product/details/50993

Source: https://schmitt-anchors.com

Sensitive Populations: Plumbers, construction workers, surveyors, home do-it-yourselfers, pregnant women, women of childbearing age, manufacturing workers, and retail employees can be exposed during product manufacturing, sale, installation, and disposal.

Exposure Pathways: include touching products before eating, smoking, or putting hands in the mouth, or inhaling vapors during manufacturing. It also may be possible that lead is spread around when these are hammered into concrete or brick, as the lead may scratch off.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater. Also, when mounted in exterior locations subject to rain, they will likely leach some lead over time, similar to lead flashing.

B. 7. Lead Press Seals

Pure lead seals are used to provide security seals in applications where tampering needs to be prevented (such as utility meters). Typically, a lead 'puck' is squeezed with calipers to deform and create a seal over a steel wire. The only way to remove the lead seal is to cut the steel wire, thus indicating tampering. Lead seals are also still used in parachuting in the United States although the FAA has now authorized the use of plastic tamper-proof seals (https://parachutist.com/Article/riggers-begin-using-lead-seal-alternatives).

Source: https://bascousa.com/dependable-lead-seals-1-2-inch-plain-seal-imprintable-8-inch-wire.html

Sensitive Populations: Tradespeople, home do-it-yourselfers, manufacturing workers, and retail employees and parachutists can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways: include touching products before eating or putting hands in the mouth, or inhaling vapors during manufacturing. Areas where the seals are stored and moved, leading to the seals rubbing against each other or other objects (such as bins) can become contaminated with lead dust, leading to added exposure pathways.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater. Additionally, when used outdoors, rainwater will leach lead out from the seals into surrounding areas.

B. 8. Garden Hoses

A study done in 2016 of many popular garden hose brands found lead content of up to 68,000 ppm in the PVC used for the tube [15]. Brass and other metal fittings can contain higher levels of lead as well. Neither the hose tube nor fittings are subject to federal or Washington state safe water drinking laws.

Sensitive Populations: Children, pregnant women, women of childbearing age, gardeners, people eating garden grown fruits and vegetables, and manufacturing workers, can be exposed during product manufacturing, sale, installation, use, and disposal.

Exposure Pathways:

- touching products before eating or putting hands in the mouth
- drinking water from the garden hose
- using the hose to water fruits and vegetables grown for consumption

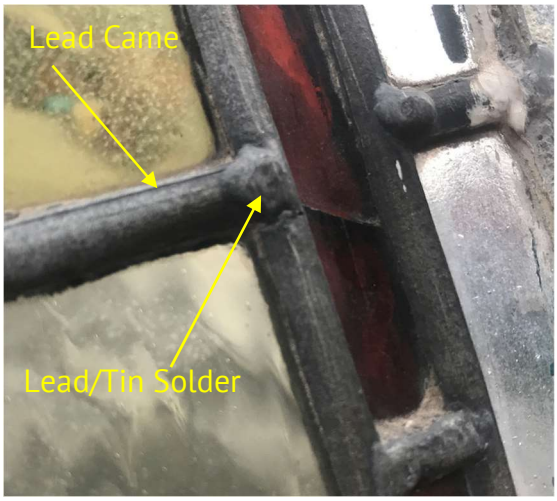
Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

C) Arts, Crafts, and Jewelry Products

Product	Lead Content	Available Alternatives
Lead Came	~ 100%	Brass, zinc, copper
Lead/Tin Solder	~ 60%	Lead-free solder alloy typically made from tin and copper and other metals such as silver, antimony, bismuth, cobalt, nickel, indium, zinc, and others.
Lead Piano key weights	~ 100%	Brass
Lead curtain/drapery hem weights and lead weighted lines/tapes	~ 100%	Ceramic, iron, steel, zinc, magnetic materials
Art Paints (Pigments)	Varies, depending on pigment.	Various lead-free pigments including titanium white, zinc white.
Jewelry	Refer to report to legislature	

C. 1. Lead Came

Straight pieces of H or U-shaped lead that hold together and surround the glass panels in stained glass windows. They are traditionally soldered together with 50/50 or 60/40 lead/tin solder.



Source: https://grandvictorian.co.uk/how-do-you-clean-leaded-windows/

Sensitive Populations: Hobbyists, stained glass workers, window installers, children, pregnant women, women of childbearing age, manufacturing worker, and retail employees can be exposed during product manufacture, sale, installation, use, and disposal.

