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To: ECHA
European Chemical Agency
Telakkakatu 6, P.O. Box 400, FI-00121 Helsinki, Finland

Date: 04.05.2021.

RE: Report on lead restrictions and using muzzle loading and breech loading firearms designed for black powder and lead projectiles

Dear Madam/Sir,

On behalf of the Hungarian Muzzle Loaders and Hunters Association (member of Muzzle Loaders International Confederation) we are submitting our report on using lead and non-lead projectiles in muzzle loading and breech loading firearms designed for black powder and lead projectiles.

1. **What is black powder shooting and hunting?**
    a. Shooting sports: Shooting with original or reproduction muzzle loading and breech loading firearms designed originally for black powder charges and soft lead bullets is more than a shooting sport. This activity is a recreational hobby of hundred thousands of sports shooters all across Europe, but it is also cultural and scientific activity. These arms are used for paper target shooting and for clay target shooting as well. Shooting with antique firearms and their modern time faithful reproductions has a scientific impact as well: plays an important part in preserving antique firearms and cultural heritage, but also aids researchers through experimental archaeology. The shooting sports are governed by the Muzzle Loaders Associations International Confederation (MLAIC), and national organizations like shooting cubs' national associations, and shooting clubs. According to MLAIC rules the firearms must be exact reproductions of originals or originals, the load should be only black powder and lead projectiles. Substitution of lead is only possible in case of shot.
    b. Hunting: Hunting with muzzle and breech loading vintage style firearms designed for black powder and lead projectiles is an ethical and popular hunting method. In numbers it is significantly less compared to hunting with modern firearms. Due to the technical parameters of these firearms, the hunt itself is more challenging and adventurous.

c. Firearms: The muzzle and breech loading firearms used for both activities are originals and reproduction of originals designed and CIP proof tested for black powder loads and lead projectiles.

2. **Substitution of lead as a projectile material**
   a. Physical requirements of a projectile for firearms designed for black powder and lead bullets. **This section of our document is based on the report of the Hungarian CIP Proof House on the effect of lead restrictions on black powder firearms:**[1]
      i. Deformability while loading: The projectile loaded into the bore of a muzzle loading arm is required to have a soft material than can deform easily while being loaded into the bore. Round projectiles are generally loaded with textile patching, that create micro grooves on the surface of the bullet to grasp the projectile firmly and transfer the spin of the rifling for accuracy. Many types of bullets are designed to be loaded without textile patching, larger than the land-to-land diameter of the bore, to be cut by the rifling while loading them into the muzzle. Some projectiles loaded into pillar and chamber breech rifles have to be hammered on the charge with the ramrod. The chambers of the percussion revolvers are loaded with oversized soft lead round balls, while the chamber mouth sheers a thin ring of lead from the bullet, an indication that the seal of the chamber is existing. This prevents chain-fires and keeps the bullet in place while the arm is being fired. **Any alloy harder than lead will prevent deformability required for loading the muzzle loading firearm.**
      ii. Deformability while firing: expansive and compressive bullets are also used for muzzle loading firearms. These projectiles deform highly while firing due to the gas pressure of the propellant. They are smaller or equal to the land-to-land diameter of the bore and are upset in the breech to fill the grooves of the rifling upon firing. **Any alloy harder than lead will prevent deformability required for firing these projectiles accurately.**
      iii. Castability, possibility to fine tune the projectiles: both antique and modern reproduction muzzle loading firearms are used all across Europe for sports shooting and hunting. The calibres of the muzzle loading arms are not standardized, therefore nearly all firearms' loads have to be fine-tuned for maximum accuracy. Shooters and hunters using muzzle loading firearms or breech loading firearms designed for black powder charges and lead projectiles require a metal that can be used for casting the specific diameter, length, weight projectile matching the specifications of the bore. Users also need a soft projectile material that allows properly sizing the projectiles to 0,001" accuracy. **There are no known materials other than lead today allowing castability and ability to fine-tune the cast projectile to exact required specifications.**
      iv. Control of gas pressure: black powder firearms – both antique and both modern time reproductions – are designed for the moderate gas pressures generated by black powder and soft lead projectiles. Black powder firearms –

