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Obliterated Weapon Markings

A Technical Analysis of Small Arms and Light Weapons Marking Obliteration, Methods of Recovery and Good Practice in Implementing the International Tracing Instrument

United Nations

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United Nations

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Foreword

In 2001, United Nations Member States adopted the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects. Four years later, they adopted the International Tracing Instrument. These instruments require that markings on small arms and light weapons are readable, durable and, as far as technically possible, recoverable, in order to enable the effective tracing of illicit small arms and light weapons.

However, when illicit weapons are seized, their markings are often removed or altered. This practice directly undermines efforts to prevent diversion and combat illicit trafficking by weakening the ability of States to trace weapons, identify supply chains and hold unauthorized users accountable.

At the fourth Review Conference of the Programme of Action, Member States requested that the United Nations Secretariat conduct a study on obliterated markings.

I am pleased to present this paper, which includes a comprehensive analysis of the prevalence of marking obliteration, the techniques used to remove identifying marks, and the forensic and policy measures available to address this challenge.

This study provides evidence-based insights to inform the implementation of the Programme of Action and the International Tracing Instrument. It is also a direct contribution to the Sustainable Development Goals. Target 16.4 commits States to significantly reduce illicit arms flows, progress on which is measured in part through information on seized weapons and the tracing of serial number markings.

I express my sincere appreciation to the Member States that responded to the survey conducted for this study, as well as to the national authorities, forensic experts, manufacturers and other stakeholders who contributed their expertise through interviews and consultations.

Importantly, I thank the research team at Conflict Armament Research and Trent University for their rigorous analysis, as well as the Governments of Switzerland and Germany, which made the research possible.

It is my hope that this study will support informed discussion among Member States and contribute to strengthened cooperation, practical implementation and continued progress in the effective tracing of small arms and light weapons.

Izumi Nakamitsu
Under-Secretary-General and
United Nations High Representative for
Disarmament Affairs

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Robert Hunter-Perkins is the Head of Research at Conflict Armament Research, overseeing the research team and helping to bridge the organization's field evidence with international research and policy priorities. He is the author and editor of more than a dozen reports on weapon diversion and has conducted research with multiple United Nations agencies. Specializing in arms control policy, Robert has previously worked on monitoring the implementation of the Arms Trade Treaty and developing the evidence base to support the political declaration on strengthening the protection of civilians from the humanitarian consequences arising from the use of explosive weapons in populated areas.

Bruno Langeani is a researcher at Conflict Armament Research, where he focuses on data analysis and research on small arms, light weapons and ammunition across multiple regions of operation. He also collaborates as a Senior Consultant with Instituto Sou da Paz in São Paulo, Brazil. Since 2012, he has authored several reports on the illicit market in firearms and ammunition in Brazil and has served as a firearms expert for the Global Firearms Programme of the United Nations Office on Drugs and Crime, the Organization of American States and the Inter-American Development Bank. He holds degrees in International Relations and Law, and a Master's degree in Public Administration and Public Policy from the University of York, where he researched firearms trafficking in Brazil.

The authors extend their thanks to all States that responded to the survey, to the experts who provided data and insights for the creation of this study, and to colleagues at Conflict Armament Research, the United Nations Office for Disarmament Affairs, the United Nations Regional Centre for Peace, Disarmament and Development in Latin America and the Caribbean, and the United Nations Institute for Disarmament Research for reviewing, providing feedback or in other ways supporting the publication.

Executive summary

This is the first United Nations-mandated analysis of weapon marking obliteration. The study maps the prevalence and patterns of the obliteration of markings on small arms and light weapons, including regional and contextual variations. It also provides an overview of existing approaches to prevention and response, as well as relevant recovery techniques.

Ten key findings:

1. **Marking obliteration is a challenge to effective weapon tracing and a global phenomenon in both conflict and criminal contexts.** Research conducted by the United Nations Office for Disarmament Affairs and Conflict Armament Research identified 77 countries that have recovered illicit small arms and light weapons with obliterated markings.
2. **The estimated number of illicit small arms and light weapons affected by marking obliteration varies widely across and within countries.** Through a survey, responding Member States identified marking obliteration as a relatively low-level challenge on a national basis, but specific localized or time- specific concentrations have been identified.
3. **Obliteration can be a low-tech but highly harmful method of inhibiting weapon tracing.** The three most common methods for marking removal reported by States were the use of power tools such as grinders or sanders, the removal of material using drills or drill presses, and the use of hand tools such as files or screwdrivers. In several reported cases, markings had been removed and replaced with false serial numbers or counterfeit branding to fabricate legitimacy, further disguise provenance, or boost value in illicit markets.
4. **Marking obliteration has been recorded on a wide variety of small arms and light weapons types.** Pistols were the most reported type of small arms and light weapons, followed by rifles, revolvers and shotguns. Obliteration of marks on some surfaces, like polymer materials or aluminium alloys, is especially challenging for traditional forensic methods to recover.
5. **Serial numbers are critical identifiers that allow investigators to trace weapons.** As such, these are often the target of obliteration efforts. Other marks, like the manufacturer, year of production, proofing or import marks, are rarely targeted. Forensic examiners highlighted the importance of “hidden” or “secret” marks and of repeated marking of key identifiers on small, internal and hard-to-access locations of a weapon. Such measures could increase the effectiveness—and therefore reduce the likelihood—of obliteration attempts, thus increasing

the potential for illicit small arms and light weapons to be traced after recovery.

6. **To enable analysis and identification of patterns of obliteration, States can record, including with images, details of the obliteration method and marks affected.** Obliteration is often understood as an isolated activity, with weapons perceived as individual exhibits. Patterns that could point to a common actor responsible for obliteration may only become evident with the comparison of weapons seized over time and in different locations, and this necessitates a record-keeping system that allows for information about the obliteration and its recovery to be collected, stored and analysed.

7. **Non-destructive and emerging recovery methodologies complement traditional approaches and provide opportunities to maintain forensic integrity and evidentiary standards.** Chemical etchants remain the most common recovery method used by forensic laboratories. This approach has a high success rate but poses challenges for examiners and is inherently destructive. Good forensic practice typically entails the layering of different methodologies, and a growing toolkit of options is available but may require specialist equipment or additional training.

8. **Forensic recovery efforts cannot ultimately compensate for marking practices that do not successfully embed recoverable identifying information on a weapon.** More guidance could be provided to manufacturers on good practices to improve marking recoverability and prevent obliteration, including recommended depth relating to different marking methods and materials. Emerging marking technologies, such as micro-scale marks or non-destructive recovery methods, may provide new opportunities to enhance weapon traceability.

9. **Laser engraving, as a widespread weapon-marking method, poses particular challenges to forensic recovery efforts.** Laser marking may involve shallow engraving and produce relatively minimal subsurface deformation, which provides less opportunity for recovery. Forensic experts have reported challenges with attempting to recover laser-engraved serial numbers, and this study has identified a clear need for additional scientific research on the recoverability of these markings on different materials and under varying conditions.

10. **Advances in digital technologies offer significant potential to strengthen traceability.** Effective weapon traceability requires a full life-cycle approach, with forensic capabilities informing not only investigative and judicial outcomes but also looping back to supporting evidence-led approaches to weapon marking and to improving international cooperation in weapon tracing.

Acronyms and abbreviations

CAR Conflict Armament Research

ITI International Tracing Instrument; International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons

MOSAIC Modular Small-arms-control Implementation Compendium

SALW Small Arms and Light Weapons

UNLIREC United Nations Regional Centre for Peace, Disarmament and Development in Latin America and the Caribbean

UNODA United Nations Office for Disarmament Affairs

UNODC United Nations Office on Drugs and Crime

UN PoA Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects

Introduction

Marking obliteration

Obliteration is the deliberate erasure or alteration of identifying markings (box 1). The removal of key identifiers like serial numbers or producer marks from small arms and light weapons (SALW) hinders criminal investigations and inhibits efforts to trace illicit SALW. It denies authorities the information necessary to effectively identify how illicit SALW enter the country and how these weapons fall into the hands of unauthorized actors. As such, marking obliteration fundamentally undermines the objectives of the 2001 Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects (UN PoA), as well as the 2005 International Tracing Instrument (ITI).

International instruments and obliteration

Two international instruments contain measures specific to preventing or countering marking obliteration: the ITI, which applies to all SALW, and the 2005 legally binding Firearms Protocol, to which some States are parties.

International Tracing Instrument

The ITI encourages SALW manufacturers to develop measures against the removal or alteration of markings (paragraph 8 (e)). In prescribing the content and nature of required weapon markings, the ITI also specifies one of States' key duties relating to the prevention of obliteration. States should ensure that all SALW marks are "conspicuous without technical aids or tools, easily recognizable, durable, and as far as technically possible, [emphasis added] recoverable" (paragraph 7). The inclusion of the caveat "as far as technically possible" is a formulation that acknowledges the fact that, while it is not practically possible for national authorities or SALW manufacturers to ensure that all weapon markings will survive all malicious efforts to remove them, measures should be taken at the time of manufacture with the specific intent of attempting to prevent its occurrence and limit the chances of successful tampering.

At the second Review Conference of the UN PoA in 2012, States undertook to strengthen national measures, where possible, against the removal or alteration of markings and to recover erased or altered markings. At the third Review Conference of the UN PoA in 2018, United Nations Member States agreed to consider adopting legislative and other measures to prohibit illicit falsification, obliteration, removal or alteration of the unique markings. In 2024, at the fourth Review Conference, States committed to exploring and taking advantage of opportunities presented by technological developments for enhanced marking, record-keeping and recovery of obliterated markings in line with ITI provisions. Member States requested the Secretariat to conduct a study on obliterated markings and recovery.[1] This mandate was

1 Report of the fourth United Nations Conference to Review Progress Made in the Implementation of

Box 1
Key terms

- **Firearms**: any portable barrelled weapon that expels, is designed to expel or may be readily converted to expel a shot, bullet or projectile by the action of an explosive, excluding antique firearms or their replicas (Firearms Protocol, 2005, Article 3 (a)).
- **Forensic recovery**: the process of restoring or re-visualizing serial numbers that have been intentionally removed (obliterated) from a weapon. This process typically involves exploiting subsurface changes in the metal's crystalline microstructure that persist even after the visible number is destroyed.
- **Obliteration**: the deliberate erasure or alteration of identifying markings. Active obliteration requires evidence of intentional efforts to remove or tamper with existing markings, as opposed to damage, corrosion or natural wear and tear that may accrue over a weapon's life span. Obliteration is often carried out to conceal the provenance of a weapon. Synonymous terms in use include "alter", "amend", "deface", "efface", "interfere", "modify", "remove", "sanitize" and "tamper".
- **Small arms and light weapons**: any man-portable lethal weapon that expels or launches, is designed to expel or launch, or may be readily converted to expel or launch a shot, bullet or projectile by the action of an explosive. Small arms are weapons for individual use, such as self-loading pistols, assault rifles or light machine guns. Light weapons are designed for use by two or three persons serving as a crew, although some may be carried and used by a single person. They include heavy machine guns, portable missile and rocket launchers, and mortars of a calibre of less than 100 millimetres (ITI, 2005, paragraph 4).
- **Tracing**: the systematic tracking of illicit SALW found or seized on the territory of a State from the point of manufacture or the point of importation through the lines of supply to the point at which they became illicit (ITI, 2005, paragraph 5).

subsequently adopted by the United Nations General Assembly's First Committee during its seventy-ninth session.[2] The Conference also decided to establish an open-ended technical expert group to consider developments in SALW technologies and develop recommendations to ensure the full and effective implementation of the UN PoA and the ITI in that regard.

During the first meeting of the Open-ended Technical Expert Group, in June 2026, States discussed means and methods to prevent the removal of serial numbers and allow for the recovery of obliterated markings.[3]

Firearms Protocol

Separately, article 5.1 (c) of the Protocol against the Illicit Manufacturing of and Trafficking in Firearms, Their Parts and Components and Ammunition (Firearms Protocol) requires States Parties to adopt measures to criminalize "falsifying or illicitly obliterating, removing, or altering the marking(s) on firearms". The Firearms Protocol, which supplements the United Nations Convention against Transnational Organized Crime, entered into force on 3 January 2005 and, as at February 2026, had 126 States parties.[4] The provisions of article 5.1 (c) relate to two aspects of mark "tampering": (a) the falsification of newly applied markings; and (b) the obliteration, removal or alteration of existing markings.[5]

Furthermore, article 8 (2) of the Firearms Protocol stipulates that "States Parties shall encourage the firearms manufacturing industry to develop measures against the removal or alteration of markings." Technical guidelines published in 2011 note several policies that could be adopted to support implementation of this requirement, including establishing a technical committee to periodically review domestic marking standards and developing a system of weapon marking specific to the country and producer, making it "nearly impossible to unlawfully reproduce those markings".[6]

Methodology

Survey

In 2025, UNODA issued a survey to all United Nations Member States in Arabic, English, French and Spanish. The survey consisted of three principal sections, comprising 36 questions developed through consultation with researchers. These questions sought to understand the following:

- National experiences of SALW with obliterated markings
- National approaches to forensic and SALW investigations
- National control systems and marking practices.

The survey was issued on 5 May 2025 and closed on 29 August 2025. The questionnaire was completed by 38 respondent States, detailed in table 1.

the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects (A/CONF.192/2024/RC/3).

2 "The illicit trade in small arms and light weapons in all its aspects" (A/C.1/79/L.40).

3 See guiding question 6 in A/CONF.192/BMS/2026/L.5

4 The status of adherence to the Firearms Protocol is available from the United Nations Treaty Collection.

5 Conference of the Parties to the United Nations Convention against Transnational Organized Crime, "Implementation of article 5 (Criminalization) of the Firearms Protocol.' Working Group on Firearms (CTOC/COP/WG.6/2024/3).

6 UNODC, "Technical Guide to the Implementation of the Protocol against the Illicit Manufacturing of and Trafficking in Firearms, their parts and components and ammunition, supplementing the United Nations Convention against Transnational Organized Crime" (2011).

Table 1
Country response by region

Africa	*Americas*	*Asia*	*Europe*	*Oceania*
Central African Republic	Argentina	Bahrain	Finland	Australia
Côte d'Ivoire	Bahamas (The)	Japan	Hungary	
Democratic Republic of the Congo	Brazil		Lithuania	
Nigeria	Canada		Luxembourg	
Rwanda	Colombia		Portugal	
Sierra Leone	Ecuador		Russian Federation	
Sudan	El Salvador		Serbia	
	Guatemala		Slovenia	
	Haiti		Spain	
	Honduras		Sweden	
	Jamaica		Switzerland	
	Mexico		Ukraine	
	Panama			
	Saint Kitts and Nevis			
7	**14**	**2**	**12**	**1**

An option to participate anonymously was extended to all respondents. This was requested by two States, which will not be named in this study. Regional data in table 1 does not include those two States.

Most survey responses were submitted by representatives of law enforcement agencies (29 per cent of survey responses) or national interior ministries (26 per cent), followed by representatives of ministries of foreign affairs (18 per cent) and national commissions for firearms (13 per cent).

As part of the survey, Member States were provided with the opportunity to submit photographs of commonly encountered obliterations. Some of those images have been included in this report. Unless otherwise indicated and referenced, all the data and analysis presented in this report should be understood as originating from the survey.

Expert interviews

The research team consulted experts from private and governmental forensic laboratories, police investigators, as well as firearms manufacturers.

The researchers conducted expert interviews with representatives of 15 forensic laboratories (including Antigua

and Barbuda, Australia, Brazil, Canada, Chile, France, Guatemala, Haiti, Mexico, Serbia, the United Kingdom and the United States, as well as three representatives asking to be kept anonymous). Researchers additionally interviewed police investigators from four countries (Argentina, Brazil, Canada and Sweden) and issued a bespoke survey to private firearms manufacturers, receiving three responses.[7]

Case studies and analysis

This study draws on field-case studies derived from iTrace,® a database developed by Conflict Armament Research (CAR) to record diverted weapons and ammunition documented in conflict zones.[8] CAR field investigation teams work in active armed conflicts alongside national defence and security agencies. The teams document weapons, ammunition and other related materiel at the point of use and track their sources back through the chains of supply. Since 2011, CAR field investigators have been deployed to conflict-affected countries around the world to physically document weapons, ammunition and related materiel that have been recovered from unauthorized and illicit custodians. CAR then traces this materiel with manufacturers, export authorities and other transfer parties to identify the chain of custody and conducts targeted research investigations into illicit procurement networks that fuel its diversion. These case studies are selected to illustrate and provide evidence of obliteration patterns and dynamics as identified in the research conducted for this study with United Nations Member States.

Consultations with other United Nations entities were conducted, including through a webinar on 15 August 2025. The United Nations Regional Centre for Peace, Disarmament and Development in Latin America and the Caribbean contributed research on the recoverability of obliterated markings through laser engraving.

7 Ballistic Headquarters/ARES Armaments (Australia), Colt Canada (Canada), and a third manufacturer that requested to be kept anonymous.

8 Conflict Armament Research (n.d.). iTrace® is an European Union and German Government-funded project that provides policymakers with precise, verified information required to understand weapon transfers in detail and, thereby, to develop effective, evidence-based weapon management and control.

CHAPTER 1

Understanding small arms and light weapons obliteration

CHAPTER 1

Understanding small arms and light weapons obliteration

1. How big is the issue of marking obliteration of SALW?

Spread

Marking obliteration is a global phenomenon and presents a challenge to national authorities worldwide. This study identified that at least 77 countries have seized or recovered illicit SALW with obliterated markings (figure 1).

The research team built this picture from three sources. First, a survey issued to all United Nations Member States in 2025 by UNODA identified 34 countries that had recovered weapons with obliterated markings (90 per cent of respondents).[1]

Only four countries responding to the survey did not report seizing such weapons. Most survey respondents were from the Americas and Europe (figure 2), with 25 countries reporting national experience on this issue.

The second source for figure 1 was the CAR iTrace® database. Since 2011, CAR field investigation teams have worked across conflict- and terrorism-affected countries to document weapons, ammunition and related materiel that has been diverted to illicit non-State actors or unauthorized end users. CAR operations have largely centred on West Africa and the central Sahel, East Africa, countries bordering the Red Sea and the Arabian/Persian Gulf, the Middle East and North Africa, as well as conflict hotspots like Afghanistan and Ukraine. CAR has encountered obliterated material in 20 of the 28 countries in which it has documented weapons.[2] Concentrated in Africa and Asia, CAR's field data sample is an important complement to the geographic scope of UNODA survey respondents.

The third data source for the map in figure 1 was national reports using the Illicit Arms Flows Questionnaire of the United Nations Office on Drugs and Crime (UNODC). The questionnaire is an annual data collection tool that gathers both quantitative and qualitative information on seized firearms. It is mandated by the United Nations Convention against Transnational Organized Crime and its supplementing Protocols, specifically the Firearms Protocol. The research team reviewed data reported by countries that recorded

1 Additionally, Antigua and Barbuda, Canada and the United States reported having seized weapons with obliterated markings during interviews.

2 Afghanistan, Bahrain, Benin, Burkina Faso, Central African Republic, Côte d'Ivoire, Democratic Republic of the Congo, Ghana, Iraq, Mali, Niger, Nigeria, Philippines, Saudi Arabia, Somalia, South Sudan, Sudan, Syrian Arab Republic, Ukraine and Yemen.

Figure 1

Countries that have reported seizing weapons with obliterated markings or where CAR field investigators have documented such weapons



Sources: UNODA/CAR research survey (2025), CAR iTrace® database (data from 2011–2025), UNODC Illicit Arms Flows Questionnaire (2016-2023).

Figure 2

Has your State ever seized illicit SALW with intentionally obliterated markings?