Exposure Pathways:

- inhalation of lead dust from sawing the lead came.
- inhalation of lead fumes when soldering.
- stained glass workers and hobbyists bringing lead on their clothing and from the studio into (or to other parts of) their home
- touching the lead came before eating, smoking, or putting hands in the mouth.
- stained glass cabinet doors in kitchens and other high touch areas have the same exposure pathways as above but the frequency of touching may be much higher.
- touching other surfaces covered in lead dust that were deposited by sawing, soldering, or handling the lead came
- touching other surfaces covered by lead dust or lead corrosion product that fell off the lead came.
- stained glass mounted in an external location exposed to rainwater will leach lead from the lead came and be carried by the rainwater to whatever is below it, such as soil. Referring to the section on lead flashing and lead planters and sculptures, this will create other exposure pathways by buildup of lead in the soil or other surfaces where the washed off lead can accumulate.
- cleaning/removing patina (which contains lead compounds) from the lead came, as recommended on some online website, resulting in lead/lead corrosion being spread to hands and surrounding surfaces and lead dust being released into the air. A picture showing someone cleaning the lead came with a bristle brush is shown on the following page.

Source: https://americanglassguild.com/forum6/40.html

Exposure to Sensitive Species and Environmental Release: The lead came may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater. Also, when mounted in exterior locations exposed to rain, lead will leach from the lead came and as described in the section on lead flashing, accumulate in the soil below the stained-glass window and or be washed into storm sewers, where it will eventually end up in a local body of water.

C. 2. Lead/tin solder

Various lead /tin solders, such as the classic 60/40 solder, are still sold for a wide variety of arts of crafts, even though electronics have removed the large majority of lead-containing solder, primarily driven by RoHS regulations in Europe. There may still be some professional uses of lead/tin solder (although time-limited exemptions in RoHS are now limited to just high lead solder used in flip chips) but there has now been enough experience using various lead-free solders that there are safer alternatives for hobbyists to transition to lead-free solder.

Sensitive Populations: Hobbyists, pregnant women, women of childbearing age, manufacturing and retail workers can be exposed during product manufacture, sale, use, and disposal.

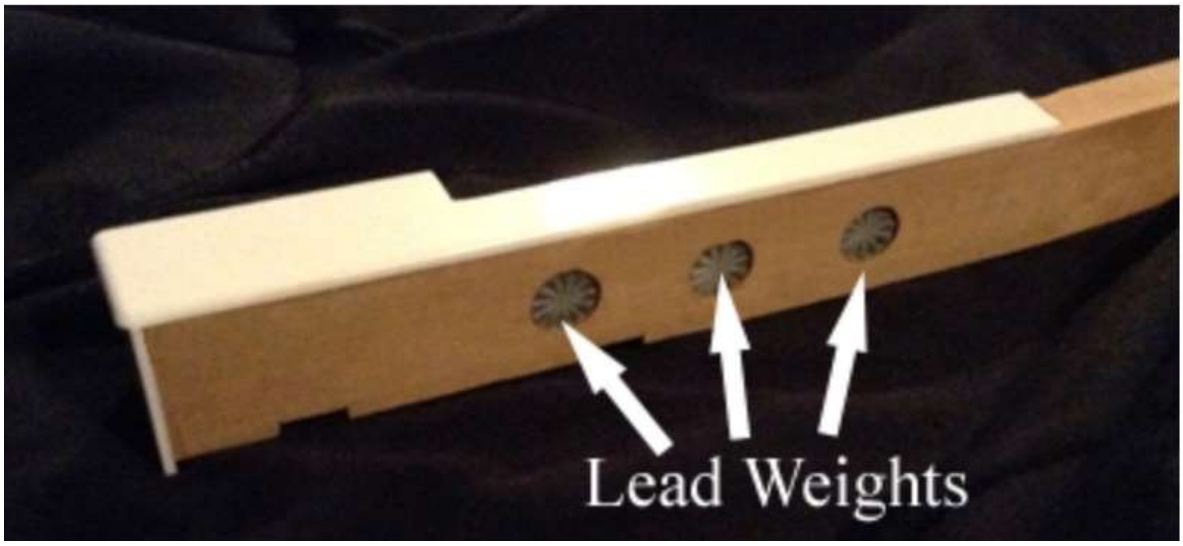
Exposure Pathways:

- inhalation of lead fumes when soldering.
- touching the lead/tin solder before eating, smoking, or putting hands in the mouth.

