Open-Ended Working Group on Ammunition

An Analysis of the Practicality and Barriers to Implementation of Proposals Presented in: UNIDIR "*Exploring the Technical Feasibility of Marking Small Calibre Ammunition*"

Prepared by

SAAMI®

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What is SAAMI?

The Sporting Arms and Ammunition Manufacturers' Institute (SAAMI®) is a technical association of the United States' leading manufacturers of firearms, ammunition, and components. SAAMI was founded in 1926 at the request of the U.S. federal government with the mission to create and promulgate technical, performance, interchangeability, and safety standards for firearms, ammunition, and components; and to be the preeminent global resource for the safe and responsible manufacturing, transportation, storage, and use of these products. Specifically, SAAMI is tasked with:

- Creating and publishing industry standards for safety, interchangeability, reliability and quality of sporting firearms and ammunition
- Coordinating technical data
- Promoting safe and responsible firearms use

As an accredited standards developer by the American National Standards Institute (ANSI), SAAMI publishes and maintains five public standards:

- SAAMI Z299.1 – "*Voluntary Industry Performance Standards for Pressure and Velocity of Rimfire Sporting Ammunition for the Use of Commercial Manufacturers.*"
- SAAMI Z299.2 – "*Voluntary Industry Performance Standards for Pressure and Velocity of Shotshell Ammunition for the Use of Commercial Manufacturers.*"
- SAAMI Z299.3 – "*Voluntary Industry Performance Standards for Pressure and Velocity of Centerfire Pistol and Revolver Ammunition for the Use of Commercial Manufacturers.*"
- SAAMI Z299.4 – "*Voluntary Industry Performance Standards for Pressure and Velocity of Centerfire Rifle Ammunition for the Use of Commercial Manufacturers.*"
- SAAMI Z299.5 – "*Voluntary Industry Performance Standards Criteria for Evaluation of New Firearms Designs Under Conditions of Abusive Mishandling for the Use of Commercial Manufacturers.*"

Preamble

While the current draft of the Open-Ended Working Group (OEWG) proposal contains language that the proposal applies to "national stockpiles," it also includes, although inconsistently, language that the proposals apply to, more generally, state-owned stockpiles. The lack of a clear definition of the affected product is where concerns arise for U.S. commercial manufacturers as much of the small caliber ammunition procured for use by many U.S. Federal and State law enforcement (LE) agencies is produced at the same facilities as sporting goods products for hunting, target shooting and personal self-defense.

Therefore, constraints placed on those law enforcement products would directly impact the manufacturing operations of commercial facilities.

The comments provided herein reflect the impacts and challenges faced by those commercial operations, designed and built for optimal efficiency and cost containment. These ***should not*** be taken as being applicable to the operations at the sole United States small arms ammunition production facility, Lake City Army Ammunition Plant in Independence, Missouri.

However, with closures of government-owned small arms manufacturing capacity, the strategy for the U.S. in times of peak demand would be to turn to the commercial base to meet manufacturing shortfalls. Should this become the case, these operating constraints would fall directly on those producers.

It should also be understood that the production volumes of commercial, sporting ammunition in the U.S. far exceeds all other countries' commercial capabilities. The challenges faced by those small manufacturing plants are not comparable to those encountered when trying to scale these approaches to the volumes produced on a daily basis by major manufacturers in the U.S.

Contact Information

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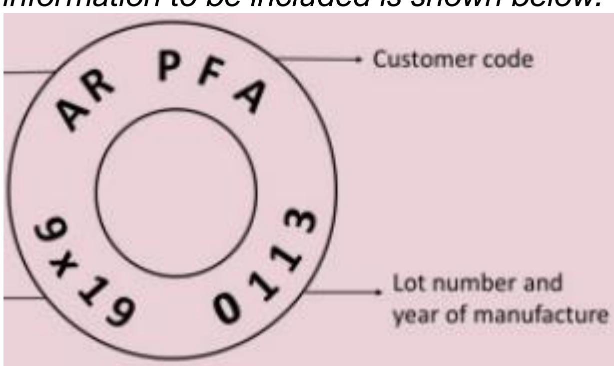
SAAMI's observations and comments begin on page 1 and contain references to page numbers contained in the UNIDIR report.