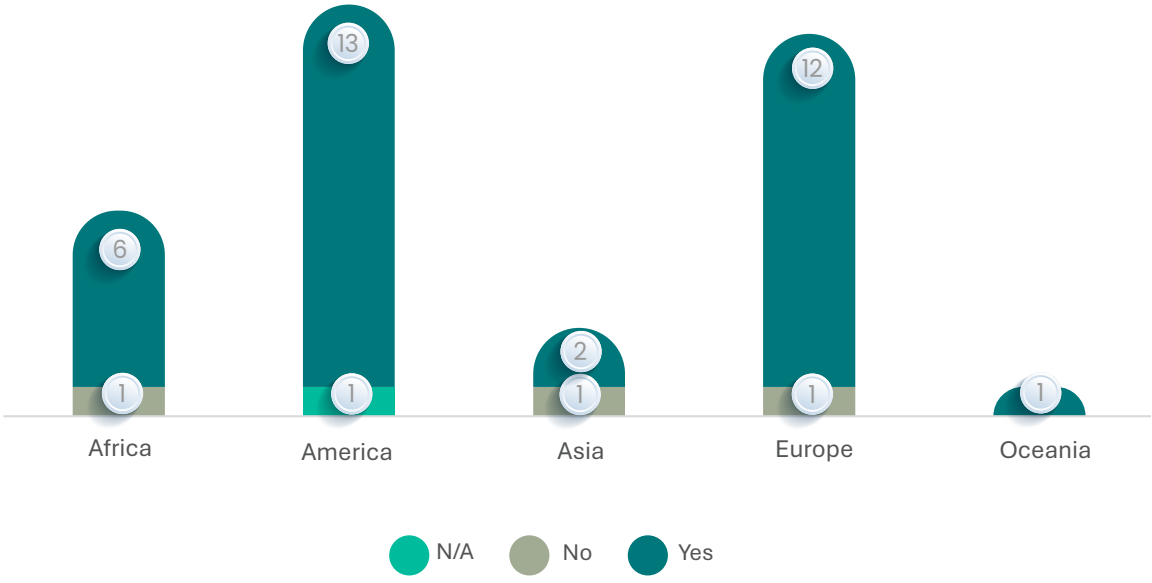
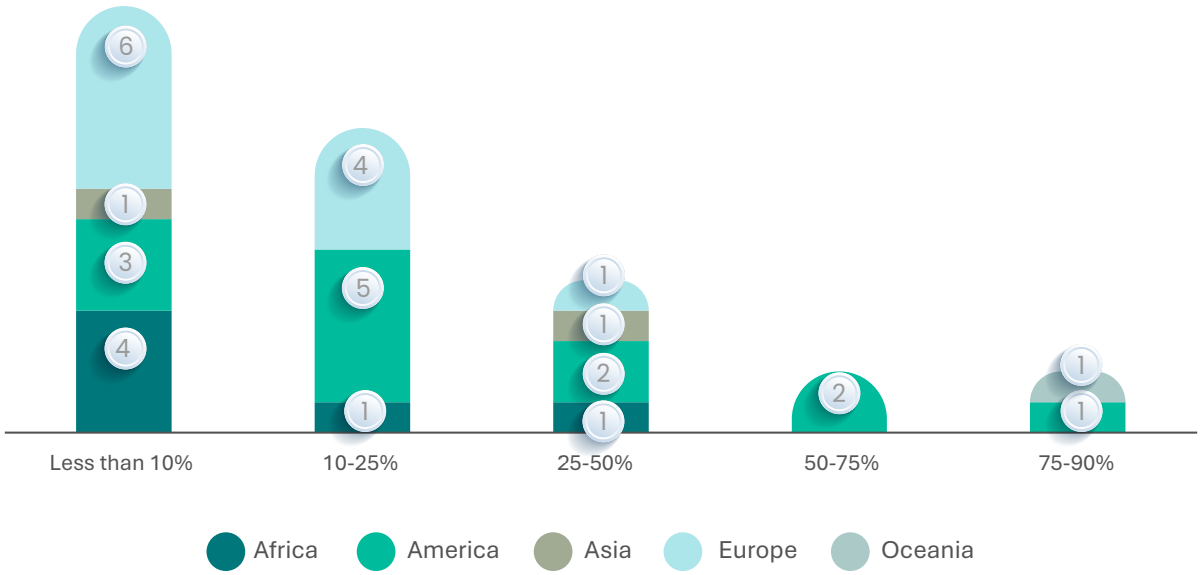


Figure 3
Of all seized SALW recovered in your State, what is the proportion that have obliterated marks



seizures of firearms with altered markings between 2016 and 2023, the latest year currently available, and used this material to supplement its data collection, as shown in figure 1. After excluding countries already identified through UNODA and CAR data, an additional 30 countries were identified through the UNODC dataset and incorporated into figure 1.[3]

The UN PoA national reporting template was amended in 2026 to include questions about Member State practices related to manufacturing (7.4), seizure (7.5) and forensic recovery of weapons with obliterated marks (7.6).[4] As new national reports were not available to researchers at the time this study was conducted, this information is not included in the scope of this study but may be considered in future research on this topic.

Scale

Estimates of the proportion of affected SALW vary widely across and within countries. This variance is illustrated in figure 3, which illustrates the proportion of seized SALW with obliterated markings, broken down by region. Of the 38 countries responding to the UNODA survey in 2025, 24 assessed that less than one quarter of illicit weapons in their country featured obliterated markings. Five States did not provide data in response to this question.

3 UNODC Data Portal, last updated May 2025.
4 See the UN PoA database of national reports.

Low

As figure 3 shows, reporting States most frequently indicated that less than 10 per cent of seized weapons in their country featured obliterated marks (14 States, or 36.8 per cent of respondents). These include Central African Republic, El Salvador, Hungary, Nigeria and the Russian Federation. A further 10 respondent States reported that between 10 and 25 per cent of seized weapons in their country exhibited intentional obliteration. This tier includes Brazil and Argentina, which reported rates of 13 and 23 per cent, respectively, for 2016–2017 in the UNODC 2020 Firearms Trafficking Study.[5] In the case of Brazil, this study and the UNODC dataset use information reported by the Federal Police, which excludes state-level seizures that make up the majority of illicit SALW recoveries nationwide. Evidence from other studies conducted in Brazil that draw on this state-level data suggests a substantially higher prevalence of weapons seized without markings or with altered markings in some regions of Brazil. A 2025 study by Instituto Sou da Paz, with a dataset of 236,000 industrially manufactured firearms, found that 45 to 55 per cent of firearms seized in Brazil's South-East region between 2018 and 2023 had no serial number or had an invalid one.[6] In France, which did not complete the survey, a ballistic expert interviewed for this study estimated that between 10 and 20 per cent of seized firearms examined by their laboratory present intentional obliteration.[7] This figure is consistent with data reported by other European countries: only one of 11 reporting countries in the region (Slovenia) indicated levels of obliteration above 25 per cent nationally.

Medium to high

Five States reported that between a quarter and half of all seized weapons featured obliterated markings. This middle tier included Mexico, Slovenia, Saint Kitts and Nevis, and Sudan. It was extremely rare for States to report obliteration across the majority of all recovered SALW in their countries. Three of the countries to report such a dynamic were based in the Americas, specifically Central and South America. Colombia and Honduras reported that 50 to 75 per cent of all recovered weapons had obliterated markings, while Ecuador and Australia indicated that marking obliteration occurred in 75 and 90 per cent of cases.

Important qualifiers should be noted in relation to those countries that reported such high results, with diverging values associated either with differences in regional data or over different time periods. The figure for Australia, for example, reflected an aggregation of data from multiple police agencies, with the highest reported incidences retained where discrepancies existed. As such, the figure should be interpreted as reflecting high-incidence regions, rather than a national average. Similarly, discrepancies between forensic expert interviews and survey responses can be expected and may reflect differences in authorities, record systems and information-sharing practices.

Data collected by CAR field investigators also supports the broad characterization shown in survey data of marking obliteration as a nationally low-

5 UNODC Global Study on Firearms Trafficking 2020.
6 Bruno Langeani and Mayra Luiza Pinheiro da Silva, "Arsenal do crime: análise do perfil das armas de fogo apreendidas no Sudeste (2018-2023)" (Instituto Sou da Paz, 2025), p. 33, 44 and 66.
7 Interview with Antoine Museau, Adjudant-chef of the Institut de Recherche Criminelle Balistique de la Gendarmerie Nationale (IRGCN/Balistique).

level phenomenon, but with specific localized or temporally specific concentrations. Globally, of the more than 11,000 illicit SALW documented by CAR investigators between 2011 and 2025, 779 weapons (6.6 per cent) were found to exhibit some form of marking obliteration.[8]

Obliterated markings make up a sizeable proportion of seized weapons in some of CAR's investigations. For example, of the 42 weapons seized in Bahrain between 2013 and 2018 that CAR investigators documented, almost half featured obliterated markings.[9] This followed a series of attacks in the country carried out by non-state armed actors, primarily against security personnel and infrastructure.

CAR documented weapons with obliterated marks in six out of eight seizures in Bahrain during this period. Notably, almost all these seizures also included material used in the production of improvised explosive devices, some of which also featured systemic obliteration.[10] In July 2013, security forces in Bahrain uncovered a weapons cache with ten weapons that had all been obliterated in an identical fashion (figure 4 shows an example of this approach). The weapons had been modified and packaged alongside sound suppressors, suggesting that they had been intended as "assassination kits" designed to equip a recipient with untraceable weapons that could be used to carry out close-quarter attacks.

8 See iTrace®.
9 *Weapon Seizures in Bahrain: Uncovering Links with Illicit Weapon Supplies in the Gulf* (CAR, 2025).
10 *The IED Threat in Bahrain: A Comparative Analysis of Components Documented in the Gulf Region* (CAR, 2019).

Figure 4



Obliteration of serial number and manufacturer marks on an assault rifle, as documented by CAR in Bahrain on 23 July 2017. (Photo credit: Conflict Armament Research)

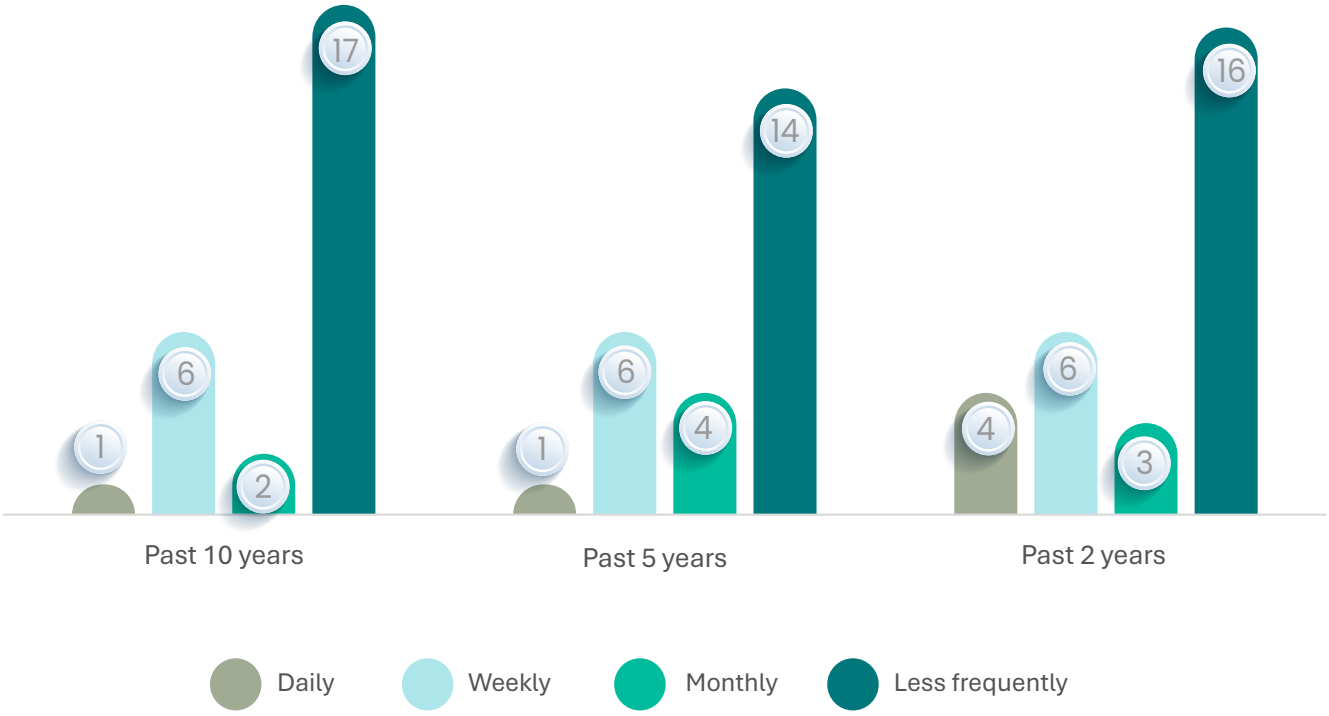
Bahrain reported through the survey that less than 10 per cent of recovered weapons feature obliteration. The Bahrain example shows how, even in national contexts where overall illicit weapon seizures are quite small, and where obliteration itself is a statistically minor consideration, evidence of marking removal on specific material and in specific contexts points to targeted and discerning efforts to disguise the origin of particular weapons. The presence of obliteration—and its comparative absence elsewhere among related seized materiel—may therefore represent an important indicator for authorities to prioritize in targeted exploitation and analysis.

Frequency

As a general observation, seizures of obliterated weapons appear to occur at a relatively low frequency in most countries. Figure 5 shows that, across the three reference periods (over the past 10 years, the past 5 years and the past 2 years), the most common response category was "less frequently than monthly".

A small number of States reported higher frequencies. Only four States indicated daily seizures in the past two years: Australia, Colombia, Ecuador and Sweden. Six States reported weekly seizures over the same period: the Bahamas, Brazil, Honduras, Slovenia, Portugal and one State that requested to remain anonymous.

Figure 5
How frequently does your State seize SALW with obliterated markings?



While not a comprehensive picture of regional experience, combined assessment of survey responses relating to both scale and frequency of seizures suggests that marking obliteration is a particularly pronounced security challenge in Central and South America. Five out of 11 respondents from that region (45.5 per cent) reported daily or weekly seizures of SALW with obliterated markings in the past two years. By comparison, none of the six respondent States from Africa reported this dynamic, as did just a third of European respondents (three out of nine States).

There was limited evidence from the survey data of changes in marking obliteration over time within a specific country. Only four countries provided data that suggested a significant shift in exposure to this issue:

Increases

- Sweden reported an increase from weekly seizures in both the past 10 and 5 years to daily seizures in the past 2 years.
- The Bahamas reported a shift from monthly seizures 10 years ago to weekly seizures in the past 2 years.

Decreases

- Panama reported monthly seizures 5 years ago and less frequent seizures in the past 2 years.
- Côte d'Ivoire also reported a decrease from monthly seizures 5 years ago to less frequent seizures in the past 2 years.

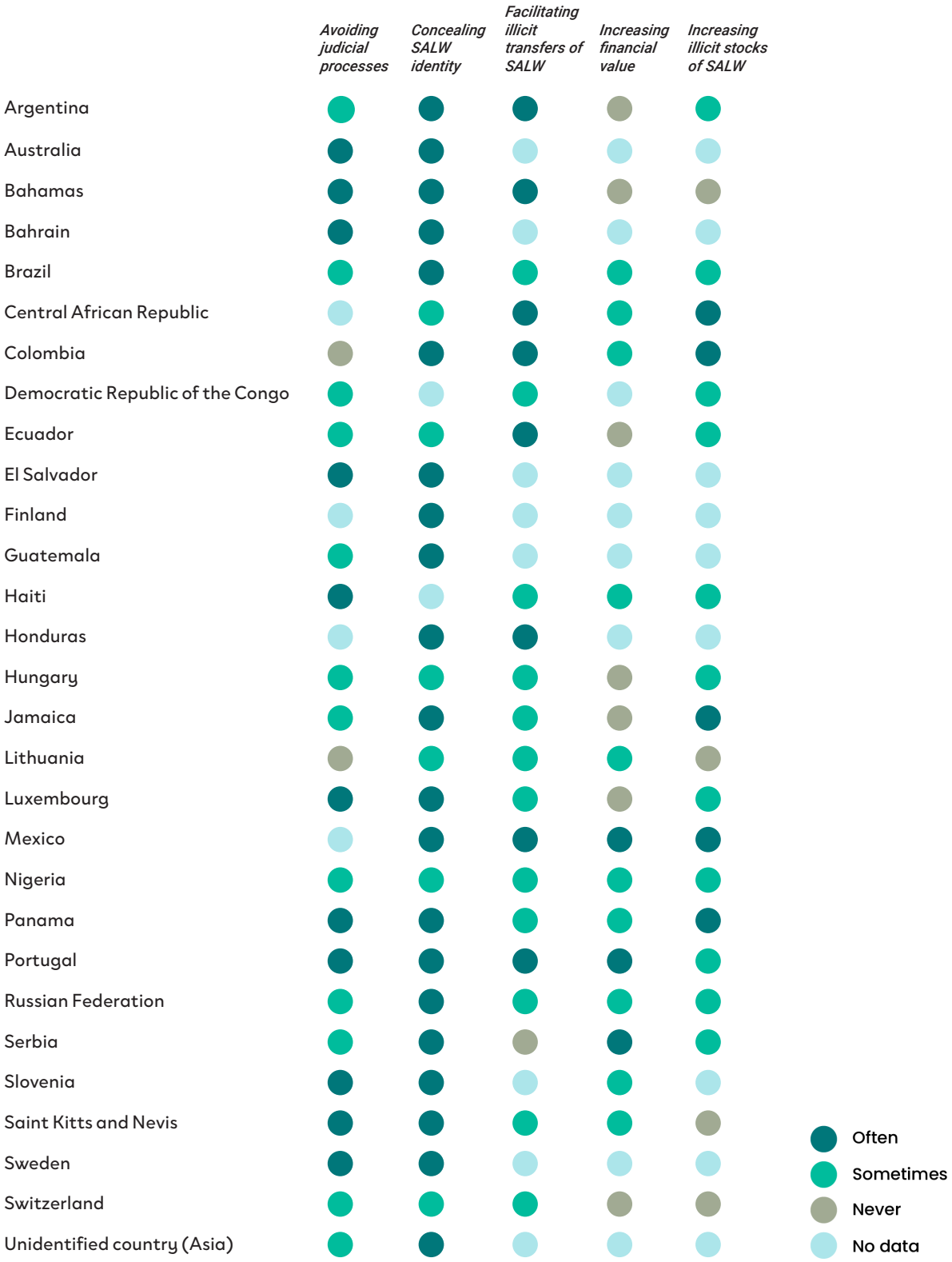
Taken together, survey responses suggest that seizures of SALW with obliterated markings represent a persistent challenge for many countries during the period assessed by this study (2016–2025). While temporary increases may be observed in specific countries, the phenomenon of marking obliteration generally appears to remain relatively stable across the assessed time periods. Importantly, this study identified that marking obliteration can be a highly localized phenomenon within a national context. Different regions or local areas may see far higher levels of obliteration seizures than others, or sizeable fluctuations in the types and quantities of material featuring removed and tampered marks. This is important information for national authorities to record on a systematic basis. National or even regional baselines do not fully articulate the nature of the obliteration issue within a country but may help authorities to discern shifting trends or the emergence of new weapon-smuggling hotspots and therefore support the identification of specialized or targeted operations to illicitly trade SALW into or within a jurisdiction.

2. Why are small arms and light weapons marks obliterated?

Motives for obliteration

Concealing the identity of SALW emerged from survey results as the primary motivation for weapon obliteration. Twenty-seven respondent States identified this as a driver of marking obliteration. This was followed by avoiding judicial processes (23 States) and facilitating the illicit transfer of SALW (20 States). Figure 6 provides an illustrative breakdown of whether different obliteration motives were "often", "sometimes", or "never" seen by respondent States.

Figure 6
Primary motives for obliteration



Interviews with law enforcement officers and forensic experts reinforce this perception, consistently framing obliteration as an act intended to hamper weapon identification, disrupt investigative work and protect the identities of those involved. An interview with a Canadian practitioner indicated that, in their regional context, such practices may be initiated by multiple types of actors, including "purchasers, middle-man and end users".[11] Sixteen of the 38 survey respondents identified obliteration as largely occurring domestically after weapons had entered the country. Seven States reported that weapons largely entered the country either partially or fully obliterated. A Haitian police officer interviewed for this study stated that, in the national context, markings are typically obliterated after firearms have entered the country illicitly across borders, and that this practice is generally carried out by end users, mostly gangs operating within the country.[12]

Obliteration was identified as a common characteristic of organized crime or non-State armed groups. In Brazil, an officer with decades of experience in combating illicit trafficking observed that organized crime relied on highly specialized groups, often linked to suppliers, that performed the professional scraping and overstamping services.[13] This dynamic was particularly noted in cases where weapons are trafficked in bulk into the country.

