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Report on lead restrictions on black powder firearms

The Hungarian C.I.P. Proof House

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Lead-ban and the black powder firearms

With reference to the published ECHA document on the proposed regulation/prohibition of projectiles with lead content in firearms, and with understanding the necessity of providing such technical information to ECHA regarding the proposed lead ban measures with reference to muzzle loading and antique breech loading arms, which may not have been available to it while drafting the the text of its proposal we have prepared the study below.

We would like to prevent ECHA from introducing such prohibitive restrictions which would render antique black powder muzzle loading guns and their reproductions and vintage black powder breech loading guns unsafe to use through causing possible danger of physical injury to their users.

C.I.P.

C.I.P. (Comission 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).

C.I.P. has 14 member countries, of which 11 are EU members as well. Some non-C.I.P. EU countries also regulated the technical gun and ammunition safety in compliance with C.I.P. standards (Croatia, Slovenia).

The Council Directive 91/477/EEC of 18 June 1991 on control of the acquisition and possession of weapons CHAPTER 3 Article 11 2. writes:

“Where a firearm is to be transferred to another Member State, the person concerned shall, before it is taken there, supply the following particulars to the Member State in which such firearm is situated:

—the particulars enabling the firearm to be identified and also an indication that the firearm has undergone a check in accordance with the Convention of 1 July 1969 on the Reciprocal Recognition of Proofmarks on Small Arms,”

This document was written by the Hungarian C.I.P. delegation in hand with the Hungarian C.I.P. Proof House, and published at the official website of the Hungarian Proof House at www.pkiv.hu

Explanations

“*antique*” firearm: in this study we understand under this designation a black powder muzzle loading firearm designed and manufactured during the black powder era till around 1890.

“*replica*”, “*reproduction*” firearm: we understand under these designations working direct copies of antique muzzleloading firearms.

“*vintage*” firearms: we understand under this designation those breech loader, black powder guns designed for lead bullet use, which were manufactured till the end of the 19th century.

“*modern design*” muzzleloading firearm: 20th and 21th century design, in-line ignition muzzleloading firearms made according to the US requirements for their special hunting season.

Arms manufactured and designed for black powder and lead projectile

A historical perspective on arms designed for black powder

Black powder guns – both muzzle loading and breech loading – were used for hunting, sports shooting and military purposes from the 14th century, till the end of the 19th century. Black powder is a mixture of potassium nitrate, charcoal and sulphur, and it is still manufactured from these ingredients by modern-day manufacturers.

The first handheld firearm was the muzzle loading handgonne, having no lock, just a forged or cast barrel closed on one end with a breech piece with a flash hole. These arms were loaded from the muzzle: powder, wadding and projectile. During the long development of the muzzleloading firearms more and more advanced ignition mechanisms as wheel lock (15th century), flintlock (in the second half of the 16th century) and percussion ignition (beginning of the 19th century) appeared. But the basic loading method – load through the muzzle remained all over this period. The rifling which gives spin to the bullet appeared first with the wheel lock, but became a common feature during the 19th century. The patched lead ball was replaced by new long, conical bullets by the middle of the 19th century, and these combined with the rifled bore increased the accuracy and effectivity of the the arms. The black powder propellant was improved to some extent with the development of powder mills, and with granulation. What remained unchanged along the centuries is the bullet material: soft lead.

From the 1840s many breech loading firearms were invented for different type of paper and metallic case cartridges still loaded with black powder. Nikolaus Dreyse's needle-fire rifle, Louis-Nicolas Flobert's rimfire system, Casimir Lefauchaux's pinfire systems paved the way towards the invention of the centre fire cartridges. These early – pre 1890's – cartridges were solely loaded with black powder and soft lead conical bullets. Up until the first arms designed for high energy smokeless powders, all the metal parts of these arms were designed to withstand the limited gas pressure of the black powder charge topped by the soft lead projectile.

Modern time use in Europe

Black powder arms – both muzzle loading and breech loading – are still used for sports shooting and hunting today. The Muzzle Loaders International Confederation (MLAIC) was founded in 1971 to be the World governing body of muzzle loading sports. MLAIC is responsible for organisation of World Championships, European and Zone Championships. These competitions are organised both for reproduction and original arms. In all cases only black powder and lead projectiles are allowed for the shooters mainly for safety reasons.