[1] E. Hamza, N. Szabian, Ö. Kalamár: Report on lead restrictions on black powder firearms. Published by the Hungarian CIP Proof House. http://pklv.hu/ECHA_lead_ban_on_black_powder_guns-Study_of_the_Hungarian_Proof_House.pdf Access: 2021.05.05. 7:40

both antique and both modern time reproductions – are officially proofed for such load components. The soft lead projectiles play an important part in managing gas pressures. **Any harder-than-lead projectile material will certainly increase gas pressures, and can lead to structural gun damage and risks of personal injury. These arms were neither designed, nor proofed for projectiles harder than lead.**

v. Unloading a muzzle loading arm: Muzzle loading firearms are loaded and if necessary emptied from the direction of the muzzle. This is done using "bullet screw" attached to the ramrod. The screw has to penetrate the soft material of the bullet, so it can be pulled. **Any alloy harder than lead will prevent unloading the muzzle loading arm.**

b. Available lead substitutes and firearms designed for black powder and lead projectiles. **This section of our document is based on the report of the Italian CIP Proof House regarding the possibilities of substituting lead in muzzle loading firearms:**[2]

i. Bismuth: the hardness of bismuth is significantly higher than lead, while its melting point is much lower. Bismuth has an excessive friability, while it can ignite while heated and produces bismuth-oxide. To control these parameters, it has to be alloyed with such toxic materials as antimony. **Bismuth is therefore not a suitable substitute for lead.**

ii. Tin: although the hardness of tin is close to lead, its melting point is significantly lower, while the material itself is subject to "tin plague", therefore has to be alloyed with such toxic materials as antimony. Its specific weight is also less than lead, therefore **tin is not suitable for replacing lead.**

iii. Monolithic projectiles from harder-than-lead materials: Barrels of muzzle loading and breech loading firearms are designed for black powder charges, and their rifling were not designed for monolithic bullets. Such bullets might increase gas pressures to dangerous levels the firearm was neither designed, nor proof tested for. Monolithic projectiles are much harder than lead and lack the physical specification required by deformability (see. 1. a. I., II., III., IV. and V.) **Monolithic projectiles are not suitable for firearms designed for black powder and lead projectiles.**

c. **Conclusion: there are no material know today that can substitute lead in case of muzzle and breech loading firearms designed for black powder and lead projectiles.** These conclusions are in accordance with the reports of the Italian and Hungarian CIP proof houses.

3. Health risks of using lead projectiles

a. Exposure to lead while shooting and hunting: Black powder hunters and shooters do understand that handling lead has health risks. This risk is reduced through education. Mandatory black powder exam is necessary for black powder hunting license in Hungary, that focus on safe handling of lead also. Hungarian sports shooters are monitored yearly by mandatory health checks. Hunters are monitored in every 2-10 years periodically depending on age.

b. Exposure to lead while casting bullets: Black powder hunters and shooters do understand the risks of casting bullets from lead. This risk is reduced through

[2] Use of lead in muzzle-loading guns. Published by Banco Nazionale di Prova. 2021.05.04. See Annex 1

education and by well understanding product user manuals supplied by manufacturers of accessories for bullet casting.

c. **Conclusion: black powder shooters and hunters are qualified to manage the health risks of handling lead projectiles and casting bullets.**