Several interviewees also noted that, where systematic tracing practices and investigations into the origin of firearms were not routinely conducted by law enforcement, the incentive to obliterate markings diminished. Conversely, where investigations and tracing efforts are effective in identifying and prosecuting those involved, it is expected that offenders will seek to refine and professionalize their methods of obscuring identifying features. One expert commented that, in their region, they observed that "the level of forensic awareness among criminals has increased. Offenders are becoming increasingly professional, removing a wider set of marks and refining the work."[14] In other words, obliteration perpetrators appear to adapt their practices in response to policing and investigative capacity.

With respect to how obliteration affects the financial value of a firearm, several nuanced perspectives emerged from the interviews. In certain cases, an increase in value was reported where obliteration was used to misrepresent the weapon as another type or brand, typically by imitating weapons perceived as being of higher market value. Examples include air weapons converted to live-fire capability, or industrial firearms re-marked to resemble brands regarded as superior. Outside these specific scenarios, however, interviewees consistently suggested the opposite effect. Police officers representing law enforcement in Mexico and Canada described how obliteration more commonly reduced the value of a firearm on the illicit market. This was attributed both to the perception of obliteration as physical damage, rendering the weapon less original or less "new", and to the increased suspicion that the firearm may have been previously used in another crime, thereby introducing additional risk for prospective buyers.

11 Interview with Shane Staniek, Firearm and Toolmark Specialist with the British Columbia Provincial Forensic Firearms Laboratory, Organized Crime Agency of British Columbia.

12 Interview with Ralph Stanley Jean Brice, Inspecteur Général de la Police Nationale, Haiti.

13 Interview with Marcus Dantas, Federal Police of Brazil.

14 Interview with Marcelo Druzian, Forensic Unit, Southern region, Brazilian Federal Police.

Contexts of obliteration

Obliteration is present in both conflict and crime-affected contexts. The dynamics of illicit weapon obliteration may, however, differ markedly between conflict-affected regions and areas dominated by criminal activity.[15] Where demand for weapons is primarily driven by organized criminal groups, weapon sanitization typically targets small batches and is aimed at evading law enforcement and protecting illicit supply chains. In the context of armed conflict, by contrast, non-state armed groups may utilize obliteration to obscure the origin of weapons and external backers, including to disguise illicit supplies from state-linked networks. These differences underscore that the motivation to conceal a weapon's identity depends on context.

In the perception of respondents, marking obliteration was more frequently characterized as an isolated and dispersed practice (21 responses), rather than as an organized phenomenon. Just two States, Lithuania and Colombia, reported this being a more common dynamic in their national context. Six States indicated that both patterns occurred in equal proportions (Australia, Brazil, Honduras, Mexico, Slovenia and Sweden). A senior Brazilian forensic officer working in a border region of the country reported that it was common to seize groups of trafficked firearms that appeared "to have undergone systematic, serial obliteration, resembling a form of production-line process". The assessment that these alterations are carried out collectively is based not only on the types of marks removed but also on the fact that obliterated weapons of the same model are frequently seized with interchanged components. This suggests that multiple weapons are disassembled simultaneously, subjected to obliteration in sequence, and subsequently reassembled, potentially in an arbitrary manner once original markings can no longer be used to correctly match components. The obliteration can also be followed by the installation of automatic fire conversion kits (auto sear/switches).[16]

Understanding the extent to which obliteration is occurring on an organized or isolated basis—and identifying the perpetrator responsible—requires several preconditions. Measures must exist for a State to adequately record obliteration at the point of recovery, providing detailed visual evidence of how the marks were removed. This information needs to be reported and stored in a way that is searchable across different authorities, both within a national context and potentially with regional neighbours. This is detailed further in chapter 3 of this study.

Patterns of obliteration emerge only with analysis of data that is collected, organized and shared at scale (see box 2). This is compellingly demonstrated by two initially separate investigations conducted by CAR field investigators in West Africa and the Syrian Arab Republic. In August 2015, a CAR field team documented a Chinese Type 56-1 assault rifle that had been used in an attack on the Hôtel Byblos in Sévaré, Mali. The rifle featured an eight-digit serial number starting with the prefix "560". Several markings had been obliterated from the rifle's rear sight block. Around the same time, another CAR field team documented a rifle in the same series in Kobane, in the northern Syrian Arab Republic. CAR continued to document rifles in this series,

15 Bailey Henwood, "Tracking the Untraceable: An Assessment of Global Obliteration Techniques on Small Arms", PhD thesis, Cranfield University, Shrivenham, UK, 2024.

16 Interview with Marcus Dantas, Federal Police of Brazil.

used in a wave of attacks across West Africa between August 2015 and March 2016, with at least 15 rifles bearing the same distinctive obliteration pattern, an example of which is shown in figure 7.[17] CAR documented these rifles with similar obliteration patterns in Burkina Faso, Côte d'Ivoire, Mali and Niger.

Several years later, investigators documenting weapons used in a series of high-profile attacks in the north-east of the Syrian Arab Republic, conducted by top-tier Da'esh cells, found another 16 "560" Type 56-1 assault rifles that featured the same obliteration to the forward trunnion and rear sight block. Analysis of the obliteration pattern across the rifles in the Syrian Arab Republic, and comparison with those previously recorded in West Africa, found that the same removal technique was used (see figure 8). Toolmarks showed signs of a repeated, left-to-right oscillating motion, carried out by a small rotary tool with a polishing bit. Through its sustained field monitoring and by cross-referencing weapons in its iTrace® database, CAR was able to determine that these rifles had all very likely passed through the same location for mark removal.[18]

17 *Investigating cross-border weapon transfers in the Sahel* (CAR, 2016), pp. 39-41.

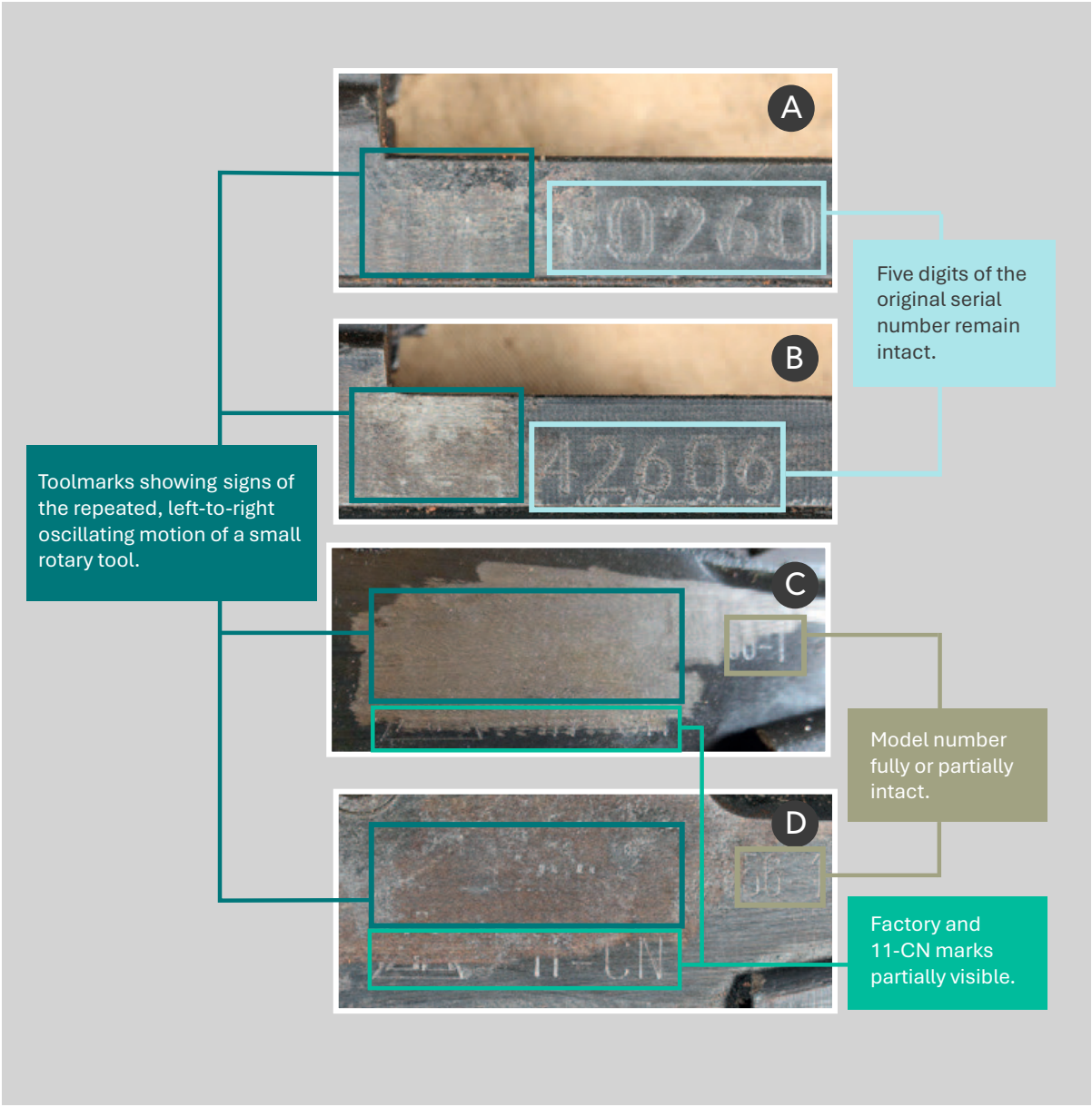
18 *After the Caliphate: Islamic State Weapons in High-Profile Operations in North-East Syria* (CAR, 2024), pp. 40-43).

Figure 7



A Type 56-1 rifle, documented by CAR in the Niger in April 2016, showing obliterated marks on the rear sight block, which had been overpainted in black. (Photo credit: Conflict Armament Research)

Figure 8



Analysis of mark removal on four different Type 56-1 rifles, documented by CAR in Mali (C) and in the Syrian Arab Republic (A, B and D). (Photo credit: Conflict Armament Research)

Source: *After the Caliphate: Islamic State Weapons in High-Profile Operations in North-East Syria* (CAR, 2024), p. 43.

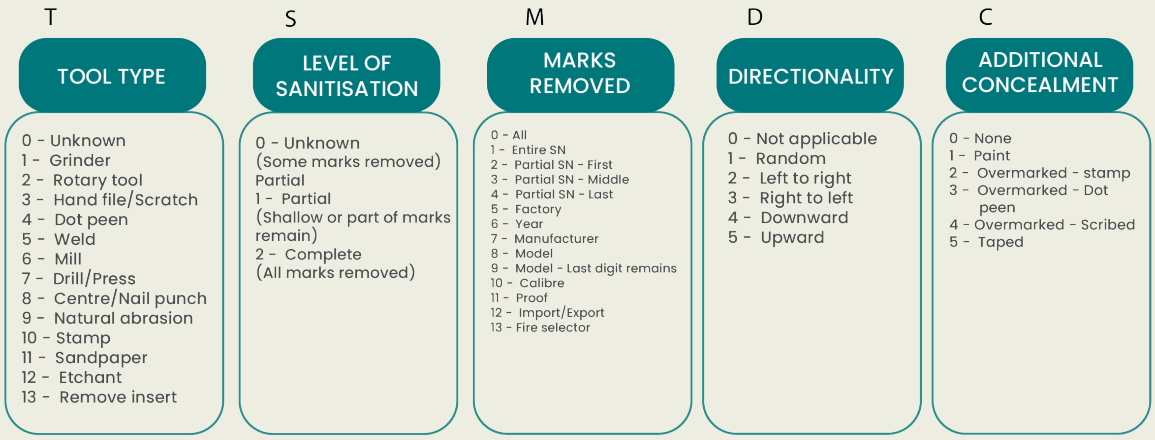
When assessed on a case-by-case basis, each obliterated weapon may only appear as a solitary indicator of an isolated obliteration action. A pattern may be more readily apparent within a single State through appropriate record-keeping, forensic analysis and internal information sharing. However, the full transnational scale of obliteration in this case, and its clear large-scale organization, only became apparent with in-depth field monitoring. This is discussed further in chapter 3.

Box 2
A methodology for analysing marking obliteration

Obliterated marks on recovered SALW may share common technical characteristics that can be analysed to identify commonalities within and between different countries or even regions. In 2024, researchers developed a methodology to code and analyse five key features of an obliteration (see figure 9), including:

- The type of tool used (T);
- The level of sanitization observed (S);
- The types of marks removed (M);
- The directionality of the obliteration (D)
- Whether additional concealment methods were recorded (C).[19]

Figure 9
A novel coding methodology for assessing marking obliteration



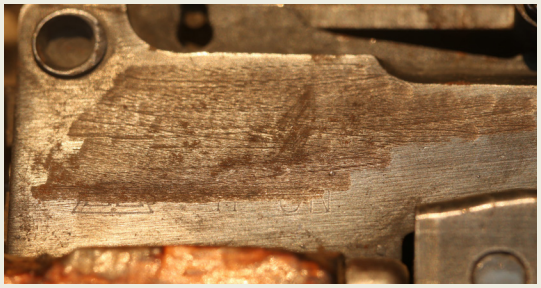
By creating a standardized framework for classification, the system allows forensic examiners to link recovered weapons and other evidence exhibiting similar obliteration characteristics. An example of this methodology in practice is shown in figure 10. This relates to rifles with similar obliterations documented by CAR field investigators in Mali, the Niger and the Syrian Arab Republic. Image analysis identified that these weapons had been partially obliterated (S=1) using a similar rotary tool (T=2.1). The entire serial number, factory and model marks had all been removed (M=1/5/8) from a left-to-right direction (D=2), and with no additional concealment effort (C=0).

19 Henwood, "Tracking the Untraceable".

Figure 10



Mali



Niger



Syrian Arab Republic

Three weapons sharing the same obliteration code – 2.1.1/5/8.2.0 – documented in Mali, the Niger and the Syrian Arab Republic. (Photo credit: Conflict Armament Research)

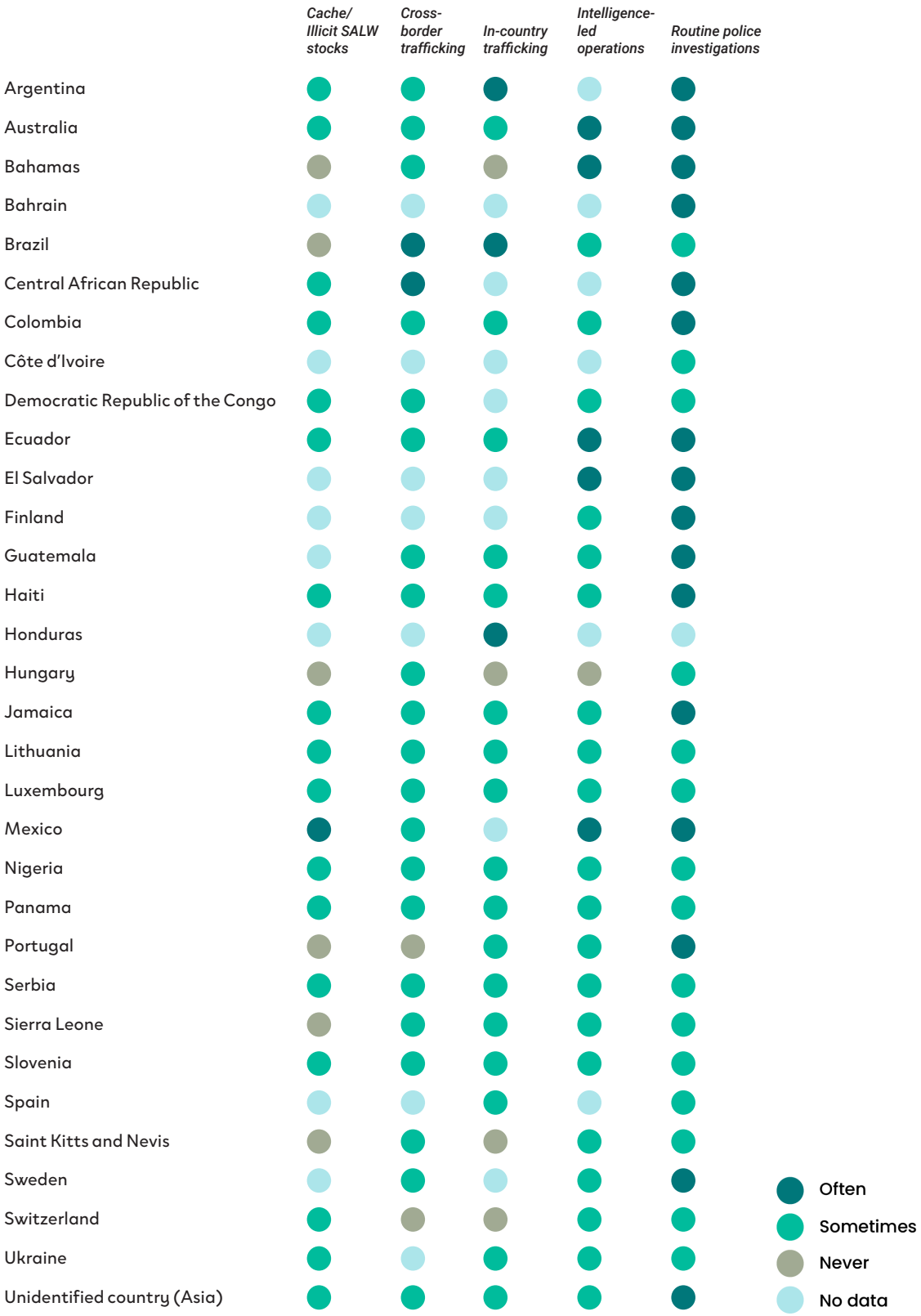
While the presence of a particular obliteration code in a single country or region does not provide sufficient evidence to pinpoint the exact origin of the sanitization, aggregating observations across multiple cases could enable analysts to identify trends and infer potential patterns of tool use or mark removal associated with specific jurisdictions. Similarly, the identification of rare or unique toolmark signatures can reveal highly specialized workshops or organized criminal operations that would otherwise remain undetected.

Seizure patterns

The survey responses showed the operational contexts in which national authorities recover SALW with obliterated markings. First, the survey asked Member States about the circumstances of the recovery of obliterated weapons. Recovery through "routine police investigations" was by far the most reported recovery type (31 responding States), followed by intelligence-led operations (25 responding States). Figure 11 illustrates the distribution of responses across different frequency categories.

Figure 11

Circumstances of seizure of SALW with obliterated markings, by frequency



The survey responses identified the most common scenarios in which SALW with obliterated markings are seized, allowing for more than one response per country. Responses were concentrated in small-scale seizure contexts: 81 per cent referred to seizures involving between one and four weapons at a time, equivalent to 39 responses. Within this group, seizures occurring *in situ* or while the weapon was in use were the most frequently reported, accounting for 61.5 per cent of responses. A further eight States reported seizures of larger quantities, between 5 and 20 weapons. Only one State reported seizures involving larger quantities, defined for this study as more than 20 weapons.

3. What types of weapons and markings are most commonly obliterated?

Weapons

Marking obliteration has been recorded on a wide variety of SALW types, as well as associated ammunition (see box 4). Twelve weapon types were included in the survey: anti-aircraft/tank gun; grenade launcher; machine gun; mortars (calibre less than 100 mm); portable launcher (missile/rocket systems); pistol; recoilless rifle; revolver; rifles or carbines; shotgun; submachine gun; and air weapons/converted firearms.[20]

Pistols and revolvers

Pistols were the SALW type most reported by United Nations Member States as being recovered with obliterated markings. Handguns like pistols, including those with polymer frames (see box 3), and revolvers are highly susceptible to diversion, being small and relatively easy to conceal. These weapons are especially common in illicit markets, particularly in contexts affected by organized criminal groups. Twelve countries indicated that national authorities often recovered pistols with erased markings.[21] Another six States indicated that they often recovered revolvers with obliterated marks (see figure 14). Figure 13 shows several pistols with obliterated serial numbers, seized in St. Kitts and Nevis.

All respondent States that provided data in response to this question indicated seizing pistols with obliterated marks. Analysis shows a clear regional divergence, however. In the Americas (eight out of 13 respondent States), for example, pistols were by far the most frequently reported type of seized SALW with obliterated markings. In Africa, by contrast, none of the five responding Member States reported pistols as a frequently seized category.[22]

20 Weapon types based on the United Nations Register on Conventional Arms.

21 A further 20 countries reported sometimes making such seizures.

22 Instead, rifles and carbines (three of five respondent States) and recoilless rifles (two of five) were most reported as the obliterated weapon types often seized by African respondent States.