Besides competitive black powder shooting, recreational shooting with these arms also exists.

Black powder hunting with muzzle loading and vintage breech loading black powder guns is also present in Europe as a traditional hunting form. Black powder hunting highly differs from modern hunting as it lacks the modern features as high power scopes, night vision aiming systems, repeating or semi-automatic firing and the range of the smokeless powder guns, giving the game more chance, and facing the hunter with real adventures. Hunting with muzzle loading guns is legal in many EU member states.

Their use for re-enactment is out of the scope of this study as re-enactors do not shoot projectiles, just blank charges.



1. Original muzzle loading rifle (source: www.kapszli.hu)

The scope of this study does not include modern design muzzleloading firearms, as their design allows more flexibility in the material of bullet used for them.



2. Modern design in line muzzle loader (source: muzzle-loaders.com)

About black powder

Black powder – as a ballistic propellant – has approximately one-third of the energy content of the modern smokeless powders. Additionally, its burning rate does not change significantly with the pressure developed, while used in guns. It generates less steep pressure rise compared to smokeless powders while it is used with traditional lead projectiles which the black powder firearms were designed for. This is the reason for antique black powder guns made with old manufacturing technologies (barrels made by casting, sheet metal rolling and forge-welding, twist / damascus barrels, etc.), from low-grade construction materials (at least by 21st century measures), and with less pressure resistant ignition systems (matchlock, flintlock, percussion, pinfire, rimfire) could and in many cases still can safely withstand the pressures generated by the black powder propellant.

The 20th-21th century reproductions, replicas of these antique firearms have almost identical properties, as the system of the guns match their original, and the structural materials used for them is selected to meet black powder and lead projectile requirements. This practice is based on the mechanical design principle that the properties of materials have to match the planned stress and wear. This stress and wear is obviously less with black powder and lead projectile, than with smokeless powder and harder then lead projectiles. It is a requirement of MLAIC competitions that reproduction firearms should be manufactured so as to be "in the spirit of the original."

The basic stress caused by the gunshot on firearms is caused by the pressure of propellant gases. This pressure developing while discharging a firearm. It is a function of the ignition conditions, propellant

type and grain size (surface area), the internal dimensions of the gun's chamber and barrel, the calibre, weight and hardness of the projectile, and its 'resistance' whilst being pressed in the forcing cone of the barrel, and passing through it. Additionally, the location of the maximum stress in the gun depends also on the beforementioned factors. Other factors as temperature, loading density, etc. also have influence on the pressure developed.

About changes in the loads of black powder firearms

As the loads and cartridges for black powder muzzleloading and breech loading guns are not standardized, the traditions, well known rules of thumb in their loading (amount of propellant, bullet type and diameter to load, wad/patch, etc.) have the most important role to keep their use safe. **Any change in this well proven system (i.e. lead free bullets with different to lead properties (hardness, weight, rigidity, fouling properties, etc.) might cause danger.**

Additionally, the 20-21th century reproductions of these guns have been sold with user manuals, instructions and load markings by the manufacturers based on the traditional lead projectile use. **Any change on the projectiles used would make these instructions, markings invalid.** (See the supporting links in the footnote.)¹ Retrospectively it is not possible to update these manufacturer's instructions for the guns already in circulation either with shooters or gun dealers. 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. The damage of the gun or the injury of the shooter due to non-lead bullet use would result lawsuits against firearm manufacturers. By the end the cost of the property damages or loss of health will not be covered at all, or will be covered by someone who is not responsible for the regulation, which prevented the use of lead bullet.

C.I.P. as the governing body in civilian firearms safety testing in their member countries – including proof testing – apply decisions on proofing muzzleloading firearms with the use of black powder and lead projectile. (Decision XIX.-7) **The proof of the muzzleloading firearm ensures safe usage with lead projectiles.**

Possible soft alternatives

Metals somehow close in hardness to lead as bismuth or tin might be suitable lead alternatives for the first glance – as they are also used as lead free shot alternatives – but related to black powder firearms this is not the case. In modern shotgun cartridges the shot pellets are placed in the plastic shot

¹ Uberti: https://www.uberti-usa.com/sites/default/files/originals/product-manuals/black_powder_revolvers.pdf Access: 2021.05.03.