Exposure to Sensitive Species and Environmental Release: The lead came may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

C. 3. Lead Piano Key Weights

Lead weights are used to control the inertia, or 'weight', of piano keys. Piano tuners will add or remove weights to give each piano key the right feel.



Source: https://pianopricepoint.com/piano-touch-with-david-stanwood/

Sensitive Populations: Piano tuners, piano builders, and piano recyclers.

Exposure Pathways:

- touching the piano key weights before eating, smoking, or putting hands in the mouth.
- It's not clear whether lead dust is released onto the keys when lead piano key weights are installed. Additionally, the in some cases the lead piano key weights may corrode over time and release dust - I read some reports that other chemicals, perhaps in the wood, may interact with the lead piano key weights, resulting in the formation of corrosion and release some dust. This would take further study, but if true, then an additional exposure pathway would be anyone playing the piano and then eating, smoking, or putting their hands in their mouth.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

C. 4. Lead Curtain/Drapery Hem weights

These are solid weights or weighted lines or tapes sewn into the (bottom) hem of a curtain, drape, or shower curtain to make them hang straight.

Source: https://www.joann.com/fabric-cov-drapery-lead-weights-12ct/10702173.html

Sensitive Populations: Sewists, stitchers, women of childbearing age, pregnant women, children, and manufacturing workers.

Exposure Pathways:

- Handling/touching the weights (whether they are in a perforated pouch or bare lead) before eating, smoking, or putting hands in mouth.
- Abrasion of the lead weights by rubbing against other materials or hitting walls or other objects when curtains are opened and closed (particularly in a rougher manner by children) can further increase the lead available for pickup or contaminate surrounding surfaces.
- Children playing with the curtains and weights and then putting hands in their mouth. I remember doing this as a child, although the weights at the bottom of our blinds were thankfully steel.
- Weights that are removable may end up in a child's mouth.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

C. 5. Art Paints (Pigments)

Paint is a combination of a pigment, which gives it color, and a binder, also called a vehicle. The binder holds the pigment particles and is the film forming component of paint that allows it to be applied to a surface.

It is the pigments that historically have been the source of concern for toxic metals, including lead, cadmium, mercury, chromium, and others. Various lead whites (flake white, cremnitz white, mixed white, etc.) Naples yellow, and chrome yellow are examples of lead pigments.

Lead white paint for example, can be made by mixing lead carbonate (the pigment) in vegetable drying oil (the binder), usual linseed oil or safflower oil, or perhaps walnut oil. The amount of lead carbonate in the payment may be as high as approximately 50% by volume.

ECHA has added a number of lead pigments to Annex XIV of REACH so they are now banned in the EU except for restoration of historical art works by professionals.

Sensitive Populations: Artists, children, pregnant women, women of childbearing age, and manufacturing workers can be exposed during product manufacture, use, and disposal.

Exposure Pathways:

- Touching the lead paint before eating, smoking, or putting hands in mouth.
- Ingestion of lead due to inadvertent hand-to-mouth contact or pointing the paintbrush with the mouth while working with the paint.
- Inhalation of lead fumes when the paint is heated, sprayed, or sanded.
- Additional exposure may occur when old paint dries, cracks, and releases dust.
- Inhalation of lead dust when the dry pigments are mixed with binder to create the paint.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater. Products may also be disposed of down the drain when rinsing art tools and equipment.

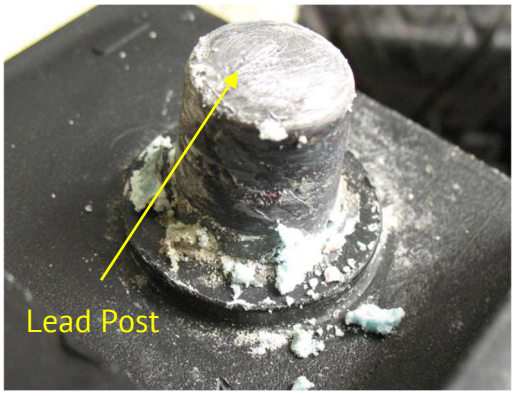
D) Vehicle Accessories

Product	Lead Content	Available Alternatives
Lead-Acid Batteries	~ 100% (Battery Plates and Posts)	Lithium-ion batteries
Lead Ballast	~ 100%	Steel, tungsten

D. 1. Lead-Acid Batteries

Used to start vehicles and maintain auxiliary power. Also used in other modes of transportation, such as golf carts and mobility scooters. Smaller lead-acid batteries are also used in electronics such as UPS (Uninterruptable Power Supplies).