Figure 12

Types of weapons with obliterated markings, reported as being "often", "sometimes", or "never" seized



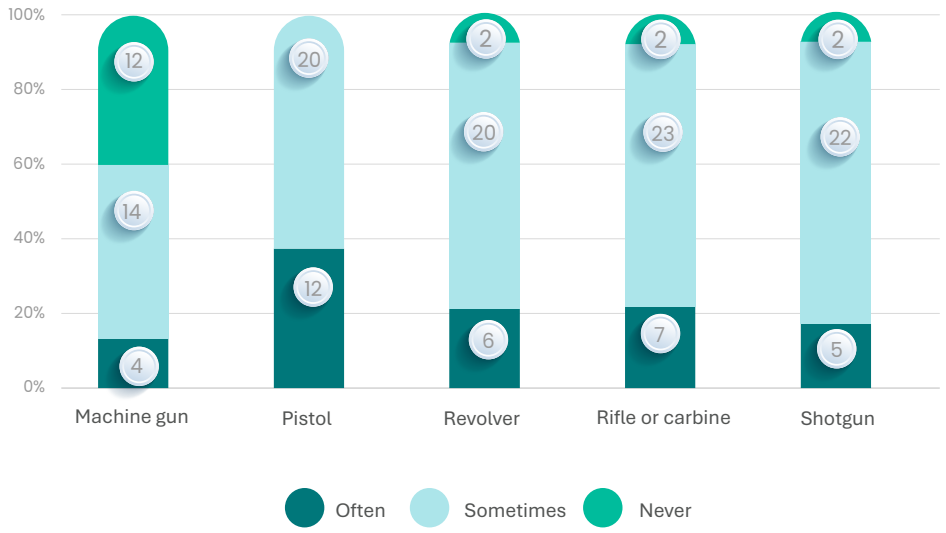
Figure 13



Self-loading pistols with obliterated serial numbers, produced by Smith & Wesson (left), Beretta U.S.A. (middle) and Taurus. (Photo credit: St. Kitts and Nevis)

Figure 14

States indicating the frequency of seizures of selected weapon types with obliterated marks



Box 3

Obliteration of marks on polymer weapons

While using polymer materials in weapons production is no longer a new or emerging technology, Member States have identified using polymer material as posing particular challenges in implementing the UN PoA and ITI, explored in the context of the Open-ended Technical Expert Group. A key reason for this specific concern is that polymer weapons, such as handguns with polymer frames or rifles with polymer lower receivers, may be more vulnerable to obliteration than those produced with traditional materials like steel.[23] This study identified three key aspects of obliteration on polymer weapons.

23 Report of the Secretary-General on current developments in science and technology and their potential impact on international security and disarmament efforts (A/79/224), para. 64.

First, one forensic expert identified the vulnerability of marks applied directly to the polymer mould itself, referring to the prospect of perpetrators melting the marked locations, making it impossible to recover.[24] These are non-unique identifiers, such as producer or model marks or post-production marks. The lines are increasingly blurred between industrial polymers and unmarked polymer frames used in artisanal, "craft", or improvised weapons, particularly 3D-printed firearms.[25]

Second, where serial numbers are applied to metal insert plates, it is possible not only for the marks to be obliterated while the plate is in situ, but for the entire plate to be removed from the frame. The Modular Small-arms-control Implementation Compendium (MOSAIC) guidelines state that for weapons with non-metallic frames, the marking should be "applied to a metal plate permanently embedded in the material of the frame." Per MOSAIC, the plate should be embedded so that it cannot be easily removed without destroying a portion of the frame.

However, several ballistics and law enforcement experts interviewed for this study reported that it was "common" for plates to be entirely removed from seized weapons. Unless sufficiently permanently integrated, the embedding of metal tags is unlikely to be in accordance with ITI requirements, as paragraph 10 of the instrument specifies that "a unique marking should be applied to an essential or structural component of the weapon where the component's destruction would render the weapon permanently inoperable and incapable of reactivation".

Figure 15



A blank-firing pistol, documented by CAR in the Niger in March 2021. The serial number on the metal insert plate has been obliterated. (Photo credit: Conflict Armament Research)

24 Interview with Aleksa Anicic, Director of the Agency for Testing, Stamping, and Marking of Weapons, Devices, and Ammunition in Serbia.

25 Matilde Vecchioni and Rueben Dass, "Don't try this at home! Current trends and developments in improvised weapon production", UNIDIR, 29 November 2025.

Third, in cases where marks are obliterated from the metal insert plate (e.g., see figures 15 and 16), these may pose additional challenges for forensic recovery efforts. Marks may be very shallow on the thin metal used, and it is difficult for examiners to suitably prepare the surface area before treating it with chemical etchants without causing damage that makes recovery efforts impossible.

As noted by Dr. Rachel Bolton King, Associate Professor of Forensic Science at Nottingham Trent University in the United Kingdom, "Laser marks on polymers are not very deep. They are quite easy to remove, and you cannot then restore them for tracing purposes. Likewise, if you are looking at shallow surface-level methods for making serial numbers on thin metal, we also find it virtually impossible to restore the marks as the marks are so easy to remove."[26] At least four of the forensic experts interviewed by the research team identified this as a particular challenge in their national context.

Given these challenges and the high prevalence of pistols with obliterated marks generally among some responses provided to this study by Member States, prevention of obliteration of marks on these weapons might be viewed as a special priority for consideration by the Open-ended Technical Expert Group.

Figure 16



Obliteration of a laser-engraved serial number on the metal insert plate of a Glock pistol. (Photo credit: Conflict Armament Research)

26 UNIDIR, "Use of polymer in manufacturing of SALW and marking, record-keeping and tracing for modular weapons", video, 28 October 2025.

Rifles and other firearms

Eight countries reported often recovering rifles or carbines with obliterated markings. These included countries experiencing or recovering from armed conflict, such as the Central African Republic and the Democratic Republic of the Congo.[27] This trend is mirrored in CAR's conflict database, where assault rifles are generally the most common weapon type and make up 83 per cent of all the weapons documented with erased markings.[28]

Through the survey, 23 States reported sometimes recovering obliterated markings on rifles or carbines. These weapons have high appeal to actors in conflicts and high-intensity armed violence, as they are highly durable with interchangeable components, making them long-lasting and easy to maintain.

The long life of these rifles means that they often circulate extensively across borders and between conflicts, sometimes linking actors that otherwise have entirely disparate affiliations, objectives or territories. CAR investigations between 2016 and 2019 into weapons used in intercommunal violence in Nigeria between organized armed groups aligned with pastoralist and agrarian communities found four Iraqi-manufactured Tabuk assault rifles whose markings had been removed in a highly distinctive and identical fashion (see figure 17).[29] The method of obliteration, involving a stone-grinding bit fitted to a handheld die-cutting tool, was also identical to Tabuk rifles that United Nations staff in Mali had previously identified after their use in a terrorist attack carried out by the Macina Liberation Front (Front de Libération du Macina) in January 2016.[30]

CAR has subsequently documented a further 13 Tabuk rifles, all seized in the Niger and Nigeria in the Lake Chad border region.[31] CAR identified serial numbers on internal components of these weapons, but as those components can be changed between different weapons, it was unclear in this case if the numbers recorded were also those of the rifles themselves. They appear to all have closely sequenced serial numbers, which suggests they might have come from the same manufacturing lot. The commonalities between these weapons'

27 Uppsala Conflict Data Program.
28 iTrace®.

29 *Nigeria's Herder-Farmer Conflict: Dispatch from the Field* (CAR, 2020).
30 The Macina Liberation Front, now known as the katiba Macina of Jama'a Nusrat ul-Islam wa al-Muslimin, was added to the sanctions list of the United Nations Security Council on 4 October 2018, pursuant to resolutions 1267 (1999), 1989 (2011) and 2253 (2015).
31 *Weapon Supplies Fuelling Terrorism in the Lake Chad Crisis*, Dispatch from the Field (CAR, 2022), pp. 58-59.

Figure 17

Tabuk rifles with distinctively erased markings, recovered from herder communities in Nigeria. (Photo credit: Conflict Armament Research)



From militants in the Lake Chad border region and documented by CAR in the Niger in October 2019. (Photo credit: Conflict Armament Research)



original serials, and the fact that their method of obliteration was so distinctively similar, suggests that these weapons all originated from a common source.

Additionally, shotguns (27 respondent States, including five reporting often making such seizures) and machine guns (18 respondent States, including four reporting often making such seizures) both featured prominently in survey responses.

Light weapons

Light weapons, such as portable missile or rocket launchers, mortars and recoilless rifles, were the least reported weapon types to feature obliterated markings. Only two countries (Central African Republic and Côte d'Ivoire) reported often seizing such weapons, while five others (Brazil, Colombia, Mexico, the Russian Federation and Ukraine) reported that they sometimes encountered these larger-calibre items. This is consistent with insights collected by CAR researchers, who have recorded very few instances of obliterated markings on larger weapon systems. A rare example is shown in figure 18, which shows the collar of a mortar recovered in South Sudan in 2013. There may be several related factors for this dynamic. First, such weapons are comparatively rarer and less in circulation than smaller "personal" firearms. Second, there are fewer contexts in which these systems are in active use with non-State armed groups and where associated ammunition is available to such actors. Third, perpetrators may less frequently associate these weapons with tracing efforts and the consequent accountability measures.

Figure 18

A mortar with obliterated marks on the collar. Documented by CAR field investigators in South Sudan on 9 May 2013. (Photo credit: Conflict Armament Research)



Air weapons or converted firearms

Eleven countries reported seizing "air weapons or converted firearms" with obliterated markings. These weapons include several different modalities through which replica, non-lethal or less-lethal weapons are made lethally operational.[32]

Types of convertible firearms include "blank-fire" or "alarm" weapons,[33] airsoft guns and deactivated firearms, which are reactivated after having previously been modified to not fire live ammunition.[34] Obliteration perpetrators either carry out these conversions themselves or procure converted weapons on illicit markets. These weapons pose heightened challenges to the implementation of the UN PoA and ITI, and their proliferation is linked to an inconsistent global and regional regulatory environment.[35]

Interviews with forensic specialists also highlighted challenges faced in attempting to recover and prosecute cases involving converted weapons, with one expert noting that these weapons were actively deprioritized for investigation because of the low likelihood of a successful investigative outcome and another stating that "Initially, when the phenomenon of converting traumatic weapons [to fire live ammunition] began, criminals would erase the serial numbers; today, they no longer do so. Criminals have likely realized the obstacles we face in tracing these weapons, and nowadays, they no longer waste their time erasing them."[36]

32 Matilde Vecchioni, *Unregulated Production: Examining Craft-produced Weapons from a Global Perspective* (UNIDIR, 2024).

33 The Permanent International Commission for the Proof of Small Arms (CIP) defines alarm weapons as "any portable device not designed to fire solid projectiles". These are often referred to as "blank-fire" weapons. (CIP, 5.4 Technical Annex for Testing Alarm Weapons (Annex to 5.1.) (2001).

34 Nicolas Florquin and Benjamin King, *From Legal to Lethal: Converted Firearms in Europe* (Small Arms Survey, 2018).

35 Report of the Fourth PoA Review Conference (A/CONF.192/2024/RC/3).

36 Interview with a police ballistics expert that requested to be kept anonymous in this study.

Box 4
Obliteration of ammunition markings

While this study is focused on the obliteration of marks on SALW, this practice has also been recorded by CAR investigators on associated SALW ammunition and its packaging. Such obliteration is extremely rare in CAR's conflict data, perhaps reflecting the inherent limited traceability of loose small-calibre ammunition.

Packaging

Ammunition packaging not only includes traceable production information, such as lot or batch numbers, but also often features details about the intended recipient. Perpetrators might deem it necessary to remove this information, not only to obscure the provenance of the material but also to prevent identification of how and where it was diverted. In January 2013, for example, when representatives of the United Nations Panel of Experts on Yemen documented the cargo of the interdicted Jihan

1 vessel, they observed that most of the crates had been overpainted to hide their original markings, while labels affixed to the boxes had been scratched to remove key identifying information.[37]

Figure 19



A metal ammunition tin seized by the Iraqi Armed Forces in June 2016 near Fallujah. Documented by a CAR field investigation team in July 2016. (Photo credit: Conflict Armament Research)

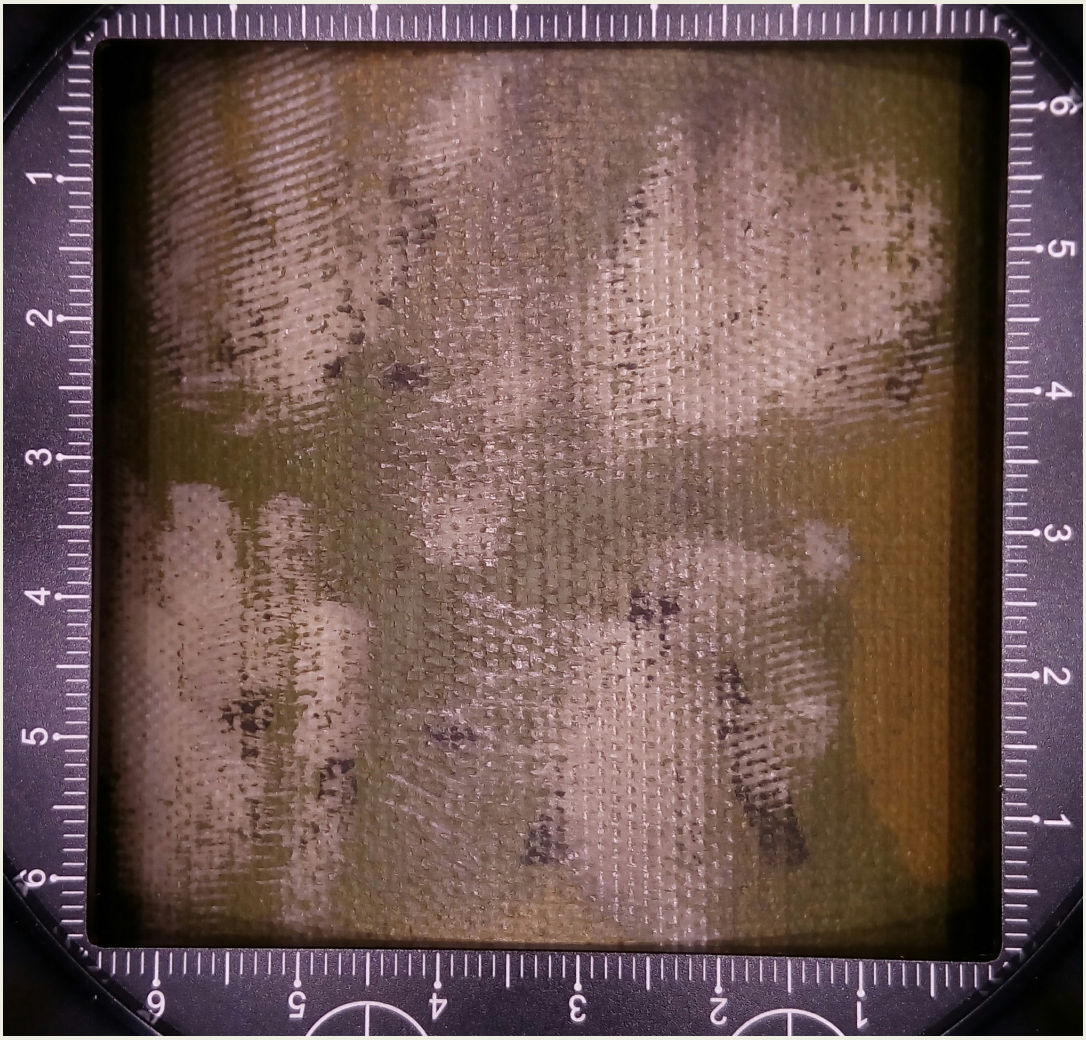
Similarly, in June 2016 Iraqi Armed Forces seized a convoy operated by Islamic State in Iraq and the Levant (Da'esh). Among the convoy's contents was a metal ammunition tin. A CAR field team inspecting the tin found that most of the markings containing traceable information, such as the lot number and year of manufacture, had been removed using an oxy-acetylene torch (figure 19).

Large-calibre ammunition

CAR field teams have documented some instances where there has been evidence of concerted effort to disguise the supply chain for large-calibre ammunition items. In Ukraine, CAR documented disposable rocket launchers whose identifying marks had either been sanded off with an abrasive material such as emery paper, filed off by hand or cut away with a die-cutting tool (see figure 20).[38] The varying degrees of sanitization and the different methods used indicated that the process may have taken place further down the chain of custody, perhaps after the rocket launchers had been divided and assigned to their respective units.

37 Figure 2 in *The IED Threat in Bahrain: A comparative analysis of components documented in the Gulf region* (CAR, 2019).
38 See *Weapons of the War in Ukraine* and *Investigating Obliterated Markings: a CAR case study* (CAR, 2021).

Figure 20



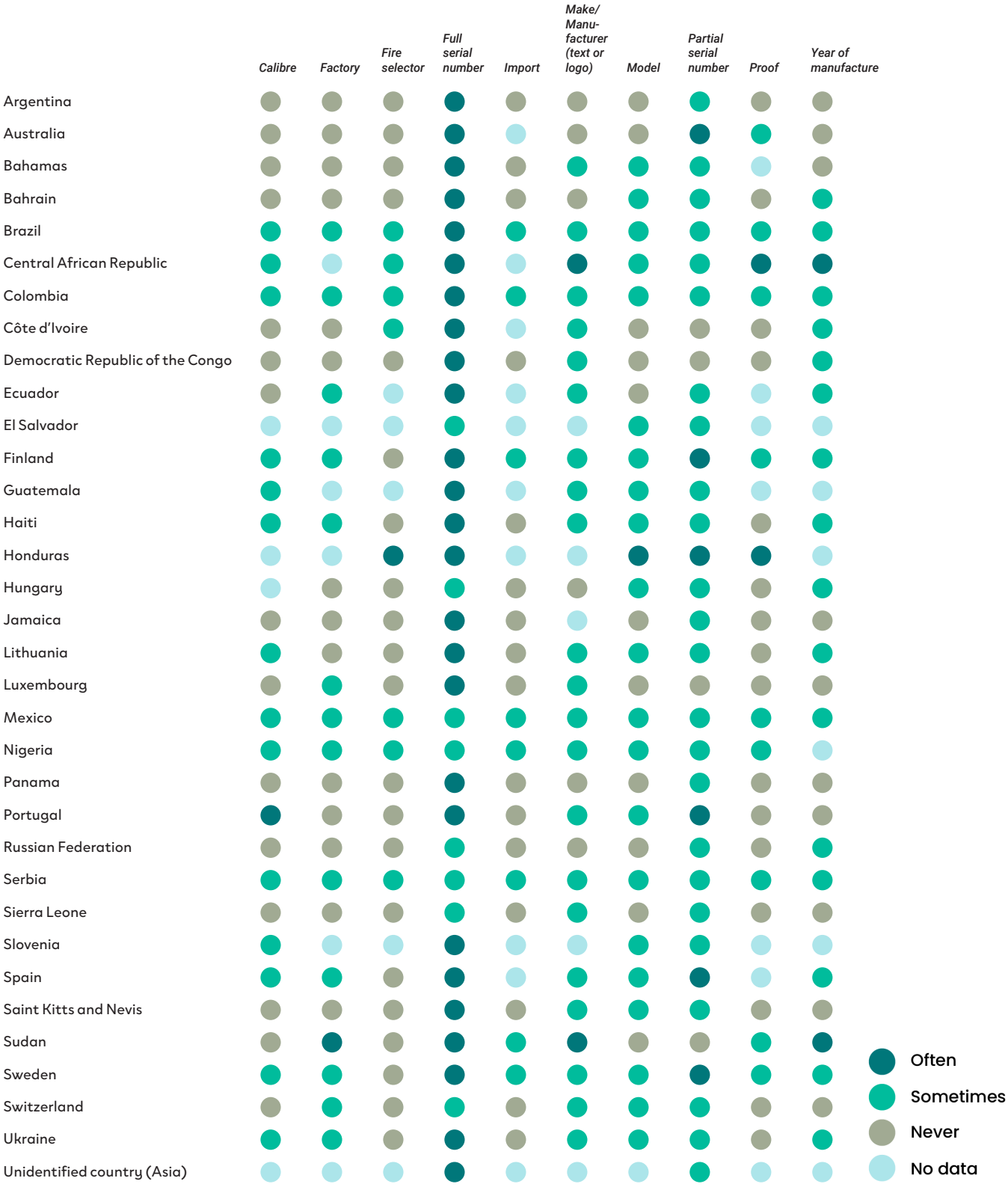
Attempted recovery of the obliterated model designation, lot, date and factory marks of an RPO-A disposable rocket launcher. Documented by CAR in Kyiv, Ukraine, on 25 September 2018. (Photo credit: Conflict Armament Research)

Marks

With respect to the types of markings most frequently obliterated, responses were received from 34 States (see figure 21). The markings most reported as being obliterated were the full serial number and partial serial number, followed by the make or manufacturer and the model.