Statement in UNIDIR Report	Commentary/Observation
Pg. 1 – *"While ammunition packaging sometimes contains information on the ammunition, such as the manufacturer, the customer, the specific lot number, the year and location of production and more, …"*	It is standard practice for U.S. commercial manufacturers to ***always*** include the manufacturer's name, address, ammunition identification (cartridge type), and a lot number traceable to a single production shift. This information appears on both the outer shipping cases and interior retail package.
Pg. 1 - *"This means that, once rounds are unpacked and distributed, specific details that could enable the identification and tracing of individual ammunition rounds are lost."*	It is unusual and counterproductive for ammunition to be removed from its original factory packaging until immediately prior to use. "Distributing" loose ammunition makes no logistical sense as it exposes the products to damage and loss.
Pg 1. – *"It should also be noted that these different markings can be combined and used altogether on a single round. Double or triple marking can therefore help overcome challenges faced by individual methods."*	Double or triple marking *might* compensate for a weakness of one system but will not mitigate their challenges. In fact, the challenges are multiplied when these schemes are used in combination, often exponentially.
Pg. 2 – Stamping: *"Depending on the information to be included, space may be limited"*	Space available on most cartridge heads is extremely limited, with most space currently consumed with information (manufacturer/brand and cartridge type) required for safe use. On page 8 of the UNIDIR report, this fact is highlighted as the reason for not using this approach in Brazil.
Pg 2. – Laser marking: *"Equipment and processes are in place in selected factories or companies which have specifically chosen to use this method."*	Such capability exists in an extremely small fraction of current worldwide small arms ammunition capacity, and specifically in comparison to the production volumes of major U.S. commercial manufacturers.
Pg 2. – Table; Comparison of marking methods	It is interesting that this table fails to highlight the uncertainties associated with these technologies other than in the softest of terms. For example, the absence of any acknowledgement of the potential hazards with the use of lasers on parts containing explosives.

Statement in UNIDIR Report	Commentary/Observation
Pg. 2 – Chemical Taggants	This is a technology that can best be classified as experimental. In addition, it suffers from the major drawback of being unreadable by the unaided human eye, meaning product/taggant mixes in the manufacturing environment would require specialized equipment to detect and sort, if it is even possible. This increases the potential for undetected lot identifiers being mixed, or items marked multiple times, and reaching the market, negating any potential benefit the mark might provide.
Pg 2 – *"In addition, associated costs are also not off-putting given that some of the countries that have currently introduced or are seeking ammunition marking are lower-income countries."*	The argument that low-income countries "seek" such markings bears no relationship to the costs involved. The capitalization costs for full implementation (unlike the partial implementation in Brazil) are staggering. The absence of an actual analysis of the capital and operating costs is, itself, telling.
Pg 2 – *"Data collection and record-keeping of ammunition markings are crucial regardless of the marking methods used, as these data can help with the tracing and identification of the ammunition."*	Despite the admission that record-keeping is a "crucial" part of this scheme, any discussion of cost for this functionality is omitted from the summary. Furthermore, the fact that at least one patent exists in the U.S.[1] which would potentially make the electronic record-keeping a sole-source service is also ignored. In addition to the cost of record-keeping, missing from any evaluation of impact is energy consumption and carbon generation. Any record-keeping system with sufficient capability to store and analyze the movement of ***billions*** of individual records generated per year will be massive and significant in its impact in these areas.

Statement in UNIDIR Report	Commentary/Observation
Pg 4 – Discussion Box 1. *The potential issue of reloaded ammunition*	The discussion of reloaded ammunition appears to ignore two key considerations. First, while not directly addressed, commercial operations exist in the U.S. specializing in the reloading of used cartridge cases at a scale that cannot be easily dismissed as insignificant. Second, the absence of reloaded ammunition in recovered diverted ammunition in the current environment overlooks the fact there is currently no significant benefit to the use of reloaded products to criminal or other illicit markets. Changes that increase the value of reloaded ammunition (lack of traceability) in diverted endeavors alters the equilibrium and will likely result in a corresponding change to the value placed on it for illicit activities.
Pg 5 – Discussion Box 2 – *"The proposed information to be included is shown below."* 	The illustration provided removes information on the manufacturer of the cartridge (a legal requirement in C.I.P. signatory countries) and it further presupposes the customer is known at the time the shell case is manufactured. Presumably, the "year of manufacture" is the third and fourth digits in the code shown. This leaves two digits to describe a lot number, limiting the available lot number range to 00 – 99 for the entire year. In a commercial sporting ammunition plant, an individual load specification (for example, specifically 9mm Luger 115-gr Metal Case bullet) can be produced at annual volumes up to and exceeding 50MM rounds, resulting in lot sizes of, at best, 500,000 shell cases.
Pg 7 – *"Based on data obtained from 17 interviews with 20 experts from research organisations, industry, …"*	No reference in the appendix is identified as being associated with "industry." Furthermore, no reference is identified as being associated with the U.S. commercial base.

