

# CRAFTSMAN'S CRIBSHEET

 NUMBER  
**64**

 Miles Free – Director of Industry Research and Technology  
  Technical  
  Regulatory  
  Quality  
  Management

## Leaded Steels: What You Should Know

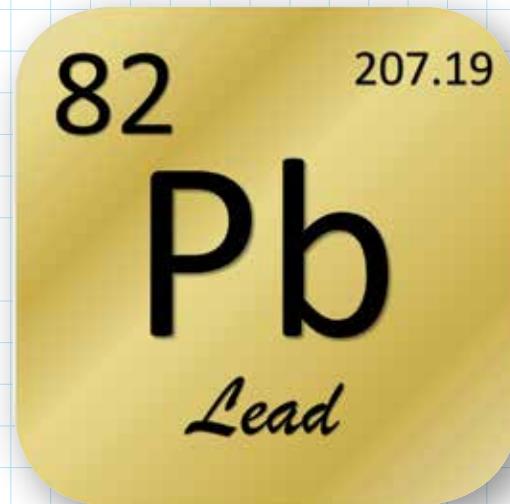
Lead is not banned by the European Union's "End of Life Vehicles Regulations" for machining purposes in steel, aluminum and brass. Lead is not banned by the European Union's "Restriction of Hazardous Substances (RoHS) Directive."

The exemption reads, "Lead as an alloying element in steel containing up to 0.35 percent lead by weight, aluminum containing up to 0.4 percent lead by weight, and as a copper alloy containing up to 4 percent by weight." This exemption is located in article 4.2 and Annex, line 6.

**If even the European Union recognizes the additions of lead in materials for machining is worthy of exemption, lead must provide some significant benefits, such as:**

- "Boosts machinability 25 percent at lower cost," says Pat Wannell, La Salle Steel, April 1994, quoted in "Modern Metals Magazine."
- "Cutting speeds can normally be increased from 15 to 25 percent above those employed for the standard grade." - Monarch Turning Manual
- "Lead, found mainly enveloping manganese sulfide inclusions, promotes machinability in two ways, possibly three. By forming a layer of liquid lubricant at the tool chip interface, it reduces the stress required to overcome friction. By acting as an initiator of microcracks and, possibly, by causing some liquid metal embrittlement, it reduces the deformation stress." "American Machinist" Special Report 790.
- In our experience, we have found leaded steels to lower cutting temperatures and reduce wear rates on tools, resulting in higher uptime. Surface finish on leaded materials is superior to those on non-leaded equivalents.

Increasing speeds and production, reducing power needed (and, thus, greenhouse gas emissions) and improving surface finish are some powerful advantages that are provided by the addition of lead to materials for precision machining.



### What's the downside?

1. Lead is not soluble in iron. It is therefore a separate phase in the steel, usually visible enveloping the manganese sulfides as tails, though sometimes appearing as small particles.
2. Lead has a higher density than iron. This means it will tend to segregate while the metal is liquid, given enough time.
3. Lead has a relatively low melting point (liquidus) compared with steel. This can mean that, as processing temperatures for heat treatment, leaded steel parts can exude lead.

These three factors mean that if you absolutely must have parts that are free from possible segregation, parts that will not have potential hollows or porosity after being exposed to high temperatures and absolutely no visible indications of a separate phase in the steel (that is, "lead stringers"), you probably ought to forego the leaded grade.

And forego the 25 to 30 percent savings that it gives you on the part machining cost. So, take your pick.

All Craftsman's Crib sheets are available for viewing and download at [short.productionmachining.com/cribsheets](http://short.productionmachining.com/cribsheets).



# Letter to My Son About Lead in Machining

By Miles Free – Director of Industry Research and Technology

Hi, Son,

Thanks for asking about whether or not lead is a hazardous material. I can understand your curiosity, knowing I worked with lead in the lab, in the melt shop, in the mill where probably 25 percent of our product was leaded steel for machining and in PMPA member company shops when I am asked to help them solve process problems.

In your shop, you probably don't see a lot of leaded materials, but some shops run almost exclusively on leaded steels, aluminums and brasses. The addition of lead to steel, for example, reduces the amount of power consumed and time required to machine by about 25 to 30 percent. Needing to be competitive in a global market, the reduction in cycle time, improvement in surface finish and the reduction in power needed to make the parts all help our shops be competitive and turn our quotes into orders. Orders that you produce.