Figure 21

Obliterations by type of mark and country



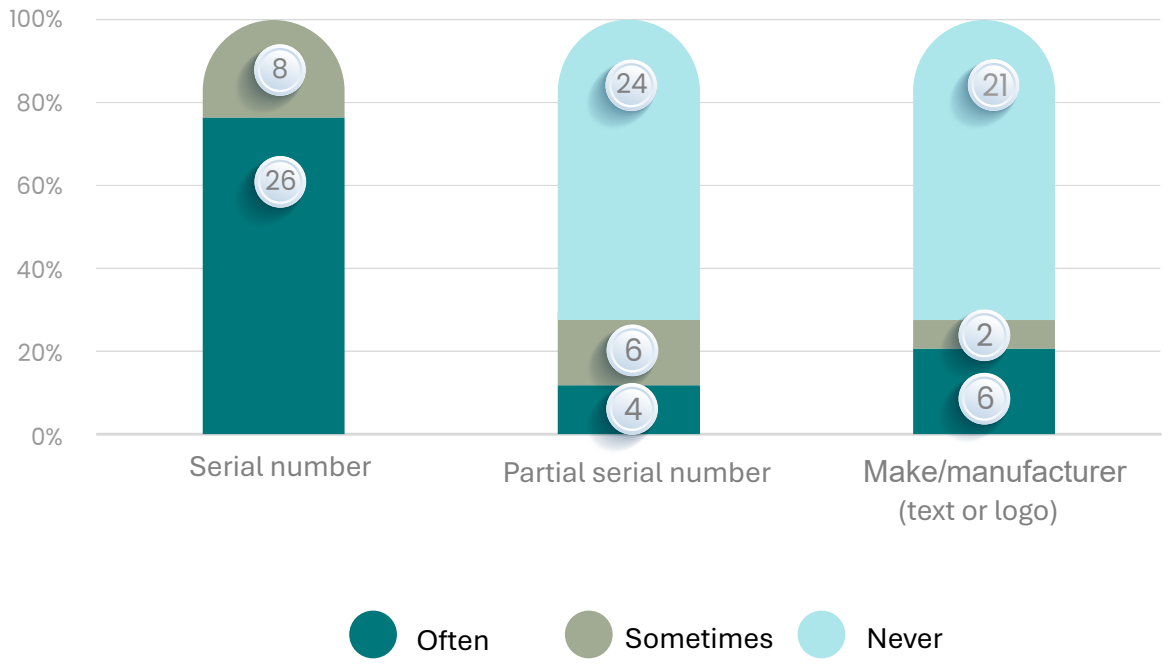
Unique markings

Unique weapon markings, as identified in paragraph 8 (a) of the ITI, include the manufacturer, the country of manufacture and the serial number. Manufacturer and country of manufacture marks are not markings unique to an individual weapon, but these attribution details can be integrated into a unique serial number mark. The ITI also notes that States can "maintain any alternative unique user-friendly marking with simple geometric symbols in combination with a numeric and/or alphanumeric code, permitting ready identification by all States of the country of manufacture".

All 34 States that provided data for this question reported that they recovered SALW with obliterated serial numbers, with 26 indicating that they often did so (see figure 22). Unsurprisingly, this is the mark type most prioritized by obliteration perpetrators for removal, given its role as the primary unique identifier of a weapon. This finding aligns with responses to other variables relating to motivation (see chapter 1, section 2).

Where the principal motivations for obliteration are reported to be concealing the identity of SALW and avoiding judicial processes, it follows that the serial number would be the marking most deliberately targeted. Twenty-three respondent States indicated that they had recovered weapons with the manufacturer mark obliterated, although only the Central African Republic and the Sudan reported doing so frequently.

Figure 22
Member States indicating the frequency of seizures of weapons with obliterated serial number, partial serial number, and make or manufacturer marks



All 20 of the forensic experts interviewed for this study stated that serial numbers were the most commonly removed mark on assessed SALW. Experts referred particularly to efforts to remove the serial number marked on the frame, forward trunnion or receiver of the weapon. Typically, this is the most prominent and visible identifying marking and corresponds to the "essential or structural component of the weapon", as per ITI requirements. The marking of the full serial number on the "essential or structural" component of a weapon is not always, however, the only iteration of this mark. Experts identified that repeated instances of a full or partial serial number on other weapon components can support tracing investigations of diverted weapons (see chapter 3.1).

Lehi Sudy Dos Santos, Head of the Ballistics Forensic Service at the Polícia Federal in Brasilia, Brazil, noted that recent legislation that entered into force in 2021 requires Brazilian firearms to have the full serial number marked in the barrel, breech face and in the frame of a weapon. This obligation may have the effect of increasing the traceability of obliterated weapons in Brazil compared to older rifles that only have the serial marked on the receiver. Brazil's record-keeping practice is also discussed in this study in chapter 3.[39]

Additional information

The ITI encourages States to mark SALW with additional information including the year of manufacture, weapon type/model and calibre. These mark types were less commonly reported as obliterated (see figure 23). Twenty-two countries, for example, stated that they had recovered SALW with the type or model mark removed, but only Honduras stated that they often seized such weapons.

39 Interview with Lehi Sudy Dos Santos, Head of the Ballistics Forensic Service at the Policia Federal in Brasilia, Brazil.

Figure 23
States indicating the frequency of seizures of weapons with obliterated calibre, year of manufacture and weapon type/model marks



Other marks

Markings most frequently reported as "never" being obliterated on seized SALW included the fire selector, proof marks and import marks. At least one forensic expert emphasized the relevance of proof marks for firearm identification, particularly when serial numbers have been removed or altered:

"Proof marks are very specific. Worldwide, there are only 26 proof houses in 16 countries, and every proof house has its own proof marks. Therefore, in cases where we receive firearms without a serial number or any other code or marking, the presence of a proof mark can still provide valuable information about that weapon. On that basis, we can continue the forensic examination to identify the further information that may be useful for the investigation."[40]

Import marking of SALW, which is a requirement for the States parties to the Firearms Protocol, is specified in paragraph 8 (b) of the ITI as a mark that permits the identification of the country of import and, where possible, the year of import. This mark is significant for counter-diversion investigations as its presence enables a weapon to be traced to the competent authorities of the importing country, thus greatly reducing the undetermined chain of custody for a recovered weapon. Only eight countries—Brazil, Colombia, Finland, Mexico, Nigeria, Serbia, the Sudan and Sweden—reported seizing weapons with obliterated import marks, and none reported doing so frequently. Forensic experts also suggested that these marks are rarely prioritized by criminals and other nefarious actors for removal.

40 Interview with Aleksa Anicic, Director of the Agency for Testing, Stamping and Marking of Weapons, Devices and Ammunition, Serbia.

Methods and tools

Through the survey, States could respond on the methods used to obliterate weapon markings. Given that certain methods are more likely to cause substantial structural damage to an obliterated weapon and can significantly impede the recovery of markings, understanding which methods are most used is important for the development of effective forensic recovery strategies. Seven methods were identified (as shown in figure 24), which were adapted from a typology of marking obliteration tools and approaches, detailed in table 2 on page 35.

The choice of obliteration method appears to be shaped by multiple factors, including the degree of organization involved, the availability of individuals with the requisite skills and access to appropriate tools and infrastructure. In several cases reported by States and identified by researchers, markings had been removed and replaced with false serial numbers or counterfeit branding (see box 5).

The three most common methods of marking obliteration reported by States as "often" or "sometimes" were the following:

- Use of power tools such as grinders or sanders (31 States)
- Removal of material using drills or drill presses (27 States)
- Use of hand tools like files or screwdrivers (23 States).

Power tools

Thirty-one respondent States reported observing the use of power tools such as grinders or sanders to obliterate SALW markings, with 20 countries indicating that they often recovered weapons with this obliteration method. Forensic experts

Figure 24

Obliteration methods by country



interviewed for this study frequently highlighted abrasive methods such as the use of hand-operated high-speed rotary tools, which leave thin, short, repeating marks on an obliterated weapon. This approach to mark removal is common in many conflict theatres due to its simplicity, speed and low-power requirement.[41] Academic analysis of a sample of 249 illicit SALW recovered across ten African countries found that the two most prominent tool types used were rotary tools (111 weapons, comprising 44.6 per cent of the sample) and grinders (91 weapons, or 37 per cent).[42]

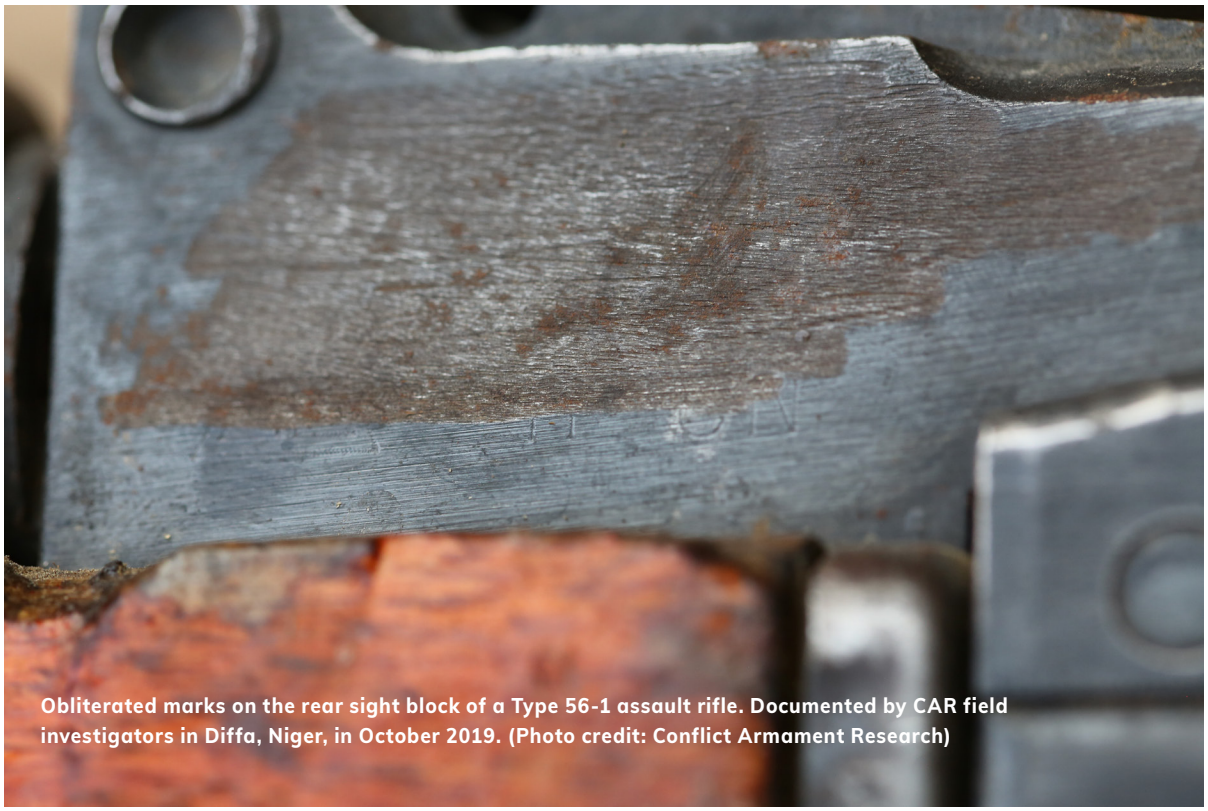
An example of this obliteration method is illustrated in figure 25, which shows the rear sight block of a Chinese Type 56-1 assault rifle. The factory mark, model name, calibre, date and country code have all been obliterated with a metal or stone grinding bit fitted to a handheld tool.[43]

Drill or drill press

Twenty-seven countries reported observing the removal of material with drills or drill presses (13 of whom reported "often" seizing such weapons). This is a highly destructive form of obliteration, involving the complete removal of material from the weapon. Static machines, as in the examples in figure 26, may result in circular shapes, while dynamic machines may remove larger areas of different dimensions.

41 *After the Caliphate: Islamic State Weapons in High-Profile Operations in North-East Syria* (CAR, 2024), p. 43.
42 Henwood, "Tracking the Untraceable".
43 *Weapon Supplies Fuelling Terrorism in the Lake Chad Crisis*, Dispatch from the Field (CAR, 2022), p. 56.

Figure 25



Obliterated marks on the rear sight block of a Type 56-1 assault rifle. Documented by CAR field investigators in Diffa, Niger, in October 2019. (Photo credit: Conflict Armament Research)

Figure 26
Examples of obliteration through removal of material with a drill or drill press



Weapon image courtesy of the State Scientific Research Forensic Center of Ukraine.



Tribunal de Justiça de São Paulo (Brazil)
(Case Reference: 1507849-04.2018.8.26.0394)



Documented by CAR field investigators in Tillabéri Region, Niger, in May 2019.
© Conflict Armament Research

Hand tools

The use of manual methods and basic hand tools to obliterate weapon markings was reported by 27 Member States, demonstrating that obliteration can be a rudimentary method of hindering weapon traceability. The low-tech nature of obliteration is one aspect of the challenge law enforcement and investigators face because the methods through which it can be executed do not require technical knowledge, tools or materials. It can be conducted with basic household implements like files or screwdrivers that are, of course, legal to acquire and possess, do not necessitate a specialist location or capability and can be highly decentralized. While difficult to detect and prevent in advance, obliteration through such simplistic methods may offer entry points for recovery methods (see chapter 2), as the damage done often does not sufficiently penetrate the subsurface of the weapon to eradicate the microscopic changes to the microstructural material under the original serial number. Forensic experts are therefore able to polish the surface and recover the marks using various chemical, analytical and visual methods.[44] Twenty-three States reported observing this obliteration method in their country, including 10 that seized such weapons frequently.

Other methods

Two comparatively rare methods, as identified in the UNODA survey results and interviews with forensic experts, were the use of chemical etchants and material addition through welding. Only seven States reported observing the use of chemicals to remove weapon markings: Australia, Colombia, Ecuador, Finland, Haiti, Mexico and Serbia. None of these countries reported seeing this method frequently. Seventeen States reported observing welding methods,

44 Henwood, "Tracking the Untraceable".

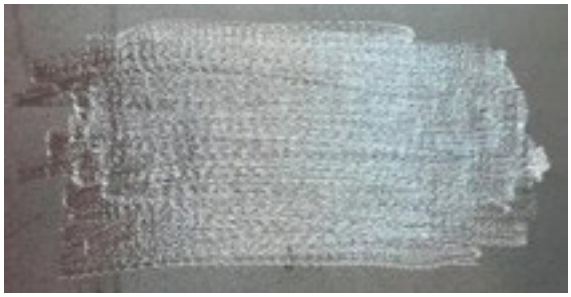
three of whom (El Salvador, Mexico and a third State that requested not to be identified in this survey) reported often doing so.

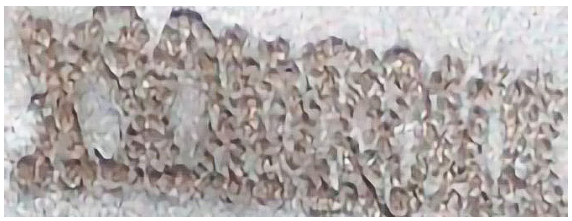
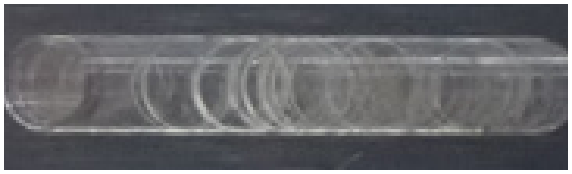
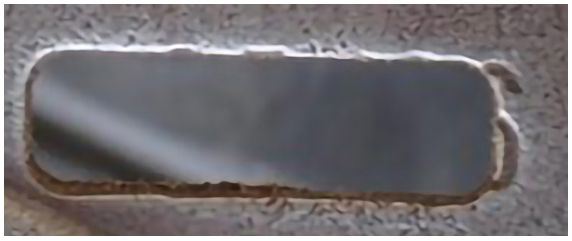
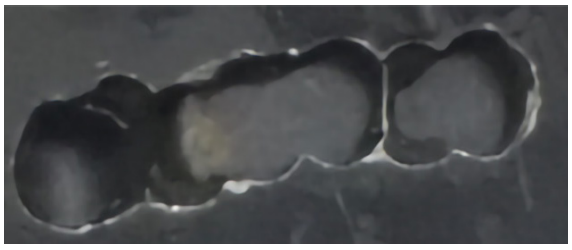
This method of marking obliteration was also highlighted in several technical interviews. An experienced forensic officer who formerly served in the Mexican police force said that, while manual methods and basic power tools were most common in the country, "more professional methods have been used, such as removing material, then welding to fill the hole, and then sanding to conceal the obliteration location".[45]

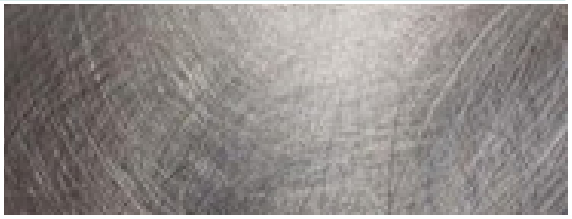
Another senior forensic expert interviewed for this study likewise noted this two-step approach, in which criminals polish altered firearms to obscure the addition of new material.

45 Interview conducted with Victor Placier, former private forensic officer of the Acapulco and Pachuca regional police, Mexico.

Table 2
A typology of methods of marking obliteration

Method	*Characteristic*	*Image*
Grinder (Edge)	Short, uniform marks. Spacing and direction of the marks depend on the speed of rotation and movement. Estimates of the diameter of the disc can be made by measuring the width of the striations.	
Grinder (Flat)	Continuous marks with a slight curve. The curve follows the circular shape of the grinder. The length of the marks depends on the time of contact with the sample.	
Rotary Tool	Thin, short, repeating marks. Spacing and depth depend on speed and force applied. Directionality can be random due to hand operation.	

Method	*Characteristic*	*Image*
Dot Peen	Individual dots stamped into the material in a pattern. Dot size and depth depends on the force of application, however material flow around the outside is a common feature.	
Weld	Individual dots, often overlapping, with evidence of heat treatment (colour change) and additional material being deposited. Direction of travel is indicated by the overlapping of marks.	
Mill	Uniform outline with circular striations inside.	
Drill/Press	Complete removal of material. Shape depends on the individual and the type of machine used. Static machines may result in circular shapes, while dynamic machines may remove larger areas of various shapes. There is no directionality associated with this category, as the bit moves up and down and can be difficult to isolate toolmarks by photographs.	 
Centre/Nail Punch	Individual circular marks, not penetrating the material. Marks will differ in depth and definition, depending on the punch used and force applied.	

Method	*Characteristic*	*Image*
Overstamp	Size and shape will change depending on the stamp used. Depth and resulting material flow will change depending on the force applied.	
Sanding	Thin, continuous striations. Random in direction, due to human interaction. Striation size may change depending on the grit size of the paper.	
Etchant	Often results in colour and/or surface finish changes. Pitting may occur. Rusting may occur.	

Source: Bailey Henwood, "Tracking the Untraceable: An Assessment of Global Obliteration Techniques on Small Arms", PhD thesis, Cranfield University, Shrivenham, UK, 2024.

Box 5
Overmarking obliterated weapons

In several cases reviewed for this study, markings had been removed and replaced with false serial numbers or counterfeit branding. Overmarking is the application of new identifiers over removed or defaced originals. It is a common armoury management process, carried out to ensure that renovated or repaired weapons are matched with their new components. It is also, however, a process through which obliteration perpetrators attempt to mask a weapon's true origin while increasing its perceived value. By replacing destroyed serial numbers or proof marks with identifiers associated with desirable manufacturers or models, offenders transform otherwise untraceable or low-value weapons into commodities suitable for illicit resale.