Traditions:

https://www.traditionsfirearms.com/data/product_owner_manuals/Traditions%20Firearms%20Musket%20Reproduction%20Muzzleloader%20Manual%20FINAL_1528835799.pdf Access: 2021.05.03.

https://www.traditionsfirearms.com/data/product_owner_manuals/BPRevolver_manual_1362674422.pdf Access: 2021.05.03.

https://www.traditionsfirearms.com/data/product_owner_manuals/P1381Derringer_manual_1362674682.pdf Access: 2021.05.03.

Investarm:

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj92cbmwa_wAhURHHcKHcV8DtIQFjAAegQIAxAD&url=http%3A%2F%2Fwww.investarm.com%2Fmedia%2Fpdf%2Fmanuale_avancaric_a_uk.pdf&usg=AOvVaw1vKf3CTu9Tv1Y46iEcBxkF Access: 2021.05.03.

container, which prevents their connection with the heat of burning powder and reduces mechanical stress caused by the propellant gases and the barrel. In black powder firearms they work different.

Tin has a melting point approximately 100 °C lower than lead, while it is harder than lead. Tin with its low melting point can melt in blackpowder guns upon discharge making it useless for accurate use, but what is even more important it may leave such deposits, foulings in the bore, which causes local bore diameter reductions which may cause loading difficulties, and even worse, locally increased pressure at the reduced bore diameter, which may cause barrel damage.

Bismuth – with a melting point in between Pb and Sn – is significantly harder than lead and has a microstructure of crystals with parallel surfaces, which make it fragile. The bismuth bullet can break from the stress of acceleration and from the deformation caused by the rifling while firing, and not suitable for the purpose of black powder arms.

Available alloys of tin and bismuth are in general harder, still fragile and have not significantly higher melting point than the pure Sn and Bi.

Firearms designed for black powder

The antique, vintage and their reproduction firearms designed and manufactured for blackpowder and lead projectile use from can be sorted to the below categories and sub-categories:

1. Muzzleloading black powder firearms (where the propellant and the projectile is loaded to the barrel or the cylinder through the muzzle)
 - 1.1. Smooth bore pistols, carbines, muskets
 - 1.2. Rifled bore pistols, carbines, muskets, rifles
 - 1.3. Revolvers
 - 1.4. Shotguns
2. Breech loading black powder firearms (where the propellant and the projectile is loaded to the barrel or the cylinder from the breech side) – these can be metallic cartridge, paper cartridge, non-cartridge designs.
 - 2.1. Smooth bore pistols, carbines, muskets
 - 2.2. Rifled bore pistols, carbines, muskets, rifles
 - 2.3. Revolvers
 - 2.4. Shotguns

Below we describe the basic usage principles of the different blackpowder guns, and the possibility/impossibility of alternative projectile use, and the reasons:

Muzzleloading smooth bore pistols, carbines, muskets

These guns are loaded with a black powder charge, sometimes covered with a wad and topped with a spherical lead ball covered by textile patch. The diameter of the patched ball – before loading – is smaller than the internal diameter of the bore. While loading/pressing the patched bullet into the bore, the patch is compressed, and it is also pressed in the soft lead projectile, making micro-deformations on the ball.



3. Imprints on a patched roundball removed from the muzzle

This connection between the ball, the patch and the bore ensure the following:

- the bullet can be pushed firmly on the top of the gunpowder or overpowder wad, despite the possible surface inequalities of the bore of the barrel,
- the patch keeps the ball in the bottom of the barrel, which is needed for safe use
- the patch and soft lead ball reduce and keeps the force uniform that is required for pushing the ball through the bore by the propellant gases during the firearm discharge.

In the case of the use of a material harder than lead ball the following risks are present:

- a non-lead bullet can stick in the bore during loading mid-barrel, making it impossible to push all the way down the bore. Such a stuck hard bullet cannot be pulled out with the traditional screw method.