4. **Lead projectiles and outdoor shooting in Hungary**
    a. Legal and safety requirements of outdoor shooting ranges in Hungary: according to Hungarian firearms laws all shooting ranges must be designed to safely prevent projectiles exiting the area of the shooting range. This is prevented by bullet traps, ceiling buffers and safety zones.
    b. Lead management of shooting ranges: all lead projectiles remain within the boundaries of the safety zone, therefore lead management is possible.
5. **Lead projectiles and hunting activities in Hungary**
    a. The share of lead shot and solid lead projectiles fired from firearms designed for black powder and lead projectiles is marginal compared to the use of modern hunting firearms.
    b. Black powder hunting in the EU: Hunting with muzzle loading and breech loading firearms designed for black powder and lead projectiles is a popular activity in nearly all EU member states. Compared to the number of hunters with modern firearms the number of black powder hunters is significantly less. Both lead shot and solid lead projectiles are used for hunting small and big game. The solid lead projectiles used for black powder firearms are slower and heavier than modern hunting projectiles, therefore they behave differently at impact. Due to the low velocities and lower impact energies the lead does not evaporate upon impact, therefore the lead contaminated meat is much less, it is easy to remove during the cleaning of the game, therefore health risks of consuming lead are much less compared to modern firearms.
    c. Lead contamination of the soil due to hunting activities:
        i. Lead contamination of the soil in Hungary: Lead contamination of the soils of Hungary are monitored by both EU and Hungarian authorities. Such report about the heavy metal contamination was prepared by the University of Szeged in 2001. The conclusion of the report was the following regarding lead: ***„In respect of Pb and Co we did not find problems. But the Ni and Cu contents are higher than the Hungarian pollution limiting values."***[3] Lead contaminated areas in Hungary are related to main roads crossing the country rather than hunting activities. Dr. Andrea Farsangi states the following in her report from 2011: ***„The lead contamination developed until the end of the researched time period is the result of the old type of fuels containing lead additives."***[4]
        ii. Lead contamination of the soil in the EU: Eurostat together with the European Commission's Directorates-General for Environment (DG ENV) and the Joint Research Centre (JRC) established a topsoil assessment component called 'LUCAS-Topsoil'. In coherence with the goal of the LUCAS project, 220,000 points are regularly monitored all across the EU. In 2009 and 2013 10% of these points were statistically analysed to obtain a picture about the

[3] Bárány-Kevei et al. p90

[4] Farsangi 2011. https://regi.tankonyvtar.hu/hu/tartalom/tamop425/0021_Talajvedelem/ch04s04.html Access: 2021.05.03. 14:00

heavy metal contamination of the top soil of the EU members states. The results were published as a study of G. Tóth, T. Hermann, M.R. Da Silva, L. Montanarella in Environment International: *„Based on our regional assessment, Central Italy, France Germany and the UK display the highest share of samples with relatively high concentrations of Pb in soils (Fig. S8A, B). Samples from the Baltic states, Finland and Hungary did not display detectable traces of lead contamination on agricultural land (Fig. S8B). The highest percentage of samples with Pb concentrations above the threshold value is found in Lazio province in Central Italy, probably due to the abundance of tertiary volcanic material in this region. However, none of these samples display a concentration above the guideline value for agricultural land.* ***Such samples are very rare; only a few cases around Europe were found among the over twenty thousand samples, indicating that currently lead is not a problem for food safety."***[5]

iii. Protecting wildlife of wetlands: Hungary as most of the EU member states is part of the Ramsar Treaty, and also the Hague Convention for protecting the wetlands, and accordingly banned the use of lead shot in such areas.

d. Conclusion: There is no proof that, on areas other than wetlands, hunting is responsible for lead contamination of the soil. The case of shooting ranges should be separated from the case of hunting. Their lead contamination is of course existing. But this is the reason why we do not grow plants on shooting ranges, nor we feed cattle there. Bullet stops and safety areas of shooting ranges allow proper management of lead, and they prevent bullets and shot exiting to agricultural lands. Instead of banning lead, the appropriate goal should be the proper management of lead on shooting ranges.

6. Safety and liability

a. Proofing of firearms designed for black powder and lead projectiles: "C.I.P. (Commission Internationale Permanente, www.cip-bobp.org) is an international organisation set up by the Brussels Convention of 1 July 1969 to ensure the technical safety of civilian guns and ammunition, with the standardisation of the safety testing procedures and mutual recognition of other member countries tests and test marks (proof marks)."[6] According to the report of the proof house: *"C.I.P. as the governing body in civilian firearms safety testing in their member countries – including proof testing – apply decisions on proofing muzzle loading firearms with the use of black powder and lead projectile. (Decision XIX.-7)* ***The proof of the muzzle loading firearm ensures safe usage with lead projectiles****."*[7]

b. Manufacturers recommendations for firearms designed for black powder and lead projectiles: black powder arms are designed for the low pressure of black powder charges and soft lead projectiles. **Any change in the system might cause unpredictable increase in gas pressure that the firearm was neither proof tested, nor designed for.** The major manufacturers therefore recommend using only black powder and lead projectiles. The product warranty and liability are strongly related to this fact.[8]