Overmarking commonly involves the reapplication of serial numbers (as shown in figure 27), logos, calibre markings or institutional markings using hand punches, rotary tools or inexpensive laser engravers. Forensic practitioners interviewed for

this study in Brazil, Canada, Mexico and the United States reported cases in which weapons exhibited restamping of false serial numbers, indicating attempts not merely to conceal origin but to fabricate legitimacy. Overmarking is also used to disguise converted blank-firing or alarm pistols, where safety or calibre markings are replaced to conceal prior modification.

Figure 27



A 7.62 x 39 mm assault rifle advertised for sale in a black market in Iraq. Horizontal striations on the rifle's forward trunnion indicate that the original serial number had been obliterated and overmarked. The replacement, an inauthentic serial number included double-stamped marks and an upside-down "2". Documented by CAR field investigators on 16 January 2019. (Photo credit: Conflict Armament Research)

CHAPTER 2

Forensic responses to marking obliteration

CHAPTER 2

Forensic responses to marking obliteration

Recovery techniques

Serial numbers are critical identifiers that allow investigators to trace weapons, map the chain of custody of individual weapons and identify the causes and perpetrators of diversion. When these unique identifiers are intentionally removed or altered, forensic laboratories may attempt to restore the original markings using a range of scientific techniques. A summary of these methods, as well as their limitations, is detailed in table 3.

When a serial number is applied, historically most commonly through stamping, it plastically deforms the underlying metal. This process produces a zone of permanent microstructural deformation beneath the visible surface of the marking. Even if the visible characters are later removed through grinding, filing, or other forms of mechanical obliteration, the subsurface deformation often remains. These residual distortions in the metal's crystalline structure can sometimes be detected and visualized using chemical, electromagnetic, or imaging methods (table 3).

Table 3
Obliterated serial number recovery techniques

Type	*Technique*	*Scientific principle*	*Suitable materials*	*Advantages*	*Limitations*
Chemical Etching	Fry's Reagent	Acid etching preferentially attacks strained crystalline regions beneath stamped characters due to plastic deformation and work hardening.	Carbon steels	Inexpensive, effective for shallow obliterations, widely validated in firearms labs.	Destructive (chemical removal of surface), operator-sensitive, less effective on stainless steel or non-ferrous alloys.
	Nitric Acid + Sodium Hydroxide	Differential chemical attack reveals deformation patterns in ferrous alloys.	Carbon and low-alloy steels, aluminium	Simple preparation, good contrast in some steels.	Highly destructive if overused; limited success on deep grinding.
Electrolytic Etching	Electrolytic Etching	Controlled electrochemical dissolution reveals plastically deformed regions at different rates.	Steel, some non-ferrous metals	Greater control than manual acid etching; can localize areas of interest.	Requires power supply and setup; still destructive.

Type	*Technique*	*Scientific principle*	*Suitable materials*	*Advantages*	*Limitations*
Electro-magnetic	Magnetic Particle Inspection (MPI)	Magnetic flux leakage occurs at regions of subsurface strain; iron particles accumulate along distorted grain structure.	Ferromagnetic materials (steel)	Non-destructive, rapid, good for initial screening.	Only works on ferromagnetic materials; low resolution compared to chemical etching.
	Magneto-Optical Visualization	Electromagnetic induction detects conductivity variations caused by subsurface deformation.	Conductive metals (including aluminium)	Non-destructive; useful for non-ferromagnetic alloys.	Requires calibration; depth penetration limitations; equipment settings not quantified.
Emerging technologies	Raman Spectro-scopy	Laser-based vibrational spectroscopy detects subtle structural or compositional differences in strained regions.	Metals, coated surfaces, polymers	Non-destructive; may work without removing coatings.	Experimental for serial recovery; limited penetration depth in metals; financially restrictive.
	Scanning electron microscopy	High-resolution imaging of microstructural deformation patterns below obliterated surface.	Most metals	Extremely high magnification; can detect subtle strain patterns.	Expensive; destructive, limited field of view.
	X-ray Computed Tomography (Micro-CT)	3D imaging reveals density differences from plastic deformation beneath surface.	Metals and some polymers	Non-destructive; visualizes subsurface deformation in 3D.	Expensive; limited availability; may lack sufficient contrast in some alloys; financially restrictive.
	Thermal Imaging/ Infrared Methods	Differential heat conduction due to strain hardening reveals subsurface markings.	Metals	Non-destructive; rapid screening potential.	Experimental; limited forensic validation.

The following section details some of the main recovery techniques and technologies in use in forensic labs. Notably, good practice in this area involves using multiple complementary techniques, applied in a tiered manner. Laboratories typically begin with non-destructive methods before progressing to mechanical surface preparation and chemical etching, where appropriate. Practitioners consistently emphasized that reliance on a single technique is rarely sufficient, particularly where marks have been professionally removed using rotary tools or aggressive obliteration techniques.

Chemical etching

Chemical etching methods are among the most widely used restoration techniques in forensic laboratories. Forensic practitioners from 11 countries interviewed for this study reported the use of chemical etchants. Three stated that they rely solely on this method due to financial restrictions.

Chemical etching methods involve Fry's reagent or similar chemical compounds being applied to the surface of the obliterated area. These chemicals preferentially attack regions of the metal that have experienced plastic deformation during the original stamping process. Because the strained crystalline structure reacts at a different rate than the surrounding metal, the original characters may reappear as the etching progresses. These methods are relatively inexpensive and have been extensively validated in forensic practice. This method was assessed to have a high success rate—as much as 80 per cent, as noted in forensic interviews—with traditional marking methods like stamping. However, several laboratories noted that this rate dropped significantly when this method was applied to shallow or laser-engraved markings, with one expert referring to it as "a toss of the dice" and another stating that "if they [SALW manufacturers] use lasers, it is a nightmare".

Chemical etching has several drawbacks. It is inherently destructive as it removes layers of the surface material during the etching process. Several forensic experts interviewed for this study identified this as a deterrent. As one expert noted, "Sometimes you can't fully stop the process once you've revealed the marks, and if some of the chemicals go inside the barrel, that's bad."[1] Other interviewees described this method as a "last resort" or stated that it was not used in major crimes like murder because it destroyed the evidence needed for judicial processes. The success of this method also depends heavily on examiner training and the extent of the original obliteration.

Additionally, there are inherent risks to the examiners due to the use of caustic acids if appropriate personal protection equipment or suitable ventilation is not available. While Fry's reagent works effectively on steel components, the harsh acids used on steel firearms can have negative effects on aluminium components. In these cases, alternate or diluted reagents may be used, many of which are less aggressive than Fry's reagent.[2]

Electrolytic etching

Electrochemical techniques provide an alternative approach with somewhat greater control. Electrolytic etching uses an electrical current in combination with a chemical electrolyte to selectively dissolve material from the surface. By controlling the electrical parameters and focusing on a specific area of interest, investigators may reveal deformation patterns associated with the original serial number. While this technique can offer improved precision compared to manual chemical etching, it still involves the removal of surface material and requires specialized equipment.[3] Only three countries reported use of electrochemical etching in forensic laboratories.

1 Interview with Lehi Sudy Dos Santos, Head of the Ballistics Forensic Service at the Policia Federal in Brasilia, Brazil.

2 Mohd Azlan Mohd Zaili, Ramesh Kuppuswamy and Hafizah Harun, "Restoration of engraved marks on steel surfaces by etching technique", *Forensic Science International*, vol. 171, Issue 1 (2007), pp. 27-32.

3 Charles A. Davis, "Restoration of Eradicated Serial Numbers by an Inexpensive Electro-Acid-Etch Method", *Journal of Criminal Law and Criminology*, vol. 48, Issue 4 (1958).

Electromagnetic methods

Eight forensic agencies reported using Magnetic Particle Inspection (MPI) in forensic examination. All eight use MPI as a first, non-destructive step in the restoration process. MPI relies on the behaviour of magnetic flux within ferromagnetic materials. When a magnetic field is applied to a steel component, disruptions in the metal's microstructure, such as those created by stamped characters, can cause small amounts of magnetic flux leakage. When fine iron particles are applied to the surface, they accumulate along these disturbed regions, sometimes revealing the pattern of the original serial number. Commercial systems refine this process and are widely used in industrial non-destructive testing. However, these techniques only function on ferromagnetic materials and generally provide lower resolution than chemical etching methods. One expert stated that the overall success rate for this method stood only at about 25 per cent, but that it was almost always used as a first technique complementary to other approaches.[4]

Another non-destructive approach involves magneto-optical techniques, employing electromagnetic induction of eddy currents to detect variations in electrical conductivity associated with subsurface deformation.[5] This technique can be particularly useful for conductive but non-ferromagnetic materials, including certain aluminium alloys increasingly used in modern firearms. Eddy current testing offers the advantage of preserving the surface of the evidence, with one expert commenting, "My preferred technique is eddy currents. This is the one [recovery method] that has given me the best results because it is non-destructive, fast, you can immediately generate the spectrogram and use image enhancement tools with the software."[6] The effectiveness of this method depends on user training and is limited by the depth at which deformation can be detected. Recent or ongoing pilot trials and academic research are taking place with organizations in several countries, including Burkina Faso, Brazil, Canada and the United Kingdom (see box 6).[7]

4 Firearms examiner who requested to be kept anonymous in this study.

5 Javier García-Martín, Jaime Gómez-Gil and Ernesto Vázquez-Sánchez, "Non-Destructive Techniques Based on Eddy Current Testing", Sensors (2011), pp. 2525-2565.

6 Expert submission from Luis Fernando Galindo Martin, Technical Leader at the Fiscalía General del Estado de Querétaro, Mexico.

7 Bailey Henwood, Aimée Helliker, Rachael Hazael and Katherine Hewins, "An assessment of a non-destructive magneto-optical imaging technique for the recovery of laser engraved marks from steel plates and firearm components", *Science & Justice*, vol. 63, Issue 6 (2023), pp. 736-742.

Box 6
Field-deployable electromagnetic recovery

While chemical etchants are the most used method of serial number recovery in traditional forensic laboratories, this approach causes damage to the weapon, potentially compromising forensic evidence, making re-examination impossible and posing safety risks to examiners. CAR has developed a novel application of the eddy current methodology to recover obliterated serial numbers that allows for its use in remote, hostile and typically non-permissive environments (see figure 28).

Figure 28



CAR staff demonstrating the field-deployable eddy current non-destructive serial number recovery kit in Ghana in 2021. (Photo credit: Conflict Armament Research)

Evidence can be gathered at the point of recovery using this method, which utilizes eddy currents and magnetic fields to detect subtle material differences and generate magneto-optical images of original markings. This approach relies on the same properties as chemical etchants but is entirely non-destructive, meaning that the forensic integrity of evidence, in the form of obliterated weapons, can be preserved while advancing weapon tracing and counter-diversion investigations. CAR forensic specialists examined 18 firearms using this non-destructive serial number recovery method in Brazil, in partnership with the Federal Police of Brazil, the Polícia Científica do Estado do Paraná and the Polícia Técnico Científica do Estado de São Paulo, and successfully recovered markings from 14 firearms.

Emerging technologies

Advances in analytical instrumentation have resulted in the introduction of several emerging or advanced techniques for serial number recovery. Raman spectroscopy, for example, uses laser-based vibrational analysis to detect subtle differences in molecular structure and stress patterns in materials. While this approach has the advantage of being non-destructive and may function through certain coatings or surface treatments, its application for serial number restoration remains largely experimental and is limited by shallow penetration depths in metals.[8]

High-resolution imaging techniques such as Scanning Electron Microscopy (SEM) coupled with electron backscatter diffraction allow investigators to examine microstructural deformation at extremely high magnifications. By analysing subtle strain patterns beneath the obliterated

8 Cédric Parisien, Gitanjali Kolhatkar, Frank Crispino, André Lajeunesse and Andreas Ruediger, "Reconstruction of Obliterated Characters in Polycarbonate through Spectral Imaging", *Analytical Chemistry*, vol. 89, Issue 21 (2017), pp. 11648-11652.

surface, SEM may reveal traces of the original characters. However, the technique requires significant sample preparation, offers only a limited field of view and involves expensive instrumentation.[9]

Similarly, X-ray Computed Tomography (Micro-CT) provides three-dimensional imaging of internal material structures. In principle, differences in density caused by plastic deformation may be visualized beneath the surface without physically altering the evidence. Although this technique offers significant analytical potential, it is costly, not widely available in routine forensic laboratories and may not always produce sufficient contrast in certain metal alloys.

Taken together, these methods illustrate the multidisciplinary nature of serial number recovery, drawing on principles from metallurgy, materials science, chemistry and non-destructive testing. No single technique is universally successful; rather, forensic examiners typically apply a sequence of complementary methods depending on the material involved and the condition of the evidence. As SALW manufacturing evolves to include new materials and marking technologies, such as laser engraving and polymer frames, the development and validation of additional restoration methods will remain an important priority for forensic laboratories and international investigative bodies.

Factors affecting forensic success

The success of serial number restoration depends on several factors. These include the following:

- Depth and force of the original marking
- Technique used to apply the mark
- Degree and method of obliteration
- Material properties of the component part. [10]

Although forensic recovery is often treated as a downstream technical issue, policy decisions directly determine whether recovery is possible at all. Markings that generate subsurface deformation compatible with metallurgical recovery techniques are significantly more likely to be restored, even following aggressive obliteration techniques. By contrast, shallow or surface-only markings effectively foreclose forensic recovery options. This is detailed further in chapter 3.1.

Traditional restoration methods tend to be most successful on ferromagnetic steels, which are commonly used in the production of weapon receivers and barrels. In contrast, modern SALW increasingly incorporate aluminium alloys or polymer frames, both of which present additional challenges for conventional chemical recovery techniques due to their different mechanical and electromagnetic properties (see box 3).

A consistent finding across jurisdictions is the inherent limit of forensic intervention. Where obliteration removes the subsurface deformation zone created by the original marking, recovery becomes unlikely regardless of examiner skill or technique. This underscores a central conclusion of many expert exchanges and consultations conducted for this study: forensic science alone cannot compensate for marking practices that fail to embed recoverable information in the first place. The next section of this study therefore situates forensic and technical efforts to counter marking obliteration within a broader

9 Ryan M. White and Robert R. Keller, "Restoration of firearm serial numbers with electron backscatter diffraction (EBSD)", *Forensic Science International*, vol. 249 (2015), pp. 266-270.

10 Annalisa Fortina et al., "Restoration of Obliterated Numbers on 40NiCrMo4 Steel by Etching Method: Metallurgical and Statistical Approaches", *Journal of Forensic Sciences*, vol. 61, Issue 1 (2016).

framework of international legal obligations, regulatory approaches and manufacturing practices. In doing so, it demonstrates that effective responses to obliteration require upstream policy intervention and regulatory refinement, alongside downstream forensic capability.

Box 7
Institutional capacity and accreditation

Of the 38 United Nations Member States that responded to the survey issued for this study, 28 said that they engage in forensic recovery of obliterated markings. Four indicated that they did not (Argentina, Central African Republic, Democratic Republic of the Congo and Nigeria) and six left the section blank. Twenty-three States reported having had positive investigative outcomes, specifically criminal prosecutions, based in part on these recoveries.

Twenty-four respondent States indicated having some form of technical or financial challenge in addressing marking obliteration. Forensic experts interviewed for this study also highlighted gaps, particularly regarding training provision. The four main areas identified were the following:

- Capacity (either related to personnel or excessive caseload): 21
- Financial: 14
- Resources and equipment: 15
- Training: 18

Recovery outcomes are shaped not only by technique, but by institutional capacity and quality control frameworks. Jurisdictions with accredited laboratories, standardized training and rigorous documentation practices consistently demonstrate high recovery success and strong judicial acceptance of results.

France's national forensic institute illustrates this dynamic. Supported by accreditation, advanced microscopy and standardized recovery protocols, French laboratories observed and reported consistently high recovery rates and strong evidentiary credibility. Rigorous documentation and chain-of-custody procedures contribute to judicial confidence in restored identifiers.

Canada provides a similar example of institutional coherence. Although overall caseloads are comparatively lower, strong inter-agency cooperation between provincial and federal laboratories, combined with uniform accreditation and reporting standards, ensures that recovery outcomes are both technically robust and legally defensible.

In comparison, decentralized systems exhibit greater variability and, while State-level laboratories with access to integrated databases achieve high recovery and electronic-matching performance, smaller municipal laboratories may be more dependent on resourcing and assistance.

CHAPTER 3

Policy responses to marking obliteration

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1. Upstream measures

Although obliteration is a downstream criminal act, upstream factors, particularly in relation to manufacturer marking practices, shape its effectiveness and impact.

While the ITI and the Firearms Protocol establish the normative framework for weapon-marking principles, neither specifies how marking should be conducted (e.g. minimum depth of markings), nor their uniqueness or issues such as the durability of markings (which itself is influenced by the type, grade and dimensions of the marked metal.

As a result, weapon markings may satisfy formal ITI requirements while remaining highly vulnerable to mechanical abrasion, shallow grinding or surface-removal techniques. Likewise, while paragraph 8 (a) of the ITI encourages manufacturers to "develop measures against the removal or obliteration of markings", it does not indicate how this might be achieved.

At the international level, the Modular Small-arms-control Implementation Compendium (MOSAIC) provides the clearest guidance on marking methods.[1] This is a voluntary toolkit developed by the United Nations to support implementation of the UN PoA, ITI, the United Nations Firearms Protocol and the Arms Trade Treaty. Module 05:30 of MOSAIC provides guidance on good practices for weapon marking and record-keeping. The module notes that serial numbers applied through stamping are more likely to be recoverable after erasure, specifying that "the stamping method should be used to apply markings to SALW at the time of their manufacture" and that stamped markings should have a depth of at least 0.20 mm.[2] As box 8 illustrates, manufacturers employ a range of different marking depths at the point of manufacture or import.

1 Regional and voluntary tools have also been developed, including, for example, the Organization for Security and Cooperation in Europe's "Best Practice Guide on Marking, Record-keeping and Traceability of Small Arms and Light Weapons" (2003) and the Organization of American States' "OAS Firearms Standards: Marking and Recordkeeping" (2016).

2 United Nations, Modular Small Arms Control Implementation Compendium, Module 05:30, "Marking and Record Keeping", sect. 5.2.1.1.6 (2022).

Box 8
Marking depth

Member States, in their responses to the survey issued for this study, identified a range of marking depths applied to weapons at the point of manufacture or import. These were reported by 13 respondent States and are presented in table 4.[3] In addition, four countries that manufacture SALW indicated that national legislation governing this production does not specify a required depth of marking.

Even within this small sample is some notable regional harmony across these responses. For example, six of the countries that reported marking weapons at the point of manufacture to a depth of 0.0762 mm are members of, or aligned with, the European Union and its Implementing Directive 2019/68 of 2024.[4]

Table 4
Marking depth values reported by respondent Member States

Depth	*Manufacture*	*Import*
0.0762 mm/ 0.003 inches	7 (Hungary, Lithuania, Rwanda, Spain, Sweden, Switzerland)[a]	9 (Hungary, Lithuania, Nigeria, Portugal, Rwanda, Spain, Sweden, Switzerland)[a]
0.10 mm	2 (Brazil, Mexico)	4 (Brazil, Mexico, Nigeria, Sierra Leone)
0.20	3 (Colombia, Ukraine)[a]	3 (Colombia, Ukraine)[a]

[a] Includes one country that requested to be kept anonymous in this study.

3 Some Member States have additionally published a nationally mandated marking depth. The United States Bureau of Alcohol, Tobacco, Firearms and Explosives requires, for example, all engraved, cast, or stamped serial numbers to be applied to a minimum depth of .003 inches. (ATF eRegulation, 27 CFR Part 478.92 (effective 22 January 2026))

4 Commission Implementing Directive (EU) 2024/325 of 19 January 2024 amending Implementing Directive (EU) 2019/68 as regards the minimum depth of markings on firearms and essential components, *Official Journal of the European Union*, 22 January 2024.