4. Pulled lead round ball and ball screws

- discharge of a firearm with a bullet stuck (and impossible to pull) mid-barrel in the bore **causes high risk of barrel blow up, personal injury.**

- even a properly seated ball made from a material harder than lead fired from the barrel may cause higher friction due to its limited deformability, **which may result higher gas pressures of the combusting propellant, that the weapon was not designed, nor tested for;**

Muzzleloading rifled bore pistols, carbines, muskets

1.2.1 Muzzleloading rifled bore pistols, carbines, muskets with rifling designed for patched lead ball

These guns traditionally loaded with a black powder charge, sometimes covered with a wad and topped with a spherical lead ball covered by a textile patch. The diameter of the patched ball – before loading – is in most cases smaller than the bore diameter, but there are rifles that were designed for the ‘forcing principle’, when the lead round ball is larger than the bore diameter before loading. While loading/pressing the patched bullet into the bore, the patch is compressed, and it is also pressed into the soft lead projectile. The bullet is also deformed by the rifling through the patch.



5. Marks of the rifling imprinted in the lead round ball through the patch

This connection between the ball the patch and the bore ensure the following:

- the bullet can be pushed firmly on the top of the gunpowder or overpowder wad, despite possible bore surface inequalities,
- the patch keeps the ball in the bottom of the barrel, which is needed for safe use
- the patch and soft lead ball reduce and keep the force uniform which is required for the ball passing through the bore by the propellant gases during the firearm discharge,
- the patch makes a firm grip between the bullet and the rifling to ensure spin stability to the ball.

In the case of the use of a harder than lead ball the following risks are present:

- a non-lead bullet can stick in the bore during loading mid-barrel, making it impossible to push all the way down the bore. Such a stuck hard bullet cannot be pulled out with the traditional screw method.
- discharge of a firearm with a bullet stuck (and impossible to pull) mid-barrel in the bore **causes high risk of barrel blow up, personal injury.**
- even a properly seated harder than lead ball fired from the barrel may cause higher friction due to its limited deformability, **which may result higher gas pressures of the combusting propellant, which the weapon was not designed, nor tested for;**

1.2.2 Muzzleloading rifled bore pistols, carbines, muskets with rifling designed for soft lead conical bullet

1.2.2.1 Muzzleloading rifled bore pistols, carbines, muskets with rifling designed for soft lead conical bullet cut by rifling upon loading – forced loading principle (some types of these bullets are also used for the guns described in point 1.2.1.)

These guns traditionally loaded with a black powder charge, and topped with a soft lead, or patched soft lead conical bullet, which have at least similar or larger diameter than the distance between the lands of the rifling.



6. REAL bullet (source: www.kapszli.hu)



7. Maxi Ball bullet (source: www.kapszli.hu)

These bullets are hammered into the bore through the muzzle, while they are deformed (cut) by the lands of the rifling.

This loading method and connection between the lead conical bullet and the bore ensures the following:

- the bullet can be loaded into the bore as it is soft enough to be able to cut/deformed by the rifling of the muzzle, while not needing excessive force

- the bullet can be pushed firmly on the top of the gunpowder or overpowder wad, despite the possible bore surface inequalities,
- the soft lead reduces and keeps the force uniform that is required for the ball passing through the bore by the propellant gases during the firearm discharge,
- the cut/deformed bullet makes a firm grip between the bullet and the rifling to ensure spin stability of the conical bullet.

In the case of the use of a harder than lead projectile the following risks are present:

- impossibility to load or excessive force needed to load a bullet, **may cause barrel damage**
- non-lead bullets may stick in the bore during loading mid-barrel, making it impossible to push way down the bore. Such a stuck hard bullets cannot be pulled out with the traditional screw method,
- discharge of a firearm with a bullet stuck (and impossible to pull) mid-barrel in the bore **causes high risk of barrel blow up, personal injury.**

1.2.2.2 Muzzleloading rifled bore pistols, carbines, muskets, rifles with rifling designed for undersized soft lead expansion (Minié), compression (Wilkinson, Lorenz) and chamber deformed bullets (Kammerbüchse, Dornscützen)