Statement in UNIDIR Report	Commentary/Observation
Pg 8 – *"… or roll marking, where the stamp head gradually moves across the surface. Press stamping usually applies to the head of the case, whereas roll marking is applied to the side."*	While roll marking is very common for the marking of information on the sides of sporting firearm barrels, no application of this technique is known in the U.S. or internationally.[2] Only ink marks applied to the side of cartridge cases is known to have been used. The exact method of application is unknown to the authors. The durability of ink markings is generally poor for this application. True roll marking of the side of the cartridge would likely create stresses in the metal leading to premature failure of the sidewall, creating safety issues upon use. Furthermore, the sidewall thickness of small arms ammunition cases is also too thin to support traditional roll marking without collapse.
Pg 9 – *"Despite this one example, it is nonetheless possible to add relevant and detailed information via headstamping: figure 2 illustrates …"*	Figure 2 exactly illustrates the challenges of the limited room on the case head. These examples do not include the breath of information recommended on page 5. See specifically the amount of available space on the headstamp of the example 9mm Luger shell. The 9mm Luger is the single most popular round and while there are performance differences between this cartridge and the current U.S. military 9mm round, the space on the head is identical.
Pg 9 – *"Stamping appears to be the most cost-effective technique for marking individual rounds, as it is commonly an integrated step in the manufacturing process of ammunition."*	This statement is an overly simplistic view of the state of high-volume manufacturing and fails to consider the implications of changes needed to down-stream processing to ensure the continued segregation of individual batches. Current continuous-flow processes would create unreconcilable cross-mixing of products with different markings.

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Pg 10 – Table 1; Challenges; Cost: *"The use of unique identifying information on smaller-sized lots could lead to an increase in costs."*	That there would be cost impacts for any approach of headstamp application that requires an increase in the frequency of tooling (bunters) changes, uniqueness of tooling, negative volume discounts for their manufacture, and increased handling to ensure part segregation is undeniable.
Pg 10 – Table 1; Challenges; Ability to mark across the life cycle of a round: "*This could have an impact on the current manufacturing process, where cartridges are produced before knowing who the specific end client will be. Thus, applying unique identifiers could require an adaptation to the current manufacturing process, which could be mitigated by producing smaller lot sizes per customer.*"	In major U.S. manufacturing facilities, the customer is unknown at the time of cartridge headstamping in almost all cases. Production in smaller lots multiplies the challenges of keeping small batches segregated and increases costs. It further presupposes a prior customer will reorder or the cases marked for them would have to be scrapped.
Pg 10 – *"This marking method can be applied at the end of the production process to completed or live ammunition, meaning that it can be used retrospectively. … Marking other areas, such as the side of the cartridge or its case head, means that the marking is usually done before the primer is added for safety reasons."*	In other words, the mark can be applied at the end of the manufacturing process, except that such an approach, in a process upset or improper operation, can present serious safety implications. "[0033] 2) the amount of energy transferred to the other side of the engraved sheet (in contact with the primer, propellant, etc.) becomes relevant, increasing the risk of accidental firing of the ammunition."[3] The cartridge also contains smokeless propellant ("gunpowder"), which is an additional safety concern for ignition or degradation if exposed to high temperatures, such as laser etching of metal would incur.

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Pg. 10 – Laser Marking: *"For example, marking in the extractor groove means that the marking can be applied at the end of the manufacturing process, prior to being packaged and sent to the customer Marking other areas, such as the side of the cartridge or its case head, means that the marking is usually done before the primer is added for safety reasons."*	Laser marking of loaded rounds, ones containing explosive materials in both the primer and cartridge case, is especially problematic. See SAAMI's submission dated, Working Paper SAAMI 01-May-2022[4] for a more detailed discussion of safety concerns operating lasers in the proximity of explosives and metal removal from cartridge cases that could be only .015" - .017" (0.38 mm – 0.43 mm) in their starting condition. This technology also suffers from being a sole source, patented approach when such markings are placed in the extractor groove.[5] Marking prior to primer insertion creates a similar set of challenges as other early production phase technologies – the end customer is unknown at that time, segregation of product during subsequent operations, and reduced operational efficiency (increased cost) from excess handling of smaller production increments.
Pg 11 – Figure 4.	This appears to be an example of the ease with which laser markings can be obliterated.