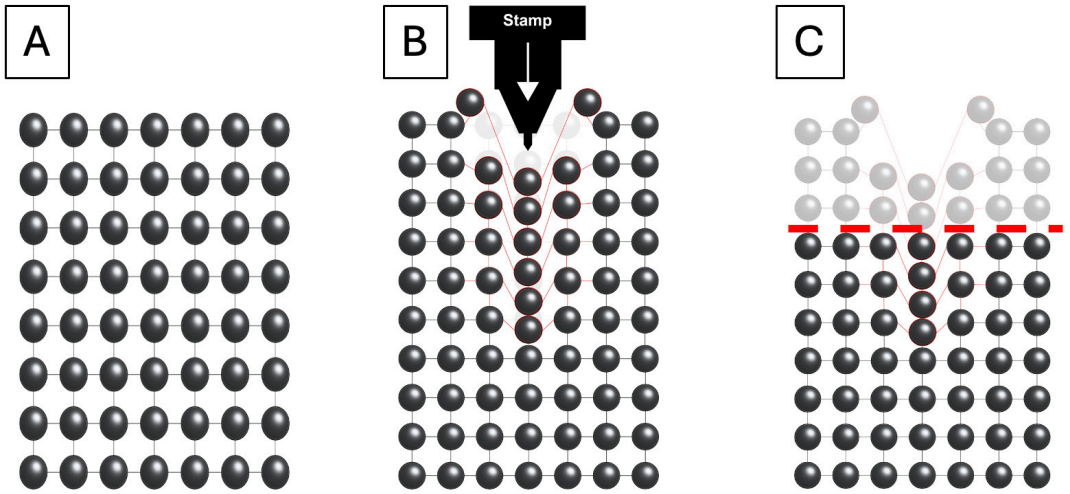
Marking methods

A critical component of ensuring long-term weapon traceability lies in the method of mark application. A range of technologies are available to manufacturers, including stamping, casting, mechanical engraving, roll marking, dot peening and laser engraving. An overview of some methods is detailed in annex A of MOSAIC module 05:30.

Evidence from forensic studies and practitioner interviews indicates that traditional techniques such as mechanical stamping and dot peening produce marks that are inherently more recoverable than many modern alternatives. These techniques deform both the surface and subsurface material, creating plastic displacement that preserves the mark even when the surface has been subjected to wear, corrosion, or deliberate obliteration attempts (figure 29).

Figure 29

Visualizations of the effect of stamping (or dot peening) on the structure of metallic firearms



Unaltered crystalline microstructure of steel.

Source: Trent University (2026).

Illustration of the effects of compressive marking techniques (e.g. stamping and dot peen), with representation of atomic reorganization within the microstructure where semi-transparent atoms indicate material displacement resulting from plastic deformation and compressive flow.

The visible depth of the serial number and compression under the visible mark where residual compressive deformation persists and may be exploited for forensic recovery. Depiction of the typical material removal depth associated with deliberate obliteration attempts (above red line).

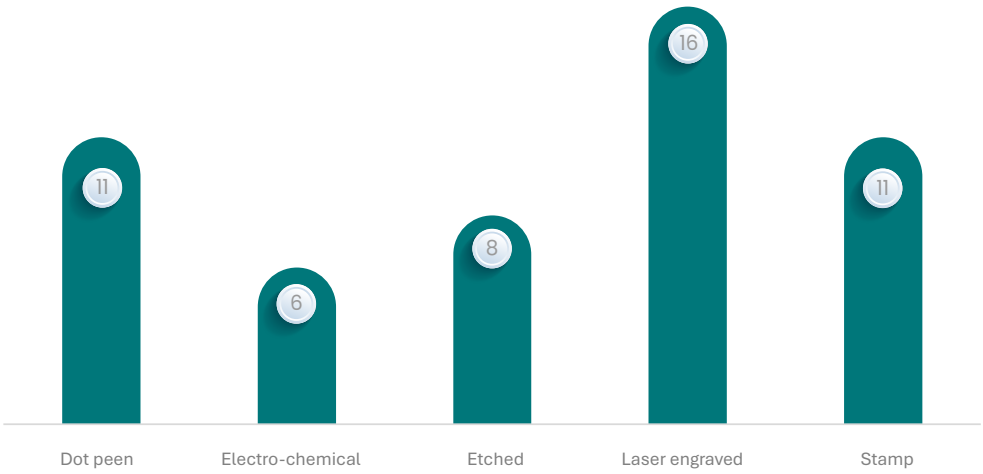
Stamping, typically applied with hardened steel dies, ensures deep and consistent impressions, while dot peening delivers precise, durable micro-indentations that remain legible under forensic examination. Both methods also offer reliable control over placement, depth and character formation.

From a forensic perspective, this subsurface deformation is critical, as it forms the physical basis for many serial number recovery techniques (as detailed in chapter 2 above).

Laser engraving of serial numbers has become increasingly widespread in the past few decades. It provides manufacturers with a fast, precise, repeatable and cost-effective method for marking weapons in large quantities. Modern fibre lasers require minimal mechanical wear and integrate easily into automated workflows. Lasers are also highly versatile, enabling a wide variety of marks and applications across different material types.

Laser engraving was the most common method identified by countries completing the survey prepared for this study (see figure 30). Eighteen countries submitted information about the types of marking methods used by national SALW producers. Most described a combination of methods in practice, but laser engraving (16) was used by SALW producers in all but two respondent countries, illustrating the popularity of this marking method, even within a small sample size.

Figure 30
Marking methods used by States that manufacture SALW



Most Member States reported using more than one method. Each identified method has been counted once.

Despite these operational advantages, laser engraving poses significant forensic challenges. This is extensively detailed in research carried out in 2024 by the United Nations Regional Centre for Peace and Development in Latin America and the Caribbean (UNLIREC) (see box 9).[5] Compared to traditional methods of weapon marking, laser marks are generally shallow and limited to the surface (see figure 31). Depending on parameters used, laser marking may involve limited surface discolouration or ablation, often producing minimal subsurface plastic deformation. Interviewed manufacturers acknowledged that laser marks were more vulnerable to removal than stamped marks.

From a material science perspective, no amount of forensic expertise can recover information that was never embedded in the metal substrate. Forensic experts interviewed for this study consistently reported that laser-marked serial numbers often fail to meet forensic expectations, even when fully compliant with regulatory requirements at the time of production.

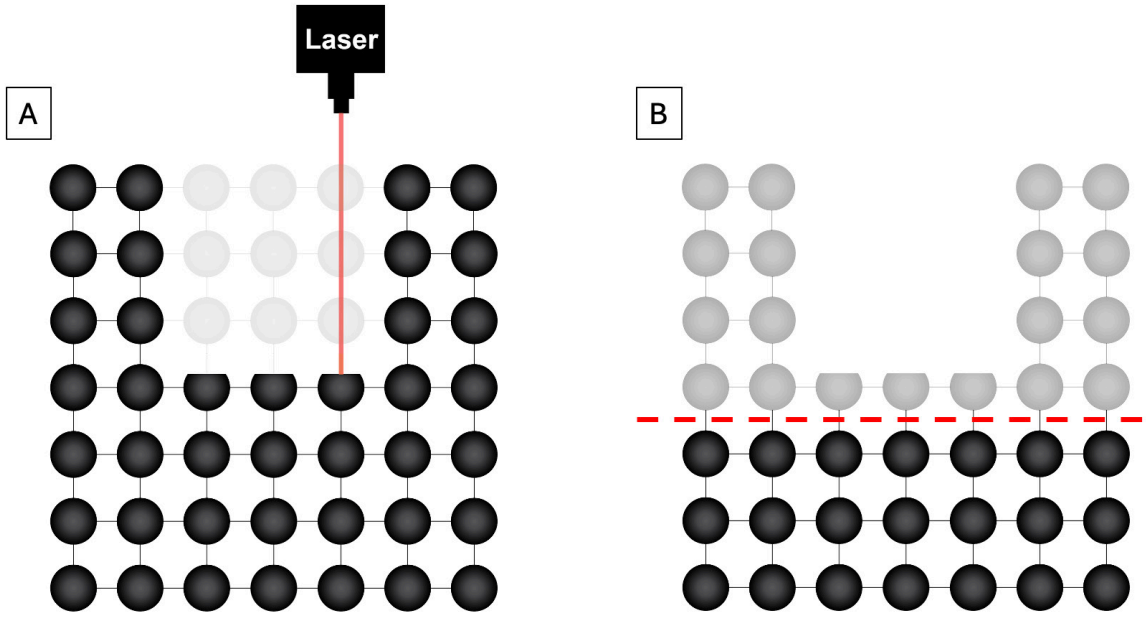
Obliteration of laser-engraved marks therefore poses a significant challenge to forensic analysis of seized illicit SALW. Recovery attempts are often inconsistent, and outcomes depend heavily on the metal type, depth of the original marking and obliteration, laser settings and the skill of the examiner. One expert, a senior firearms examiner with more than 30 years of experience, stated that the "method[s] used to mark firearms, specifically serial numbers, have a huge impact on the possibilities to restore or recover obliterated markings. Previously, stamping has been the go-to method, and that is really what allows us to do restorations at all [...] To my knowledge, when the shallow lasered markings are ground off, there is nothing to restore."[6] Chemical etching in particular was noted as having very poor results in recovering serial numbers engraved with lasers, and that preliminary surface preparation of the weapon may remove any available traces of the original marking.

5 UNLIREC, "Firearms marking with laser engraving: Technical insights and recommendations", working paper (2025).

6 Interview with Patrik Hertzman, Senior Firearms Laboratory Unit of Maricopa County Sheriff's Office, Arizona.

Figure 31

Visualization of the effect of laser marking on the structure of metallic firearms



Visualization of the effect of laser marking on the structure of metallic firearms.

Depiction of the typical material removal depth associated with deliberate obliteration attempts (above red line), which does not leave any exploitable microstructural changes.

Laser engraving illustrates a tension between the commercial and operational pressures faced by SALW manufacturers on the one hand, and the need of forensic laboratories, law enforcement and investigators for weapons to retain their evidential value throughout their life cycle on the other.

Interviews with weapon manufacturers, conducted for this study and in previous research by this study's authors, have shown that manufacturers often implement marking requirements to comply with national regulatory frameworks but do not necessarily conceptualize weapon marks as long-term evidentiary tools expected to remain recoverable decades after production. Durability, a key concept within the ITI, is often interpreted narrowly as a mark's resistance to routine handling or environmental exposure, rather than its resistance to deliberate obliteration. One producer reported plans for incorporating dot peening into its serial-number marking process after learning that law enforcement tests had successfully obliterated its product's marks and after consulting with forensic specialists.[7]

A core assumption of international arms control and tracing frameworks is that markings applied at the point of manufacture retain evidentiary value throughout a weapon's life cycle, enabling the systemic and successful tracing of weapons seized or recovered in illicit contexts. This assumption is often incorrect. From a policy perspective, this is problematic because, when international, regional

7 Expert submission from a major small arms producer that requested to be kept anonymous.

or national regulations emphasize the presence or type of a mark rather than how to enhance its recoverability, manufacturers rationally optimize for regulatory sufficiency rather than long-term forensic utility. The result is wide variation in marking application methods across the global market, producing SALW that are legally compliant at manufacture but potentially vulnerable to obliteration once they enter illicit circulation.

Box 9
Laser engraving recoverability research

In 2024, UNLIREC conducted experimental tests to identify applications of laser engraving for marking firearms that could enhance their recoverability in cases of obliteration.[8] This is the first United Nations-led research on this question, which has previously been a subject of academic study and is gaining increasing relevance in the context of understanding marking resilience to obliteration efforts, given the spreading pre-eminence of laser engraving as a marking method for SALW.

The experiments, conducted in collaboration with authorities in the Dominican Republic, Grenada, Jamaica, Saint Lucia and the United Kingdom, entailed engraving alphanumeric markings, using three different fibre laser machines, on 64 mild steel, stainless steel and aluminium plates, as well as 20 samples of polymer previously removed from a Glock frame. Researchers engraved the mark to depths between 0.12mm and 0.22 mm. This was conducted to assess the efficacy of the MOSAIC-recommended depth of 0.2mm but is not necessarily consistent with the current practice of many manufacturers, who mark to a shallower depth (see box 8).

Researchers then obliterated the marks using a rotary power tool before conducting a restoration process using chemical etchants and an electromagnetic method. The tests concluded that it was possible, in some instances, to recover marks if applied to at least 0.2 mm depth. It noted, however, that markings with a depth of 0.14 mm on mild steel plates presented challenges, especially with the electromagnetic method, and shallow marks on aluminium samples were not possible to recover. Efforts to restore test laser marks at a depth of 0.22 mm on polymer samples were not only unsuccessful but also resulted in the destruction of the material. Attempted recovery of markings of 0.22 mm or deeper was partially successful in approximately 50 per cent of cases, and researchers noted, "the restored marks were only visible briefly, as the polymer began to melt under the applied heat".[9]

The research demonstrated that, while it was technically feasible to recover some obliterated laser-engraved marks under specific test conditions, laser-engraved marks should be applied to at least the MOSAIC-recommended depth of 0.2 mm or

8 UNLIREC, "Firearms marking with laser engraving".
9 Ibid.

more. This is an important observation, given the increasing uptake of this marking method by weapon manufacturers and indications in this research that the industry standard, and national requirements in many cases, are far shallower than 0.2 mm. The working paper also highlighted the potential application of laser engraving to additional marking types other than serial numbers, noting that its capacity to add minuscule, highly detailed markings to hard-to-access components means laser engraving could be positively applied to apply security marks,[10] geometric symbols or barcodes that could store more extensive data on a weapon.

Given the small sample size, UNLIREC recommended further scientific research, including with shallower depths, a broader range of other obliteration methods that more accurately replicate criminal behaviour and additional restoration methods, to assess whether laser-engraved marks can be recovered systematically.

10 Security markings are defined by MOSAIC as "a back-up in case classical markings are removed or altered" (i.e. marks that contain the same information as "primary" or "required" marks but provide additional redundancy in the case of removal of those primary markings. MOSAIC advises that security markings are "hidden by being applied to parts of the weapon that are difficult to manipulate after the weapon has been manufactured and that, if tampered with, would render the weapon unusable". (MOSAIC 05:30 "Marking and recordkeeping", sect. 5.7.3).

Marking measures for improved traceability

Expert consultations affirmed that the placement and location of weapon markings was a key factor influencing recovery success rates.

The ITI states that all marks required by the instrument should be applied on an exposed surface, and that unique markings should be applied on an essential or structural component of the weapon.[11] This component, which the ITI frames as one that, if removed or damaged, would render the weapon itself inoperable, is recommended by MOSAIC module 05:30 to be either the frame or receiver. The rationale for the serial number to be marked on an exposed, clearly visible location is self-evident both from a weapon inventory and traceability perspective, but it also inadvertently presents an obvious target to prospective perpetrators of weapon obliteration. To solely place serial numbers in such a location, therefore, may meet the normative requirements of the ITI, but also establishes a critical vulnerability.

Forensic experts interviewed for this study consistently highlighted the value of additional, repeated application of serial numbers, security marks and other identifying marks to SALW, especially if these marks are applied in such a way as to not be immediately apparent to criminal and other nefarious actors. This may be especially important in contexts where obliteration perpetrators are demonstrating increased forensic awareness, such as locations with longstanding challenges with controlling illicit SALW circulation.

This could involve two complementary dimensions. The first is the application of marks to locations less accessible to obliteration techniques like grinding or filing.

11 ITI, para. 10.

Experts in forensic laboratories in Brazil, Chile, Guatemala, Mexico and the United States were among those who referred to "hidden", "concealed", or "secret" marks as beneficial to their work. They identified several producers, including one company not named in this study, that already utilize variations of this practice, recently changing the position of this mark to disrupt efforts to identify and remove it. One forensic practitioner interviewed for this study, the director of weapon testing and marking for the Serbian SALW Proof House, said that while criminals may prioritize the primary serial for obliteration, they may either neglect—or be unaware of—repeated serial number markings on small components within the weapon.

In the Serbian context, authorities rely on good collaboration with firearms producers in the country to identify weapons based on internal markings. These marks therefore allow for identification and tracing of seized weapons even where the primary serial number has been removed.[12]

Secondly, emerging marking technologies also increase the potential for new marks to be added to SALW, thus increasing their traceability. Several interviewees noted that some manufacturers already take a twin-track approach to marking SALW, using a traditional approach like stamping for the primary serial number and preserving laser engraving or electroetching pen for additional markings of internal components. Micro-scale or internal markings, applied during manufacturing processes that affect the material structure rather than the surface alone, may further complicate obliteration efforts. In 2024, researchers from the United Nations Institute for Disarmament Affairs (UNIDIR) and the Flemish Peace Institute surveyed 14 technologies to assess their possible applicability to countering SALW diversion. This included several technologies relevant to weapon marking, such as 2D codes, chemical encoding and DNA coding. The research noted that 2D codes, as a visible marking method, were still vulnerable to obliteration but provided a way to add a large amount of traceable information in a very small space.[13] Interviewed experts from Canada and France reported that adding QR codes or dot matrix codes to hard-to-access locations inside a weapon had contributed to improved forensic recovery efforts. One challenge with this, however, is updating these databases and maintaining access for appropriate users. Chemical encoding (the use of individual combinations of chemical compounds to apply a unique mark) and DNA coding (placing a unique DNA code from synthetic or biological sources) are two marking technologies that have distinct additional advantages for marking traceability, most notably the fact that these marks cannot be viewed with the naked eye.[14]

These methods, used in other sectors, could theoretically greatly improve the resilience of SALW markings against obliteration. While such approaches raise relevant operational considerations for SALW manufacturers, they illustrate how technology could substantially increase the

12 Interview with Aleksa Anicic, Director of the Agency for Testing, Stamping, and Marking of Weapons, Devices and Ammunition at the Serbian SALW Proof House.

13 Sarah Grand-Clément, "Project D-TECT: Assessing technologies to counter the diversion of small arms and light weapons", UNIDIR and Flemish Peace Institute, 2024.

14 Sarah Grand-Clément and Diederik Cops, "Project D-TECT: Technologies to counter the diversion of small arms and light weapons and components of conventional weapons", UNIDIR and Flemish Peace Institute, 2023.

effort, time and technical skill required to obliterate marks from a weapon.

2. Downstream measures

Criminalization of marking obliteration

Of the 38 countries that completed the survey for this study, 27 stated that they had legislative measures to deter tampering with, or obliteration of, identifying marks on firearms. Article 5.1 (c) of the Firearms Protocol requires its States parties to adopt such measures in relation to firearms. Examples of these measures are detailed in table 5. Further examples of the practical implementation of these and other legislative measures are available in the UNODC Sherloc database (Sharing Electronic Resources and Laws on Crime). Sherloc is a valuable resource for researchers and policymakers as it provides a repository of case law and legislation relating to firearms offences across different jurisdictions and therefore enables analysis of the practical implementation of international, regional and national arms control frameworks. Among its attributes, Sherloc allows for the filtering of cases across different cross-cutting features pertinent to international policy and security priorities, one of which is the obliteration of weapon marks.[15] Information related to the criminalization of obliteration is not currently requested of Member States in their national PoA implementation reports.

15 United Nations Office on Drugs and Crime, "SHERLOC: Sharing Electronic Resources and Laws on Crime". Available at https://www.unodc.org/cld/st/home.html.

Table 5

Examples of legal measures to criminalize obliteration of SALW[16]

Country	*Offense type*	*Punishment type*	*Legal measure*
Australia (Western Australia region)[a]	Unlawfully interferes with any serial number Possesses, acquires, or supplies a firearm or major firearm on which any serial number has been unlawfully interfered with (whether by the person or another person)	Imprisonment for 7–10 years (depending on the type of firearm), or a summary conviction penalty of imprisonment for 3 years and a fine of AUD 36,000.	Firearms Act 2024 Part 5 Firearm authority offences, Division 8 (Sections 262 to 270)[b]
Brazil	Removes or alters the marking, numbering or any identification of a firearm or artifact Carry, possess, acquire, transport or supply a firearm with a serial number, brand or any other identifying mark that has been erased, suppressed or altered	Imprisonment for a term of 3–6 years in prison and a fine.	Article 16, I and IV of Law No. 10,826/2003 (Estatuto do Desarmamento)[c]

16 Unless otherwise referenced, these examples do not constitute direct quotes, but rather are derived from summaries provided by Member States and translated.