While Lead-Acid batteries are generally sealed, the battery posts that stick out of them (where the positive and negative battery terminals and wires are attached) are typically ~100% exposed lead. The terminals that attach the electrical wires to the posts are often also made from lead or brass containing higher levels of lead.



Source: https://mechanics.stackexchange.com/questions/51885/what-is-battery-corrosion-material

Source: https://anewwayforward.org/battery-terminal-corrosion

Sensitive Populations: Mechanics, home auto maintainers, other technicians that install and maintain lead-acid batteries (such as for UPS, boats, golf carts, and mobility scooters), manufacturing workers, recycling workers, communities located near recycling plants, and women of childbearing age, pregnant women, and children can be exposed during product manufacture, installation, use, disposal, and recycling.

Exposure Pathways:

- Touching the posts and then eating, smoking, or putting hands in the mouth.
- Excess hydrogen gas and sulfuric acid vapors are released from a sealed lead acid battery to prevent a dangerous buildup of pressure. The released chemicals react with the lead posts, resulting in the formation of corrosion products. Referring to the previous pictures, the white powder on the anode lead post is generally lead sulfate while the blue powder at the cathode lead post is hydrated copper sulfate. Exposure pathways include touching the lead sulphate powder then eating, smoking, or putting hands in mouth.
- Home auto maintainers might not be aware that the white corrosion product is a lead compound or that the posts are lead – a reasonable oversight as the batteries are marketed as 'sealed lead-acid'.
- The lead sulphate powder can be spread to other surfaces or clothing when maintaining or removing the battery. For example, a friend just blows off the dust onto his garage floor and various online forums suggest washing off the lead dust with baking powder solution or coca cola. Presumably the lead dust on the garage floor is then swept into the trash or washed off into a drain, in both cases leading to environmental release.
- Using jumper cables with typically strong alligator clips can scratch off lead from the posts or terminals if not applied and removed carefully.

Exposure to Sensitive Species and Environmental Release:
lead-acid batteries are one of the most recycled products, at around 99%. However, 100 million lead-acid batteries are sold every year in the United States, mostly as starter (auxiliary) batteries for vehicles [16]. So, if 1% of those are not recycled, then 1 million lead acid batteries will eventually be released into the environment in some way.

And the 99% that are recycled are not problem free either. This recycling is often done by companies located in poor areas of the United States, or even more typically, in developing countries where lax enforcement of environmental rules leads to significant exposure to under-privileged workers and nearby residents, including children, pregnant women, and women of childbearing age. Have a look at a battery recycling operation below:

Source: https://e360.yale.edu/features/getting-the-lead-out-why-battery-recycling-is-a-global-health-hazard

The lack of awareness and scale of problems surrounding recycling of lead-acid batteries is described in [17]:

> "*From Vietnamese villages to the backstreets of Chinese megacities, from Roma camps in Kosovo to workshops in the shantytowns of Africa, from forest clearings in Bangladesh to giant smelters in India, the unsafe recycling of lead batteries, mostly from automobiles, is a lethal and growing scar on the planet. Perry Gottesfeld of Occupational Knowledge International, a San Francisco-based organization that campaigns worldwide against industrial pollution, calls it "the most serious environmental health threat to children.*
>
> *But somehow the epidemic of poisoning from this hugely profitable business is rarely seen as a global scandal. Most people have never heard of it.*

> *The automobile industry had appeared to have purged lead from its environmental CV with the almost-total elimination in recent decades of lead additives in gasoline. In the aftermath, blood-lead levels in hundreds of millions of people across the world fell, often dramatically.*
>
> *But now, those levels are rising again, says Richard Fuller, CEO of Pure Earth, a New York-based nonprofit, in large part because nobody thought about lead in automobile batteries, even though they start almost all of the 1.4 billion vehicles on the road today."*

Even in the United States, there are repeated instances of lead recycling and lead smelting plants contaminating their workers and surrounding communities. For example:

1. A now closed battery recycling plant near Vernon, CA contaminated nearby homes, schools, child-care centers, and parks, about 7,800 in total within 1.7 miles of the plant. In [18] they state that *"Among the most troubling findings, according to the auditor's office, was Toxic Substances Control's failure to remove lead-tainted soil from most of the 50 properties, including child-care centers, schools and parks, that it identified in the early stages of the cleanup as posing a particularly high risk to children."* Exide, who operated the plant, is now bankrupt. This environmental contamination from this battery recycling plant is now one of the most expensive toxic chemical cleanups in California history.
2. Also in California, in the town of Watts, "*The owners of a metal recycling plant operating next to a south LA high school campus have been hit with 22 felony charges, after decades of complaints that the facility was contaminating school grounds with lead and other toxic waste*" [19]. The article also notes that "Watts is checkered with recycling plants, lumber yards and fabricators. Noxious pollution also emanates from a freight expressway east of the high school. The life expectancy here is about a decade lower than in wealthier parts of LA.
3. A report in [20] details (with excellent graphics) how a lead smelter in Tampa Bay exposed hundreds of workers, mostly Black and immigrant, to dangerous levels of lead.

Transition from Lead-Acid to Lithium-Ion Battereis:

One can argue that these companies need to follow the laws but there are simply too many violations to make that argument in good faith. A safer option to lead-acid batteries is needed.

The performance, durability, and low weight of lithium-ion batteries, combined with advances and economies of scale that have dramatically lowered their cost, means there is finally the opportunity to transition away from toxic lead-acid batteries.

There are now numerous suppliers of lithium-ion batteries that can replace lead-acid batteries in both EVs (including battery EVs, plug-ins, and hybrids) and ICE (Internal Combustion Engine) vehicles. For example, Antigravity batteries (https://antigravitybatteries.com) makes a wide range of lithium-ion 12-volt batteries, including those for conventional gasoline ICE vehicles, power storage and backup, motorcycles, and more. Although their batteries are about 2X to 3X more expensive to similar high performance lead acid batteries, they claim these lithium ion batteries last 2X to 3X as long. Additionally the batteries save weight (which reduces fuel or electricity usage by the vehicle) and have innovative features, like wireless remote jump start (so if your battery is nearing discharge, it shuts itself off to maintain enough power to still start your vehicle. You then press a button on your phone, and it jump-starts your vehicle without needing any jumper cables).

The lead-acid battery industry has been working hard to update lead-acid batteries to compete with lithium-ion batteries, including AGM batteries. But despite the fancy new marketing, the same toxic lead problems remain.

Hyundai and Kia are now equipping their hybrid vehicles with 12-volt lithium-ion batteries instead of lead-acid ones, starting in 2017 with the Hyundai Ioniq Hybrid, as noted in [21] and [22]. They also have a handy feature that if the 12-volt lithium-ion battery is low, it can draw power from the vehicle's main lithium-ion batteries to recharge itself.

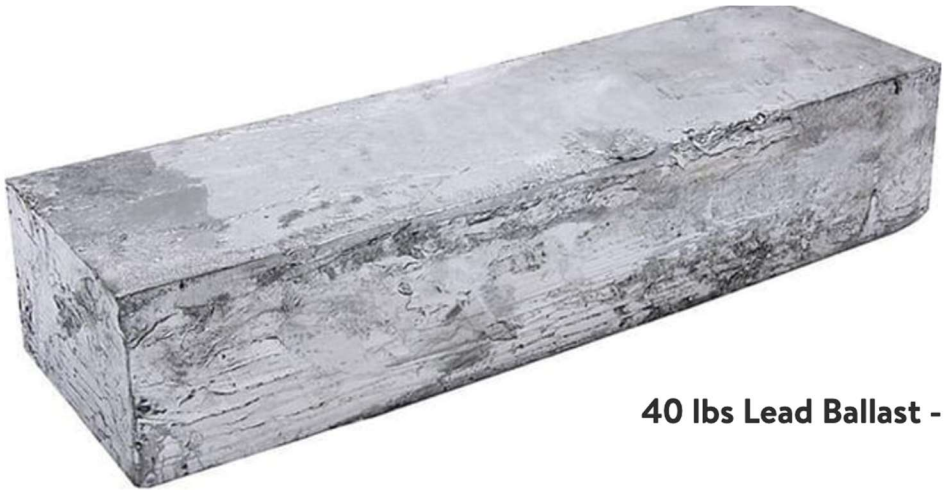
In 2021, Tesla switched the 2022 Model X and Model S from a 12-volt lead-acid auxiliary battery to a 14-volt lithium-ion auxiliary battery. [23] Telsa later began to equip all their new vehicles with lithium-ion auxiliary batteries. Tesla noted it made this shift as the lead-acid batteries didn't last long and required more frequent replacement.