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Pg 12 – *"Laser marking is very rapid; cartridges can be marked in the space of several seconds."*	While this may sound insignificant, assuming 100% efficiency (which would never be achieved), and no time need to orient, place, and remove cartridges from the marking equipment (unrealistic), a single major manufacturing plant in the U.S. would require 116 lasers operating simultaneously to keep pace. Assuming a more realistic 2 seconds per cartridge to include all handling and orientation, and an operational efficiency at world-class 80%, the total equipment requirement would become 290 lasers ***per facility***. Using an estimated cost of $62,500 per unit (an average of the quoted costs incurred by Madagascar and Brazil), this is a capital requirement for the machines alone of more than $18,000,000 per facility. Note that additional costs for equipment rearrangement, electric and other utility connections and associated installation costs could easily increase this cost to $29,000,000 per factory. No consideration is given to potential royalty payments for patented technology.
Pg 12 – *"The costs of laser marking … In the case of Brazil … maintenance costs estimated at $9,300 per 5 million cartridges."*	For a typical U.S. factory producing approximately 10 million total rounds per day, this is a daily cost increment of $22,400 today, corrected for inflation[6]. ***Annually, this would be an additional cost of $5.8 million for <u>each plant</u>.***
Pg 12 – *"For example, one company provides these two services at $0.02 for each round."*	At 10 million rounds per day total production, this is an incremental cost, just for record-keeping, of $200,000 per day, or roughly ***$50,000,000 per year <u>per facility</u>.***

Statement in UNIDIR Report	Commentary/Observation
Pg 13 – Table 2; Advantages; Durability and recoverability of the marking; *“However, this can be avoided, especially if a coating is applied after the marking process. ... The removal of markings can also be made more difficult if a coating is applied over them.”*	All the noted characteristics in this table entry would more accurately be characterized as challenges rather than advantages. Namely secondary damage via corrosion and the possibility to remove the markings. The claims that these *challenges* can be overcome by additional processing and coatings, not mentioned at any other point in the “analysis” or that the markings might be recoverable by “relief polishing and reflected light stereomicroscopy” are not “*advantages”* of the technology.
Pg 13 – Challenges; Equipment and process	This analysis fails to note, or underappreciates, the implications of metal removal from the cartridge and potential changes to the mechanical properties of the cartridge case such as strength, hardness, and ductility due to the heat created by the laser. This fact is even noted in the patent on laser marking at [0032][7]. It further appears to assume applicability across materials, cartridge designs, and manufacturing methods without supporting evidence.

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Pg 13 – Table 2; Advantages; Ability to mark across the life cycle of a round.; *"This also means that this method can be used to mark ammunition retrospectively, with a unique identifier added post-production."*	This assumes: • The entity applying such marks are sufficiently versed in the nature of the product that they can do so safely and without excess material removal, if not the manufacturer. • It is proven, to a sufficiently high level, the application of laser energy to a loaded cartridge is safe. • The ammunition remains safe to use after being heated and etched by the laser. • The need for a post-engraving coating process, discussed in detail under the heading of "Durability…", has been removed, or that the coating process is compatible with loaded cartridges and that the coating does not adversely affect the performance of the ammunition or the safety and reliability of the firearm in which it is ultimately intended to be used.
Pg 14 – 2.3 CHEMICAL TAGGANTS	Overall, this method is inappropriate to be presented as a technology at a level worthy of consideration, yet it is presented as being a viable alternative.