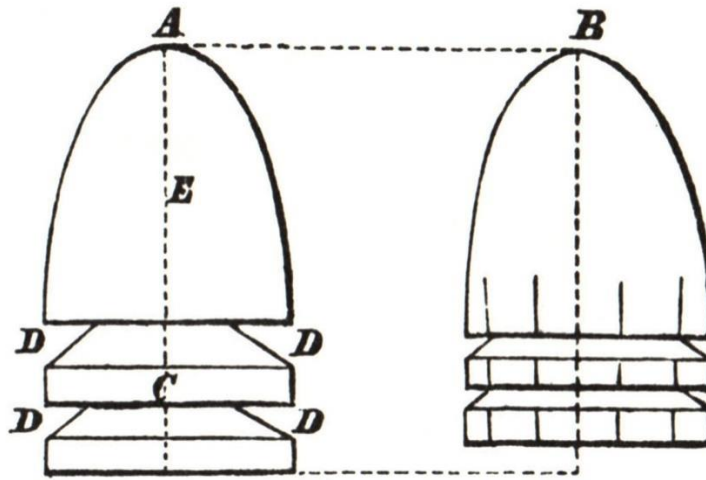
These guns are designed to shoot such bullets, which has the diameter similar or less than the land-to-land diameter of the rifled barrel bore to ensure easy loading. The bullet is pushed on the top of the black powder charge from the direction of the muzzle.

The expansion bullet works on the following principle: when the propellant is ignited, the expansion skirt of the undersized expansion bullet expands, fills in the rifling of the barrel, and this connection developed by the skirt of the bullet is responsible for sealing the propellant gases, and for giving a spin to the bullet to stabilize it in flight.



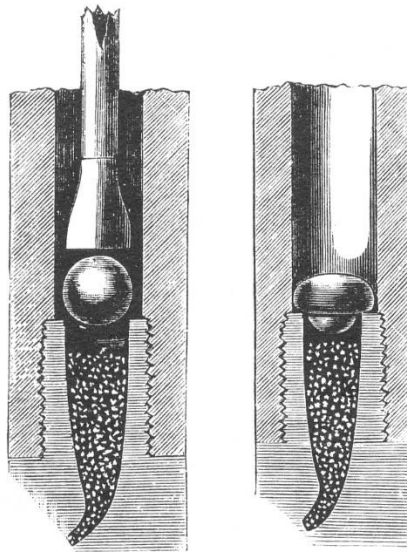
8. Skirted, expansive bullet (Minié bullet)

The compression bullet works on the following principle: when the propellant is ignited below the bullet, the force of the propellant gases hit the bottom of the bullet, the soft lead bullet is compressed by this force, and the compression causes such a diameter increase of the bullet which make it fill in the rifling of the barrel, and this connection is responsible for sealing the propellant gases, and for giving a spin to the bullet to stabilize it in flight.

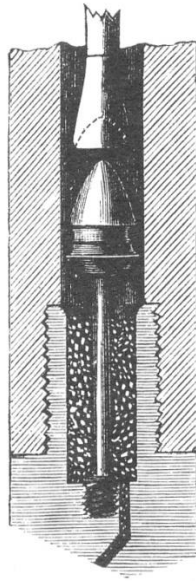


9. Lorenz type compression bullet and its working principle

The bullet compressed by the chamber principle works the following way: the originally undersized bullet is hammered down on the top of powder chamber or pillar in the breech with the use of the ramrod. This hammering forces the bullet to the specially manufactured area of the breechplug or the side of the powder chamber, which increases its diameter to a certain level so that it which makes the necessary connection with the rifling.



10. Delvigne chamber type barrel breech



11. Thouvenin type pillar breech

These bullets/guns and loading methods ensure the following:

- the bullet can be loaded into the bore as it is undersize before firing and can be pushed firmly on the top of the gunpowder or overpowder wad, despite the possible bore surface inequalities,
- the soft lead fills in the rifling due to expansion, compression, deformation, and its softness reduces and keeps uniform the force which is required for the bullet passing through the bore by the propellant gases during the firearm discharge,
- the bullet makes a firm grip between the bullet and the rifling to ensure spin stability of the conical bullet,
- sabot lead free bullets theoretically might be used for this type of guns, but the high diversity of bore-diameters would require such wide selection of sabots, which is not and will not be available on the market.