However, other big automakers haven't yet made the shift to drop lead-acid batteries in favor of lithium-ion batteries.

Now is the right time to use regulations to prod the remaining automakers to use lithium-ion batteries. A mechanism to do this under the Toxic Pollution Law would be to restrict the sale of replacement (after-market) lead acid batteries for motor vehicles and to restrict the sale of new lead-acid batteries for consumer products such as golf carts, mobility scooters, and UPS power backup.

D. 2. Lead Ballast

Typically used to lower the center of gravity of a car, adjust weight balance, or bring a race car up to minimum weight.



40 lbs Lead Ballast - 12 x 3.5 x 2.5 in.

Source: https://www.walmart.com/ip/40-lbs-Lead-Ballast-12-x-3-5-x-2-5-in/5234254408?wmlspartner=wlpa&selectedSellerId=1148

Clamp On Lead Ballast Weight Bar, 25 LB

Source: https://www.speedwaymotors.com/Clamp-On-Lead-Ballast-Weight-Bar-25-LB,327253.html?utm_medium=CSEGoogle&utm_source=CSE&utm_campaign=CSEGOOGLE&gad_source=1

Sensitive Populations: Mechanics, home auto maintainers, vehicle recyclers, manufacturing workers, and retail employees can be exposed during product manufacturing, sale, installation, use, and disposal.

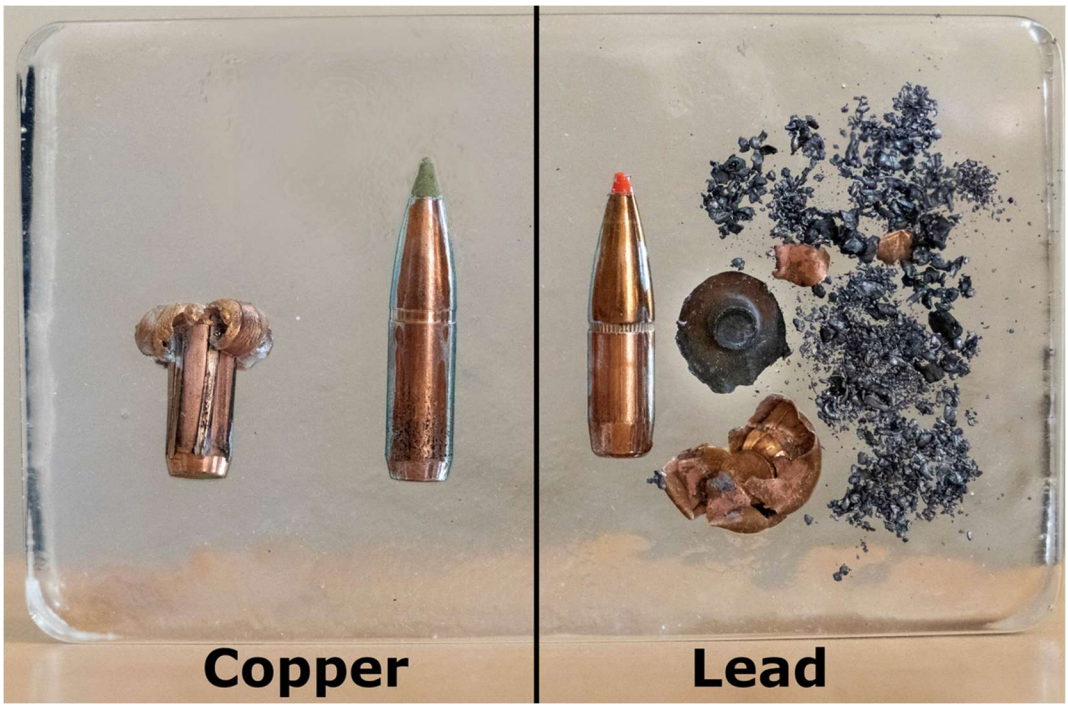
Exposure Pathways:

- Touching the lead weights, or areas contaminated by the lead weights, before eating or putting hands in the mouth.
- Depending on where the ballast weights are located, they may be subject to water or mechanical abrasion that will further increase the amount of lead released and available for pickup.