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Pg 14 – *"Each AmTag batch has an individual chemical composition that is linked to a unique code, which is registered once the specific batch is used and includes information such as the manufacturer and year of production."*	The manufacturer's identity is provided on the headstamp already for both commercial and U.S. military ammunition. The year of manufacture ***of the cartridge case*** (not the date of loading) is also included on the headstamp of U.S. military small arms ammunition production. The question raised by this is whether the described technology offers any true benefit over existing markings. Furthermore, there is no mention of the scalability of this approach. The example of Brazilian marking shown in Figure 3, provides for a possible 60 million unique codes. What is the upper limit of code possibilities, with sufficient resolution to prevent misidentification for the taggant approach under discussion?
Pg 14 – *"When the code is entered into a proprietary software application, …"*	Should the use of the term "proprietary" in this sentence be interpreted as "sole-source," thereby creating a state-sponsored monopoly?
Pg 14 – *"The solution could also be applied at the end of the ammunition-manufacturing process to associate ammunition with an end user …"*	This presupposes the end user is known at this point in the manufacturing/distribution process, which is not correct for the U.S. business model.
Pg 14 – *"Based on data from the pilot, the solution takes under 30 minutes to dry, …"*	At the rates of manufacture for a major U.S. sporting ammunition manufacturer, the backlog of product during this 30-minute drying time would exceed 200,000 rounds. No consideration of how this accumulation would be handled, nor the costs associated with that storage and processing.
Pg 14 – *"AmTag can sometimes transfer from the ammunition to the weapon, but this does not impair the functionality of either the ammunition or the weapon."*	However, if the material can be subsequently redeposited onto ammunition cases fired after a transfer to a firearm from a different lot of marked ammunition, there is no utility of this method.

Statement in UNIDIR Report	Commentary/Observation
Pg 14 – Table 3; Advantages; Durability and recoverability of the marking. *"Testing during the AmTag pilot project suggests that the chemical taggant could remain on ammunition for long periods of time, …"*	As a water-based liquid prior to application, the obvious, yet unanswered question is, "how hard is the material to remove?"
Pg 14 – Table 3; Advantages; Volume of information included in the marking. *"Given that the data is stored on database linked via a code to the solution, detailed information about the ammunition can be stored."*	The mere fact the information is stored on a database does not support any conclusion on the depth or breadth of information the technology is capable of being included. The volume of information would be defined by the number of possible codes in comparison to the number of lots the technology would be applied to and would speak to the durability of the technology to provide unique combinations before all codes had been consumed.
Pg 14 – Table 3; Challenges; Equipment and process.	The fact the marker is invisible to the human eye and only decodable at off-site facilities from the manufacturing site, makes any suggestion of this being an effective utility in a production environment completely impractical. The potential negating impacts of inadvertent mixing of the coding solutions through human error is a real risk that has not been addressed. Also absent is a discussion of the steps needed to clean and purge application equipment between code solutions to prevent cross-contamination. Again, human error in failure to properly execute those steps would cause reliability issues and, being invisible and undecodable, undetectable in the plant.

Statement in UNIDIR Report	Commentary/Observation
Pg 17 Table 4; Stamping; Equipment and process – *"Equipment and processes are for the most part already in place given that stamping is the traditional and most common marking method"*	Notwithstanding the footnote associated with this process heading, to provide an assessment that disregards the ease of implementation of the technology ***beyond the use for which it is currently employed*** can easily cause confusion for the reader.
Pg 17 Table 4; Laser Marking; Equipment and process – *"Equipment and processes are in place in selected factories or companies which have specifically chosen to use this method"*	As noted previously, such capability exists in an extremely small fraction of current worldwide small arms ammunition capacity, and specifically in comparison to the production volumes of major U.S. commercial manufacturers.
Pg 17 Table 4; Chemical Taggants	Given the current level of development of this technology, it seems inappropriate to include this method or purport to be able to adequately assess any of these characteristics.
Pg 22 *ff*	It is interesting to note here that no commercial expert or manufacturer is cited.

Endnotes

[1] United States Patent U.S. 20200167619 A1 1
[2] Email from Allan Offringa dated 15-May-2023, retired U.S. Bureau of Alcohol, Tobacco, and Firearms, expert on ammunition marking and identification.
[3] United States Patent U.S. 2008/0184873 A1
[4] https://unoda-documents-library.s3.amazonaws.com/Open-Ended_Working_Group_on_Ammunition_(2022)/OEWG-SAAMI-Submission-Final1.pdf
[5] United States Patent U.S. 2008/0184873 A1
[6] Adjusted from $9,300 in 2018 using the calculator provided on saving.org.
[7] United States Patent U.S. 2008/0184873 A1