In the case of the use of a harder than lead bullet for the above loading method the following risks are present:

- the hard bullet will not expand, compress, deform as it is required for this working principle. The fired bullet will be unstable, besides of complete **lack of accuracy, the path of it will not be predictable.**
- in the case of a non-lead bullet being stuck mid-barrel in the fouled bore during loading, it would make it impossible to push all the way down the bore. Such a stuck hard bullet cannot be pulled out with the traditional screw method.
- Saboted bullets stuck mid-barrel cannot be pulled out with the traditional screw method.
- discharge of a firearm with a bullet stuck (and impossible to pull) mid-barrel in the bore **causes high risk of barrel damage, blow up, personal injury.**

Muzzleloading revolvers, revolver-carbines

These multi-shot guns are designed to be loaded from the direction of the muzzle, but the charge and the bullet is placed into the chambers of the cylinder. The chambers of the cylinder are loaded with proper amount of blackpowder, and oversized soft lead balls or conical bullets pressed on the top of the propellant. The loading can be done with the loading lever, which is a part of many muzzle loading revolvers, or can be done with the cylinder removed, with the use of loading tools. The bullet must be oversized to be able to seal the chamber against heat and flame from other chambers (chain firing) and to properly fit the particular revolver's dimensions. Upon loading, a small ring of lead is often sheared off while pressing the oversized soft bullet in the bore of the cylinder.



12. Loaded cylinder of a muzzle loading revolver removed from the frame. Below the sheared off lead rings are visible.
(source: imgur.com)

When the gun is fired, the bullet is forced out of the cylinder into the barrel's bore by the propellant gases, and the bullet is compressed into the forcing cone of the barrel, fills in the rifling, and gets its speed and spin.

These bullets/guns and loading methods ensure the following:

- the oversized soft lead bullet physically can be loaded into the cylinder,
- the tight-fitting bullet seals the chamber against unintentional ignition (chain fire)
- the soft lead bullet keeps the force necessary to compress it into the forcing cone of the bore low and as such keeping the generated gas pressure reasonably low

In the case of the use of a harder than lead bullet for the above loading method the following risks are present:

- if the bullet oversized, it prevents loadability
- if the bullet is undersized enough to ensure its loadability, **it will not seal the chamber against chainfire, therefore may cause personal injury**
- if the bullet is undersized enough to ensure its loadability and will not stay in the cylinder upon the firing of another chamber of the gun, and may block the turning of the cylinder, **causing malfunction**
- the harder than soft lead bullet increases the force necessary to compress it into the forcing cone of the bore and will increase the generated gas pressure with an unpredictable rise, which the gun was not designed and tested for, and as such **causes risk of barrel or cylinder damage, increased wear, possibly blow up, personal injury.**

Muzzleloading black powder shotguns

These guns are traditionally loaded with a black powder charge, overpowder felt wad, lead shot and top card to keep the shot in place. The use of plastic protective wads similar to those loaded in modern nitro powder shotshells is not suitable as they are not possible to load through the choke of the barrel muzzle, and the black powder may burn and melt the plastic wad. Also, modern plastic wads are only available in standard bore sizes and original muzzle loading shotguns were made in all manner of sized bores.



13. Elements of the charge: black powder, felt wad, shot, cardboard wad

Increasing concerns of the impact of plastics released to the environment also preclude the use of single use plastics in muzzle loading guns.

The structural materials of these guns were designed for traditional lead shot use. In the use of hard lead-free shot (C.I.P. type 'B' and 'C' leadfree shots), the resistance (friction) of the shot column is significantly higher than with lead shot due to their undeformable nature, and the use of protective plastic wads is rarely possible due to the non-standard bore diameters and chokes. **This cause unpredictable gas pressure and stress on the gun which it was nor designed, not tested for.**

The use of C.I.P. 'A' and 'D' type of alternative lead-free shot might be possible in these guns, but up to now it was not studied within the C.I.P organization, nor testing protocol was set up yet, nor the existing guns were tested for them.

The alternative shots can be accidentally mixed up with lead shot by the users (as they are not loaded into factory made, properly marked cartridges), **which may cause the firearm to be damaged or cause injury to the user or bystanders.**

Breech loading firearms designed for black powder and lead projectiles

Almost all the breech loading black powder firearms were originally designed to shoot lead projectiles. Some modern reproductions of metallic cartridge guns designed originally for blackpowder have been re-designed for smokeless powder, and proof tested as such, but the vast majority of them are still black powder only.