Exposure to Sensitive Species and Environmental Release: The product may be improperly disposed of as solid waste in landfills, where the lead can leach into soil and groundwater.

E) Ammunition

Product	Lead Content	Alternatives
Lead shot	~ 100%	Steel, bismuth, and tungsten shot
Lead bullets	~ 100%	Copper, copper alloys, zinc coated in copper, brass, tin, tungsten suspended in polythermal plastic



Source: https://www.usgs.gov/media/images/copper-and-lead-ammunition-comparison

Sensitive Populations: Sports shooters, hunters, gun range workers, manufacturing workers, people who melt lead to make ammunition at home, anyone eating game hunted with lead bullets, especially children and people of childbearing age (including game that is donated to food charities) can be exposed during product manufacturing, use, disposal, and eating wild game.

Exposure Pathways:

- touching the lead shot, or areas contaminated by lead shot or fired bullets, before eating or putting hands in the mouth.
- Inhalation of airborne lead dust, particularly in indoor gun ranges.
- inhalation of lead fumes when making lead ammunition, particularly people who make their own ammunition at home
- eating wild game with lead fragments from ammunition. In cases where the food is donated to charities, the people may not even be aware lead bullets were used.

Additional information on eating wild game [24]:

- *"The Minnesota Department of Natural Resources reported the results of a study to determine how bullets commonly used for deer hunting may fragment. They discovered that small lead particles were found up to 18 inches from the wound channel, farther than previously thought."*
- *"The Minnesota Department of Agriculture tested 1,029 packages of commercially ground venison and found 26 percent of those packages contained lead fragments. They tested 209 packages of whole muscle cuts and found 2 percent contained lead fragments. Test results from a limited sample of hunters who processed venison at home showed similar results."*
- *"Other game harvested with lead bullets or pellets may also be a source of exposure to lead. Studies have shown that game birds harvested with lead shotgun shells had elevated levels of lead associated with pellet wound channels."*
- *"Most of the lead fragments in meat are too small to see, feel, or sense when chewing."*

Exposure to Sensitive Species and Environmental Release: Lead fragments from shot or bullets can be eaten by various animals. Animals who survive being shot by lead ammunition can nonetheless be fatally poisoned or poison predators that in turn eat them.

The Center for Biological Diversity states that "In the United States, an estimated 3,000 tons of lead are shot into the environment by hunting every year, another 80,000 tons are released at shooting ranges, and 4,000 tons are lost in ponds and streams as fishing lures and sinkers" [25].

Proposed restrictions on lead ammunition (and fishing tackle) in the EU:
ECHA estimates in [8] that about 97 million lb. of lead are dispersed into the EU environment from the following lead use: 57 % from sports shooting, 32 % from hunting and 11 % from fishing activities.

As a result, the ECHA has proposed restrictions as follows [8]:

"*1. Lead in hunting, sports shooting and other outdoor shooting:*

- *sale and use of lead gunshot: ban after a five-year transition period. As current rules of international competitions specify the use of lead ammunition for certain disciplines, ECHA presents - as an option for the decision maker - a derogation for use of lead gunshot for sports shooting by licensed individuals only under strict conditions, i.e. when releases to the environment are minimised; and*
- *use of lead in bullets and other projectiles:*
    - *for hunting: ban after a five-year transition period for small calibre bullets and 18 months for large calibre bullets. The technical feasibility of alternatives to small calibre lead bullets should be reviewed before the ban enters into force.*
    - *for sports shooting: use can continue if releases to the environment are minimised within a five-year transition period. This means that sports shooting ranges are equipped either with trap chambers or 'best practice' sand traps."*

There is additional helpful information in [8], including an useful Q & A section, that can serve as a roadmap for restricting lead ammunition in Washington state.