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[5] Tóth et al. 2015. p307

[6] Hamza et al. 2021. p3

[7] Hamza et al. 2021. p6

[8] Pedersoli Users Manual: „Use lead bullets only." p11; Uberti Users Manual: „The recommended projectile to assure the greatest accuracy and consistency is a round ball (cast or swaged) of pure lead."

c. Conclusion: Firearms proofed and manufactured to be used with soft lead projectiles cannot be operated safely with harder-than-lead projectiles. ***"Failure of firearm pressure parts and possible resulting injuries caused by non-lead projectile use in these reproductions would exclude product liability of their manufacturers."***[9]

7. **General conclusions and impact of lead ban:**
    a. There are currently no known materials that can substitute the lead for firearms designed for black powder and lead projectiles.
    b. Replacing the lead with harder materials in firearms designed and proofed for black powder and lead projectiles may cause structural gun damage, cause human injury and raises liability and legal questions.
    c. Firearms proofed and manufactured to be used with soft lead projectiles cannot be operated safely with harder-than-lead projectiles.
    d. There is no proof that hunting in areas other than wet lands is responsible for the lead contamination of the soil. Regarding shooting ranges and sport shooting use of lead bullets: the right direction is setting up proper measures for lead management at the range area, rather than banning the lead projectiles entirely. Shooting ranges are closed systems surrounded by bullet stops and safety zones, where lead management is a possibility. Instead of lead ban, we should talk about lead management.
    e. Banning lead will certainly kill all recreational shooting and hunting activities with muzzle loading and breech loading black powder firearms.

Best regards,

Balázs Németh, PhD

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Hungarian Black Powder Shooters and Hunters Association

[9] Hamza et al. 2021. p6

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Use of lead in muzzle-loading guns. Published by Banco Nazionale di Prova (document attached in Annex 1)

E. Hamza, N. Szabian, Ö. Kalamár: Report on lead restrictions on black powder firearms. Published by the Hungarian CIP Proof House. http://pklv.hu/ECHA_lead_ban_on_black_powder_guns-Study_of_the_Hungarian_Proof_House.pdf Access: 2021.05.05. 7:40

Users Manual of Pedersoli Firearms: https://www.davide-pedersoli.com/storage/app/uploads/public/609/11e/8cb/60911e8cb786d471448638.pdf Access: 2021.05.04.

Users Manual of Uberti Firearms: https://www.uberti-usa.com/sites/default/files/originals/product-manuals/black_powder_revolvers.pdf Access: 2021.05.03. 14:30

Annex 1

Banco Nazionale di Prova
per le Armi da Fuoco Portatili e per le Munizioni Commerciali
CAVENDO TUTUS
ENTE DI DIRITTO PUBBLICO ISTITUITO CON R. DECRETO 13-1-1910 N. 20 - RIORDINATO CON LEGGI 23-2-1960 N. 186 E 14-3-1968 N. 317 GARDONE VALTROMPIA - (BS) – ITALIA
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Prot. n. 00216 /EP- vf

Gardone V.T., 03 maggio 2021

Object: use of lead in muzzle-loading guns

Ref.Prot. n° 33 dated 20th of april 2021

Dear President,

the technological problem you have proposed presupposes the identification of a new metal material that can substitute lead in antique original muzzle-loading guns and reproductions of models prior to 1890 for ecological reasons. Before addressing any consideration of technical nature, it is necessary to outline the key aspect of the proposed problem, namely the identification of an alternative solution to lead which at the same time guarantees the following:

– the safety of the shooter using the gun.
– the non-toxicity and eco-sustainability of the new identified material.
– maintaining the functionality and ballistic performance of the guns.

Currently, a material that can effectively replace lead in this context, has not yet been identified and the issue is still the subject of study and of different experiments. The reason why the solution to the problem has not yet been easily reached, I believe, is due to the particular performance of the material that is a candidate for the substitution of lead used shooting this type of firearms.

Moreover, the new material that should be identified, must ensure the correct working of the gun and at the same time provide acceptable ballistic performances. The material must not feature excessive hardness in order to be able to engage without excessive effort the barrel's rifling, in particular for muzzle loading ones, and at the same time, must be characterized by a melting temperature such as to avoid liquefaction due to the heat produced by the shot.
In fact, for this type of firearms it is not possible to use bullets with external coating of harder material. Furthermore, the material must not show flaking phenomena to avoid its fragmentation during the shot due to the produced pressures.