Their original soft lead bullet keeps the force necessary to compress it into the forcing cone of the bore low. This keeps the generated gas pressure reasonably low. In the case one would fire lead free, harder (i.e., brass) bullets from them, the combination of the harder bullet and the deep cut rifling optimized for lead bullets may cause such increase in pressure developed by the propellant gases, for which these guns were not designed, not tested for, and **causing the risk of structural gun damage, which may cause injury.**

Also the ignition and bolt system of many of these guns were not design to seal increased pressures (Dreyse needle fire, percussion ignition, pinfire, rimfire) which may cause gas blow outs upon **firing and creates a risk of nipple blow out (in case of percussion guns), burns and eye injury to the shooter.**

Compared to recently made metallic cartridge firearms, basically no ammunition manufacturer loads factory ammunition for the vast majority of these blackpowder breech loading firearms. Their ammunition is not standardized. It means that the control of the safety of the ammunition of them depends on their users, who make or load their own ammunition, and these people are not in the position to control the possible consequences of deviating from the traditional safe ammunition making practices of blackpowder and lead bullets.

Breech loading black powder shotguns might be safely used with C.I.P. 'A' and 'D' type of alternative lead-free shots, but up to now it was not studied within the C.I.P organization, nor testing protocol was set up yet, nor the existing guns were tested for them.

SUMMARY

- The scope of this study is to investigate the safety aspects of the possible use of lead-free alternative projectiles in antique muzzle loading black powder firearms, in their 20-21th century reproductions and in vintage breech loading guns manufactured and designed for black powder and lead projectile use.
- The scope of this study does not include modern, 20th and 21th century design, in-line ignition muzzleloading firearms made according to the US requirements for their special hunting season, as their design allows more flexibility in the material of bullet used for them.
- For understanding the issues of the use of lead-free alternative bullets in the firearms made or designed for black powder and lead projectiles, we have to take it in account, that the loads and cartridges of these guns are not standardized, and not controlled by a competent ammunition manufacturer (like modern shotshells).

What makes these guns still safe to use are the well-known rules of thumb in their loading (amount of propellant, bullet type and diameter to load, etc.) and published black powder literature. This „common knowledge” has the most important role to keep their use safe. Any change in this well proven system (i.e., lead-free bullets with different then lead properties as hardness, weight, etc.) might cause a dangerous structural gun damage and personal injuries.

Additionally, the 20-21th century reproductions of these guns have been sold with manuals, and load markings by the manufacturers based on the traditional lead bullet use. Any change on the bullets used would make these instructions, markings false, untrue. Retrospectively it is not possible to update these manufacturer's instructions for the guns already put on the market. The failures, gun damage, possible injuries caused by non-lead bullet use in these reproductions would question product liability of their manufacturers.

- It is a common issue with almost all the types of muzzleloading guns (antiques and their reproduction) that non-lead bullets may stuck in the bore during loading mid-barrel, making it impossible to push all the way down the bore. Such stucked hard bullets cannot be pulled out with the traditional screw method. **If this happens it makes the gun loaded, in most cases impossible to unload, and dangerous to fire.**
- The use of harder than lead bullets is not possible safely in muzzleloading revolvers due to complete system incompatibility.
- The use of bullets in discarding sabot – which might allow the use of lead-free bullets in some muzzleloading black powder guns – are prohibited in several European countries. Additionally, the diversity of non-standard bore diameters makes no possibility for the use of saboted lead-free bullets in most of the antique and reproduction muzzleloading and vintage breech loading black powder rifles pistols carbines and muskets.
- The use of relatively “soft” alternative bullets as tin or bismuth and their alloys is not a solution for replacing lead in the black powder arms due to some of their properties described before.
- The number of guns manufactured for black powder and lead bullets still in use is a small fraction of the modern smokeless powder guns. Also their rate of fire is a fraction of the modern firearms. As such, their effect in the lead dispersed is judged to have a very low impact compared to modern, smokeless cartridge guns, given the very small volume of blackpowder shooting.
- While used for hunting, the lead bullets of black powder firearms do not break into parts and do not evaporate or disintegrate when hitting the game due to low impact velocities (approx. max. 550 m/s), and as such cause lead contamination of the meat only in the permanent shot wound cavity.
- The C.I.P. proof testing of the firearms in scope has been carried out with the use of black powder and lead projectiles, and ensures safety only for those. There are no testing protocols for lead-free projectiles as there are no suitable versatile alternatives.