The government has regulations that cover the use of lead in our shops, so we could say the government considers it to be a hazard. At the same time, these regulations do not ban its use. If a shop exceeds the quantity of 100 pounds of lead in, "manufacturing, processing or otherwise used in operations," it must be reported under community right to know and toxic release inventory regulations.

The European Union has a host of regulations that purport to ban or control hazardous materials, and yet most of those that affect the products made by our shops exempt lead. The original 2005 ELV Directive bans lead in Article 4.2(a) "...lead, mercury, cadmium or hexavalent chromium other than in cases listed in Annex II under the conditions specified therein." But when we go to that Annex II, it exempts lead for machining purposes in steel, aluminum and brass. Here is what the Annex II states:

*Lead as an alloying element: 1. Steel for machining purposes and galvanized steel containing up to 0.35 percent lead by weight. 2. a) Aluminum for machining purposes with a lead content up to 2 percent by weight (expires July 1, 2005 per website, current status unknown). b) Aluminum for machining purposes with a lead content up to 1 percent by weight (expires July 1, 2008). 3. Copper alloy containing up to 4 percent lead by weight.*

Other European regulations that concern lead include WEEE Directive, which works in concert with RoHS; RoHS (now RoHS II Recast) and others. PMPA has been keeping our members updated on the RoHS recast, and our members got a



sneak peek of the June 7, 2016, final report of the study by Oeko-Institut, Fraunhofer and IZM for the Commission, regarding exemption recommendations, which still have not been adopted by the Commission.

In my opinion, the reason lead has not been banned from our work materials is that the environmental advantages leaded materials provide far outweigh the actual human dangers to us on the job. From an environmental point of view, lead as a free machining additive saves between 25 to 30 percent of the energy required to produce suitable parts in steel by machining, so it can be argued that it is more a boon than a bane if we are looking at CO<sub>2</sub> emissions (greenhouse gases GHG) deferred. It has no effect on mechanical properties. This is also presuming no one is actually *eating* the manufactured parts that might contain 0.25 percent of lead added to reduce the energy required to machine the steel. I wrote an article, "Leaded Steels to Protect the Environment," in "Screw Machine World" Vol 2 No. 4 (July/Aug 2002). In that article, I compared the 10 percent savings on horsepower alone required to more than meet the 7 percent reduction targets of the Kyoto protocols and called lead a winner. Lead in steel for machining saves time, energy and reduces the GHG footprint as it increases your shop efficiency.

From a workplace exposure point of view, in machining shops like ours, where there are no lead vapors or fumes, human pickup of lead is unlikely except through absorption from contact with lead or lead-containing materials. Great

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## Letter to My Son About Lead in Machining

hygiene, hand washing before eating, no snacks and no smoking in operating areas, and separate lunchrooms from operating areas are best practices to minimize exposure. Welding or cutting operations that can cause a metal fume provide a pathway for uptake through inhalation and should be assessed for adequate ventilation and exposures monitored. Time of exposure to workers around molten leaded metals is also mandated and monitoring was required in my experience in steelmaking meltshops and continuous casting operations.

The Occupational Safety and Health Administration requires manufacturers to provide a safety data sheet for hazard identification of materials that they produce.

Is this dangerous material? From the current GHS sheet for Leaded Carbon steel bars from Republic Steel:

H302: Don't eat it. **OK.**

H372: Harmful through prolonged exposure. **Check: What is your exposure? What is the dose? How long?**

P260: Don't breathe in dust or fumes. **This is hard to do from a solid piece of barstock.**

P264: Wash hands. **Check. Not exactly the scariest thing you'll encounter today.**

P270: Don't eat, drink, or smoke while using this product. **This is common sense.**

P272: Isolate contaminated work clothing. **This makes sense, but again, how is the lead, which is in a solid form in the metal, contaminating the clothing?**

Bottom line: Don't eat it, don't cut leaded products with a torch and limit exposure time if working around molten leaded metals. Otherwise, remember your lessons from kindergarten and wash your hands, and don't eat or drink if you aren't in the lunchroom.

Hope this helps.

Love, Dad

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## Why Join PMPA? GROW!

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Through the meetings, resources and online connections, reports and more, we give you the tools to grow. We look at emerging markets and let you know what's hot and what's not. PMPA programs help you understand your markets so you can make sense of the issues. And we provide relevant information to help you make informed decisions.