In the present case, the search for alternative solutions to lead is also complicated by two factors:
The first is the limitation in the use of metal alloys, as the main binders (for example antimony) which are generally characterized by toxicity similar, if not more, to the lead.

Secondly, even if we wanted to evaluate solutions with physical-mechanical characteristics worse than those of lead, it would always be necessary to pay close attention to the pressures that can be reached due to these new bullets, as the material used in antique guns does not allow the use of ammunition that develop higher pressure levels than those currently produced by the lead ball-black powder combination.
In this regard, it is necessary to consider that for antique original guns and replicas of them, black powder is the absolute one that develops lower pressures and therefore there are no other propellants with lower liveliness characteristics that can compensate for the increase in pressure using materials other than lead.
Ultimately, the candidate material for the replacement of lead should be suitable for the use of current propellants (black powder) while ensuring safety shooting, to avoid damages to the shooter and the gun. Therefore, the material must avoid excessive hardness to be able to adapt and go through the rifled barrel without creating obstructions, a condition that would develop abnormal pressures with possible breakage of the gun and damage to the person.

Another problem not to be underestimated in the choice of material is the bullet deformation ability upon rebound. In fact, the tests made with lead-free bullets, produced with harder and less malleable than lead materials, have shown how, compared to lead bullets, they can undergo rebounds, maintaining a much larger mass and a much higher energy, they can have longer ranges and different rebound angles. It is useless to remember how the bounces of these bullets can be extremely dangerous in case of use both in non-confined environments and in shooting ranges.

In light of the above, after having carried out a review of the characteristics of metals (with the exception of metals that are difficult to find such as those of the seventh level of the periodic table of the elements –Mendeleev's table- and of the Lanthanides and Actinides and of those in the liquid state, such as Mercury, or dangerous due to their chemical reactivity such as alkali metals, or those notoriously toxic, such as thallium, polonium, etc.), two metals with hardness characteristics similar to that of lead have been identified, namely tin and bismuth. Below, some considerations will be made regarding the metals that are candidates for the substitution of lead in use for original antique and muzzle-loading guns:

<u>Tin</u>
Tin is characterized by a hardness HB equal to 4 and therefore similar to that of lead. The main contraindications in the use of this metal are due to the low melting point of 231.9 ° C compared to the 327.4 ° C of lead, a circumstance that increases the possibility of the bullet melting during the firing phase. Furthermore, when heated, tin loses its ductility, becoming brittle. This metal should also be bonded with antimony and bismuth to avoid deterioration and pulverization caused by the so-called "Plague of the tin". However, the use of binders, such as antimony, a notoriously toxic element, is not suitable for ecological purposes for which we are working. A further problem of the use of tin is the low specific weight of 7.3 g / cm3 compared to 11.3 g / cm3 of lead, a feature that significantly varies the ballistic coefficient of the bullet, consequently reducing its performance aerodynamics. From an economic point of view, tin currently has a market cost of about 1-2 times higher than lead.

Bismuth

Bismuth has a hardness of 7 HB and is 75% harder compared to the lead (4 HB). The main problem for the use of bismuth is due to its excessive friability. Similar to tin, bismuth is also characterized by a low melting point equal to 271 ° C compared to 327.4 ° C for lead, a circumstance that increases the possibility of the bullet melting during the firing phase. Also, when heated, bismuth in air can ignite and burn with a blue flame, producing yellow fumes of bismuth oxide. The friability and the tendency to melt could be reduced by using binders, such as antimony, metals which however feature a certain toxicity and which therefore are not suitable for the ecological purposes we are working for. From an economic point of view, bismuth currently appears to have a market cost about 5-10 times higher than lead.

Considerations

The examination of the qualities of the other metals has shown hardness characteristics that are many times higher than those of lead, a feature that is considered dangerous using in original antique and muzzle-loading guns due to the increase in pressures that would be determined by the greater effort generated from the bullet going through the barrel. This circumstance could also cause the firearm to break due to a burst with possible physiological damage to the shooter.

The Manager
(Dott. Emanuele Paniz)