CONCLUSION

With reading this paper and studying the chart in the Annex 1 it is understandable, that for the vast majority of firearms designed and manufactured for black powder and lead projectile use, there is no such existing alternative lead-free bullet, which could be safely used by them.

Due to this fact we suggest the “antique muzzleloading firearms made till the end of the 19th century, their reproductions and those breechloading firearms which have been designed, manufactured for black powder and lead projectile” firearm category be excluded from the scope of the proposed restriction of lead ammunition.

Annex 1

	Class of black powder firearm	Bullet type which the gun was built/designed for	Possible lead-free alternative bullet	Risks of using lead-free alternative bullet	C.I.P. proof of the gun
1.1	Muzzleloading smooth bore pistols, carbines, muskets	Spherical lead ball covered by textile patch	None. All proprietary alternatives are significantly harder than lead.	Stuck bullet cannot be pulled, firing stuck alternative can blow the barrel up, possibly higher gas pressure which the gun was not designed for	For lead projectile & black powder only
1.2.1	Muzzleloading rifled bore pistols, carbines, muskets	Spherical lead ball covered by textile patch	None. All proprietary are harder than lead.	Stuck bullet cannot be pulled, firing stuck alternative may blow up the barrel, possibly higher gas pressure which the gun was not designed for	For lead projectile & black powder only
1.2.1.1	Muzzleloading rifled bore pistols, carbines, muskets with rifling designed for soft lead conical bullet cut by rifling upon loading (some types of these bullets are also used for the guns described in point 1.2.1.)	Soft lead conical bullet, which have at least similar or larger diameter than the distance between the lands of the rifling	None	Impossibility to load or excessive force needed to load a bullet, barrel damage, stuck bullet cannot be pulled, firing stuck alternative may blow up the barrel, possibly higher gas pressure which the gun was not designed for	For lead projectile & black powder only
1.2.1.2	Muzzleloading rifled bore pistols, carbines, muskets, rifles with rifling designed for undersized soft lead expansion (Minié) and compression (Wilkinson, Lorenz) and breech deformed bullets	Soft lead expansion, compression, expanded by breech principle conical bullets	Saboted lead free bullets.	Stuck bullet cannot be pulled, firing stuck alternative may blow up the barrel. No wads in the necessary variety of dimensions available.	For lead projectile & black powder only
1.3	Muzzleloading revolvers, revolver-carbines	Soft lead ball, conical bullet	None	Oversize non-lead bullet prevents loadability, non-lead bullet undersized enough to ensure its loadability will not seal the chamber against chainfire, and will not stay in the cylinder while an other chamber is fired, causing malfunction, the harder than soft lead bullets increase the generated gas pressure and as such causes high risk of barrel or cylinder damage, increased wear, possibly blow up, personal injury.	For lead projectile & black powder only

1.4	Muzzleloading shotguns	Lead shot, felt or cork wad	C.I.P. 'A' and 'D' type of alternative lead free shot without plastic protective wad	If the user accidentally use C.I.P. type 'B' and 'C' leadfree shots, which increases the gas pressure upon firing, and the stress of the barrel and choke	For lead shot & black powder only
2.1.1-2.1.4	Vintage breach loading pistols, revolvers, carbines, muskets, rifles built/ designed for lead bullet and black powder with rifled bore	Lead balls or conical bullets, sometimes paper-patched	None	The use of harder than lead lead-free bullets may cause such increase in pressure for which these guns were nor designed, not tested for, and causing the risk of structural gun damage, which may cause injury. The ignition and bolt system of many of these guns was not designed to seal increased pressure (Dreyse needle fire, Percussion ignition, Pinfire, Rimfire) which may cause gas blow outs and nipple blow out upon firing and create a risk of injury of the shooter.	No such C.I.P. test exists
2.2	Wintage breach loading shotguns built/ designed for lead shot black powder	Lead shot, felt or cork wad	C.I.P. 'A' and 'D' type of alternative lead free shot with or without plastic protective wad	If the user accidentally use C.I.P. type 'B' and 'C' leadfree shots, which increases the gas pressure upon firing, and the stress of the barrel and choke	No such C.I.P. test exists