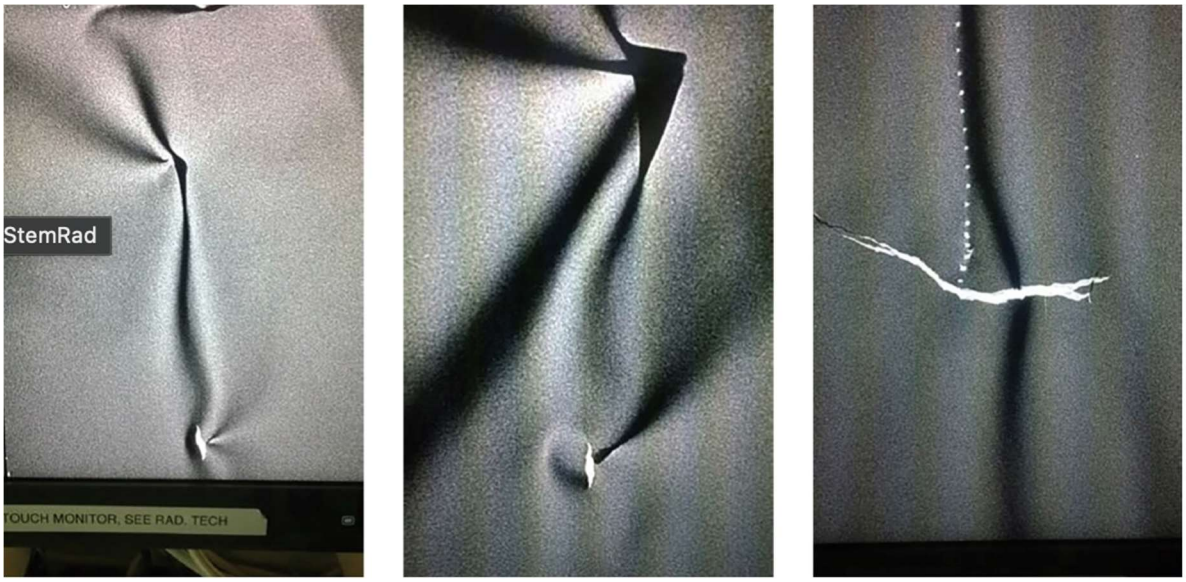
Restrictions on lead ammunition in California:

Since July 1, 2019, non-lead ammunition is required when taking any wildlife with a firearm anywhere in California [26].

F) Radiation shielding

Lead is used to attenuate (block) radiation in a variety of protective garments sold to dentists, medical doctors, nurses, radiology technicians, researchers, and nuclear power plant workers.

Product	Lead Content	Alternatives
Lead apron	~ 100% (metallic component)	A combination of aluminum, antimony, barium, bismuth, tin, titanium, or tungsten



Source: https://www.hmpgloballearningnetwork.com/site/cathlab/article/Your-Lead-Cracked-Radiation-Safety-Revisited

Exposure & Sensitive Populations: The most at risk population is people who work around X-ray and other radioactive equipment. Over time, the protective lead clothing will wear down, and the lead inside will crack, which would eventually release lead if not repaired or replaced in time. Although protective garments should be checked for damage, the focus of these checks is generally on their ability to block radiation and not necessarily whether they are releasing any lead particles. An example of tearing and cracking in a lead garment can be seen in the preceding above.

Safer Alternatives – Burlington Medical, who state they are the largest provider of radiation protection in the world, sells lead-free garments, based on Xenolite technology that was originally invent by DuPont [27]:

> *' A lead-free apron (LFA) is an apron made of a blend of attenuating heavy metals other than lead (Pb) and is a lightweight and non-toxic alternative to the traditional lead apron. These*

> *metals are usually some combination of aluminum, antimony, barium, bismuth, tin, titanium, or tungsten.* '

They also note in [27] that:

> '*Every year, more than 150,000 lead x-ray aprons are disposed of, adding in excess of one million pounds of toxic lead metal waste across the globe.*"
> In [27] they note the added benefit of lighter protective garments on the health of the workers: "*According to the Mayo Clinic, a recent study shows that many radiology professionals are reporting musculoskeletal pain from the weight of lead materials. Of those surveyed, 62% of technicians, 60% of nurses and 44% of attending physicians reported job-related pain. Pain was more often reported by women, workers exposed to radiation more frequently and by those who wore a lead apron more often.*"

A quick search shows there are other lead-free apron manufactures such Barrier Technologies who use a Bismuth-based amalgamation of different alloys, including titanium, magnesium, and tungsten. [28]

A new and innovative alternative is offered by EcoMass who use "environmentally friendly thermoplastic compounds that provide 100% lead equivalency shielding but without any toxic constituents". [29]

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