Country	*Offense type*	*Punishment type*	*Legal measure*
Canada	Alters, defaces or removes a serial number on a firearm. Possesses a firearm knowing that the serial number on it has been altered, defaced or removed.	Imprisonment for a term not exceeding five years, or "is guilty of an offence punishable on summary conviction".	108 (1) of the Criminal Code of Canada[d]
Hungary	Removes or counterfeits an individual identification mark. Acquires or uses or disposes of an article whose individual identification mark is counterfeit or forged.	Imprisonment of up to three years, or up to five years if the criminal offence is committed on a commercial basis.	Section 347 of Act C of 2012 on the Criminal Code[e]
Jamaica	Remove, alter, modify or in any manner tamper with any mark (as specified in the Act)	Summary conviction, a fine not exceeding $5 million, or to imprisonment for a term not exceeding five years (or ten years if convicted by a Circuit Court)	Article 16 of the Firearms Prohibition, Restriction and Regulation Act, 2022[f]
Rwanda	Illegally possesses an arm or alters its identification marks in any manner whatsoever	Imprisonment for a term of not less than one year and not more than two years and/or a fine of between FRW 1-2,000,000.	Law no 56/2018 of 13/08/2018 relating to arms, Article 70[g]
Switzerland	Removes, effaces, alters or adds to the prescribed marking of firearms, their essential components or accessories [...]	Custodial sentence not exceeding three years or a monetary penalty	Article 33 of the Federal Act on Weapons, Weapon Accessories and Ammunition[h]
Ukraine	Illegal removal or alteration of firearms markings.	Imprisonment for a term of • 3–7 years (first offence) • 5–7 years (repeat or by "prior conspiracy of a group of persons") • 8–12 years (committed by "an organized group")	Article 263-1 of the Criminal Code of Ukraine[i]

[a] The regulation of firearms in Australia is conducted at the subnational level by each of the federated States/Territories.
[b] Western Australia Firearms Act 2024. Official Version No. 23 of 2024.
[c] The Statute of Disarmament, Law No 10.826/03 (December, 2003).
[d] Criminal Code (Code criminel) of Canada. 2012. Revised Statutes of Canada, 1985: Minister of Justice, 2012.
[e] Criminal Code of the Republic of Hungary, amended by the Act C of 2012 on the Criminal Code.
[f] The Firearms (Prohibition, Restriction and Regulation) Act, 2022.
[g] Law no. 56/2018 of 13/8/2018 relating to arms.
[h] Federal Act on Weapons, Weapon Accessories and Ammunition (Weapons Act, WA) of 20 June 1997 (Status as of 1 September 2023).
[i] Criminal Code of Ukraine (entered into force on 1 September 2024).

Eight countries responding to the survey said they did not have legal measures in place to criminalize marking obliteration. Some of the countries that reported having legislative deterrents in place indicated legislation that provided an overall framework for criminalizing illicit SALW possession and trafficking, but they did not explicitly reference obliteration, alteration, tampering, erasure or removal of marks.

As can be seen in table 5, most of these examples focus on criminalizing the act of obliteration itself. In most cases shared with the research team, being found guilty of obliterating marks from a weapon typically carries a potential prison sentence of several years and, in some countries, may also involve a fine. A 2024 working paper on criminalization of firearms offences, prepared by the Working Group on Firearms of the Conference of the Parties to the United Nations Convention against Transnational Organized Crime, advises that States parties to the Firearms Protocol focus their legislative efforts on the conduct of obliteration rather than the result. This approach recognizes that, while obliteration efforts may vary in their effectiveness—and in some cases could be so superficial as to fall short of any technical definition of obliteration that exists in national law—what is important to criminalize is the intent of the perpetrator.[17]

Table 5 also shows that some Member States additionally criminalize the possession of a weapon with obliterated marks, regardless of whether the person in possession was responsible for obliterating the weapon or not. Some countries also take into consideration marking obliteration when assessing the gravity of other firearms offences, such as illegal possession. An example of this latter approach can be seen in Sweden.[18] Its Weapons Act has divided firearms crimes into several degrees of severity, and obliteration is considered an "aggravating circumstance" if the firearm was held in a criminal environment. As this is a concrete, demonstrable and objective criterion, it has particular value for prosecution in assessing serious firearms offences.

Record-keeping

A recurring challenge identified in research interviews relates to the fragmentation of records on obliteration within and between national authorities. When illicit SALW with obliterated marks are recovered, the relevant authority should record this information in a manner that enables retrieval and analysis, both to support investigations into the specific weapon in question and to facilitate comparison with other weapons recovered elsewhere. What may be perceived in isolation as an individual instance of obliteration could be found to be part of a wider pattern. When forensic recovery is coupled with rapid access to manufacturing, import and ownership records, even partial or ambiguous markings can yield actionable

17 Conference of the Parties to the United Nations Convention against Transnational Organized Crime, "Implementation of article 5 (Criminalization) of the Firearms Protocol", Working Group on Firearms (CTOC/COP/WG.6/2024/3).

18 Interview with Johan Gustafsson, Detective Inspector at the National Firearms Focal Point at the Swedish Police Authority.

Box 10

Linking forensic evidence to investigative processes and outcomes

Interviews with law enforcement representatives and with forensic experts during this study separately affirmed the importance of clear processes to link forensic evidence with investigative outcomes. Sweden provides a good practice example here. Courts place considerable weight on the clarity, completeness and transparency of forensic documentation.

Comprehensive records, such as detailing examiner credentials, the sequence of applied techniques and uncertainty assessment, are critical to ensuring that recovered markings withstand legal scrutiny. The evidentiary strength of any restored identifier is inseparable from the integrity of its supporting documentation. Strengthening these record-keeping practices, including standardized report templates and digital archiving, will not only enhance transparency but also facilitate peer review and inter-laboratory comparison. The Swedish National Police have issued guidance for forensic experts in the country, connecting forensic evidence with penal law. Introduced in 2021 and updated in 2023, the guidance ensures courts consistently integrate technical evidence with penal assessments.

A second aspect is the sequencing of investigations to incorporate insights from technical firearms examinations: one expert identified that, while these investigations may be time-sensitive, in contexts where a high number of counterfeit or falsely marked weapons are circulating, there is great value in ensuring that tracing efforts follow a technical examination of the illicit weapon.

Finally, experts highlighted the benefits of a two-directional flow of information so that successful outcomes are fed back to laboratories, affirming the value of their work and helping direct resourcing to efforts with proven impact.

intelligence. Furthermore, maintaining analysable records on forensic outcomes in a reportable format would provide an empirical evidentiary basis across jurisdictions to help inform the development of new guidance, technical standards and revised national legislation to ensure that manufacturer markings are more likely to support positive forensic outcomes. This evidence-based approach would allow for the evolution of policy to respond to real-world and evolving criminal practices.

Close forensic scrutiny of obliteration "signatures" (see box 2) could allow investigators to triangulate recurrent types and methods of mark removal and identify a common point in the supply chain where marks were erased. The force of removal, the direction of removal, the tools used: all of these are critical variables that are lost if a seized weapon is treated as a singular case. This was emphasized during interviews with forensic and law enforcement representatives in Brazil and Sweden. In Brazil, federal labs record not only the

make, model, calibre and serial number of an assessed weapon but also details about the nature and extent of the observed obliteration. This includes recording the outcome of recovery efforts. This information is retained in a central database that investigators can search and analyse for patterns across different weapons. Brazilian officials cited an example in which the Federal Police of Brazil had success by analysing a series of weapons with similar fake markings to identify the same importers and shops near the locations where those weapons were seized.[19]

Sweden also maintains a national system for recording seized firearms. The nationwide nature of these records was highlighted as particularly important because trends can rapidly develop and evolve. Recovered weapons are uploaded, along with photos and any DNA evidence, to allow for initial forensic analysis within 24 hours of seizure. The national forensic centre produces a final report that is then integrated into a central record. This allows for very effective and rapid trend analysis that can also be shared with colleagues in other countries, or with regional authorities like EUROPOL.[20] Sweden has developed a mobile application for police so that they can directly upload photos into case files.

Such records rely foundationally on effective documentation at the point of seizure. Experts noted that first responders do not always understand the importance of documenting markings and, as a result, do not always photograph the weapon serial number. It was observed that training and providing standardized operating procedures to aid documentation practices would benefit investigations into obliteration of weapon markings. UNODC has developed guiding templates for firearms-related investigations, which include fields relating to the forensic recovery of identifying marks.[21] Digital technologies also offer significant potential to strengthen the broader traceability ecosystem of illicit weapons, including those with obliterated markings. Enhanced electronic record-keeping systems, interoperable national databases and secure platforms for international trace requests can amplify the investigative value of recovered identifiers.

International cooperation and assistance

Tracing and cooperation

When marks are recovered, it should facilitate national and international tracing efforts. This can be conducted directly between States, by utilizing platforms like INTERPOL's illicit arms records and tracing management system (iARMS), or by working with the support of specialist civil society organizations and independent investigative experts. Tracing obliterated weapons helps establish how diversion may have occurred and what supply chain vulnerabilities can be addressed to prevent its recurrence. This, in turn, may help investigators and national authorities to identify entities culpable for obliteration efforts.

Interviews with forensic and technical experts identified good practice in international tracing efforts, particularly bilateral cooperation between authorities in Brazil and Paraguay, where the systemic tracing efforts of weapons with recovered marks helped identify cases of cross-border trafficking. The two countries have since

19 Interview with Marcus Dantas, Federal Police of Brazil.

20 Interview with Johan Gustafsson, Detective Inspector at the Swedish Police Authority.

21 *Guiding Templates for Firearms-related investigations* (UNODC, Vienna).

conducted joint operations and joint courses to bring together regional points of contact. A Brazilian expert familiar with this case stated that such positive outcomes became possible only when regional neighbours improved their record-keeping systems, enabling effective tracing responses.[22]

For small or resource-constrained jurisdictions, access to regional or international forensic networks adds significant operational value. Cooperation and coordination efforts in the Latin American and Caribbean region were, for example, cited positively by expert representatives of Antigua and Barbuda, Argentina and Guatemala. In one illustration of this, a prosecutor from a specialized firearms trafficking unit in the region, reflecting on meetings facilitated by the UNODC Global Firearms Programme and the MERCOSUR Firearms Working Group, emphasized the importance of creating opportunities for national focal points involved in firearms investigations to meet, build trust, explore potential cooperation between countries and enable informal exchanges on key issues such as evolving modus operandi and emerging innovations in firearms.

Reporting

Beyond standard-setting, international policy effectiveness depends on reporting, review and learning mechanisms. Under the UN PoA, States submit national reports describing legislative measures, marking practices, record-keeping systems and international cooperation activities.[23] This template was amended in 2026 to include data collection on national approaches to preventing, identifying and responding to the intentional marking obliteration on SALW. Newly added questions cover whether States encourage manufacturers to take measures to prevent obliteration; whether States have seized weapons with intentionally obliterated markings, including details on the types of markings affected, methods used, scale, location and motivations; and whether forensic recovery of obliterated marks is conducted, including the techniques used, responsible authorities, operational challenges and lessons learned.

Encouraging States to report not only on marking requirements but also on observed tracing outcomes, recovery success rates and instances where obliteration impeded investigations would support more evidence-based implementation review. The Illicit Arms Flows Questionnaire, which is a mandated annual data collection tool developed and implemented by UNODC, provides another highly valuable platform for States parties to the Firearms Protocol to report on seizures of illicit firearms and whether markings on those weapons have been altered or removed. One concrete benefit would be enabling the earlier identification of emerging problems affecting a particular region, thereby creating opportunities for countries to develop common responses through cooperation.

International assistance

For countries with limited access to specialized laboratories or equipment, trained examiners, or ballistic-comparison systems, recovered markings may yield minimal operational benefit without the supporting infrastructure to interpret and act on them.

A particular aspect highlighted repeatedly during interviews conducted for

22 Interview with Marcus Dantas, Brazilian Federal Police.

23 See the UN PoA database of national reports.

this study was the importance of making technical resources available to forensic examiners. This was raised by experts in several countries, including Chile, Guatemala and the United States. One expert stated that, in their view, forensic experts would greatly benefit from having access to a database of manufacturers they could consult to verify marking methods, marking locations by model and serial number patterns by manufacturer. This would help differentiate genuine from counterfeit marks and facilitate finding markings on weapons that had been completely sanitized.[24]

Regional cooperation and technical assistance emerged as essential strategies for bridging capability gaps, particularly among smaller or resource-limited jurisdictions. Shared laboratories, mobile forensic units and intergovernmental partnerships provide a cost-effective means of extending access to advanced analytical techniques without requiring each State to maintain full in-house capacity. Such cooperative frameworks also facilitate technology transfer, peer learning and harmonization of standard operating procedures. As one expert observed, the problems faced by different countries are often similar, and so sharing information regionally, including between forensic experts and national manufacturers, would provide valuable insights to help with effective weapon identification and tracing.

24 Interview with a police ballistics expert that requested to be kept anonymous in this study.

Conclusion

Conclusion

Tracing is a central pillar of national, regional and international efforts to prevent SALW diversion, disrupt illicit trafficking and support law enforcement efforts. Serial numbers, manufacturer identifiers and import markings collectively enable authorities to reconstruct a weapon's origin, movement and chain of custody. These identifiers underpin domestic investigations, mutual legal assistance and international cooperation under the ITI.

When these identifying marks are recovered, seized illicit SALW are transformed from isolated exhibits into sources of intelligence on trafficking routes, diversion points and organized criminal activity. Conversely, the deliberate obliteration or alteration of markings reduces the evidentiary and investigative value of a firearm. Tracing efforts may be delayed or rendered impossible, prosecutions weakened, and opportunities for international cooperation lost. This is a global phenomenon, with at least 77 countries having reported seizing illicit SALW with obliterated marks since 2016. Obliteration is present in both criminal contexts, including organized criminal violence and countries affected by armed conflict.

From surveys and interviews with both investigators and forensic agencies, the primary motivation to obliterate weapon markings is typically to conceal the identity and provenance of a weapon and to prevent its tracing by law enforcement. In most cases, offenders target only the most visible serial number, operating under the assumption that removing this most obvious identifier is sufficient to render a weapon untraceable. The methods used to obliterate weapon markings are overwhelmingly low-technology, often involving hand tools or small power tools. Filing, sanding, grinding, scratching and drilling dominate reported cases and can all be conducted with household implements and without specialist training or capabilities. More aggressive techniques such as over-stamping, welding, burning, or milling were also reported by States, particularly involving well-resourced criminal organizations and non-State armed groups.

While obliteration is often recorded by Member States in specific localized and temporal concentrations, the act of obliteration should be understood not as an exceptional event, or an isolated criminal tactic, but rather as a foreseeable stress test of marking systems. Where marking practices are insufficiently resilient to this test, it represents a structural traceability failure that can be exploited by criminals, non-State armed groups and other obliteration perpetrators. Standardized marking locations, shallow engraving and the absence of repeat identifiers create single points of failure that obliteration perpetrators can effectively neutralize with basic tools.

This study shows that much depends on the effective translation of good practices for weapon marking, as established under the ITI and advanced through voluntary

instruments like MOSAIC, into concrete technical guidance for SALW manufacturers. National authorities can actively shape the prospects of recoverability by specifying permissible marking methods, minimum mark depths and placement standards. This approach should prioritize the traceability of the weapon, harnessing technological advances to improve the recoverability of unique identifying marks by, for instance, increasing the application of redundant "hidden", "secret" and additional internal markings that are hard to spot, hard to remove and hard to counterfeit.

Importantly, marking practices should be actively responsive to forensic evidence. Empirical data on recovery success and failure, which should be collected systematically and analysed, can inform the refinement of marking standards and manufacturing guidance. This evidence-based approach would allow regulation to evolve in response to real-world practices rather than static assumptions.

Technological innovation in forensic science also offers meaningful opportunities to reduce the vulnerability of serial numbers and other identifying marks to obliteration. Continued development of recovery technologies offers incremental but important gains. Improvements in digital microscopy, image enhancement and surface-analysis techniques have already enhanced the ability of examiners to detect faint or partial markings. Automated or semi-automated image-processing tools may further assist examiners in interpreting degraded characters, particularly when combined with reference datasets and probabilistic pattern matching.

At the same time, interviewees consistently cautioned against overestimating the capacity of recovery technologies to compensate for inadequate marking practices. Where original markings lack sufficient depth or material disruption, even the most advanced forensic tools cannot reconstruct information that was never embedded. Technological development must therefore be understood as complementary to, rather than a substitute for, improvements in marking durability and regulatory standards.

In assessing the potential of technology, it is essential to avoid a purely solutionist framing. Technology is most effective when embedded within coherent policy frameworks, supported by institutional investment and aligned with manufacturing realities. The findings of this study suggest that the greatest gains will come not from isolated technological breakthroughs, but from coordinated, incremental improvements throughout the life cycle of SALW.

Ultimately, effective traceability requires a life-cycle approach: marking practices grounded in material science; forensic capacity supported by clear policy mandates and institutional investment; and tracing mechanisms reinforced through regional and international cooperation. Aligning these domains would strengthen the resilience of global tracing systems and enhance effective implementation of the ITI, the UN PoA and other related arms-control efforts.

Open-ended technical expert group

At the first meeting of the Open-ended Technical Expert Group in June 2026, marking obliteration was discussed by States, and the authors of the Occasional Paper presented key findings and considerations. To address serial number obliteration, a "hybrid approach" was

discussed. The Chair of the Open-ended Technical Expert Group, in his summary, noted that this would involve the use of mechanical marking techniques for the serial number on the core component, while laser marking or other methods could be used for the other marks. Inconsistent practices were reported regarding the effective minimal depth of markings needed to recover erased markings, pointing to a need for further discussion of this aspect. Non-destructive techniques, such as magnetic-optical imaging, can be used to restore obliterated marks while preserving judicial evidence. Other measures noted included systematizing standard operating procedures for investigating obliterated markings, criminalizing obliteration and information exchange on the context and methods of obliteration.

Box 11

Further considerations for the Open-ended Technical Expert Group offered by the research team in CAR and Trent University

Weapon marking

- Promoting a hybrid approach to SALW marking at manufacture and import, utilizing a combination of mechanical impressions for unique identifiers like serial numbers and laser engraving for repeat, secondary or internal markings.
- Recommending a minimum marking depth for weapons in national guidance and regulations and supporting further scientific research into effective marking depth to meet ITI requirements. States are encouraged to recommend against marking methods that are shallow or surface-only, especially for unique markings applied to the essential or structural component of a weapon, as these are less likely to be recoverable in line with ITI requirements.
- Exploring the potential provided by different marking technologies to introduce additional marks to SALW that are either in hidden or hard-to-access locations of a weapon and the use of innovative mark types, like 2D codes or methods (e.g. micro-percussion, dot-matrices, microstamping or chemical encoding) to SALW to improve their resilience to obliteration attempts.
- Encouraging national policymaking related to SALW marking methods to be based on investigative and forensic evidence. This could include outreach to SALW manufacturers to sensitize producers to marking methods shown to reliably result in recovery failures in the event of obliteration.
- Requiring SALW manufacturers to retain detailed records of marking methods, machine settings and alloy specifications. When requested, this

information helps forensic labs tailor recovery strategies and improves investigatory accuracy. Where possible, technical resources relating to serial-number marking patterns and methods could be shared with national forensic experts to facilitate accurate weapon identification and tracing.

Addressing seized weapons with obliterated markings

- Encouraging Member States to ensure that seized weapons with obliterated markings are immediately flagged for initial investigation by the appropriate national specialists. Where marks are recovered, States are encouraged to initiate formal tracing of these weapons, and the outcomes of these processes should be looped back to forensic examiners.
- Encouraging Member States to systematically collect, record and store data on obliterated markings on recovered SALW. This should ideally include photos of key internal and external markings, with special priority given to clear and accurate documentation of the weapon serial number. Such information should preferably be stored in a national or federal-level database, or in regional databases that are interlinked and interoperable, to facilitate the accurate identification of new and emerging trends across regions.
- Explore with Member States how to ensure, to the fullest extent possible, that forensic laboratories are provided up-to-date training, access to accreditation, equipment and technical resources to apply advanced recovery techniques effectively.
- Recommending that Member States take measures to criminalize the obliteration or tampering of weapon markings. For States parties to the Firearms Protocol, this is already a legal obligation under article 5. Member States could additionally adopt or amend legislation to allow for the criminalization of the possession, acquisition or supply of weapons with obliterated markings.

Supporting national capacity

- Assessing the role of new technologies in improving forensic capabilities of countries recovering weapons with obliterated markings. This includes supporting further forensic and academic research into the utility of emerging recovery techniques like high-resolution imaging and exploring their application to SALW materials (i.e. polymer frames and receivers, use of aluminium alloys) and marking methods (i.e. shallow laser engraving) shown to be particularly vulnerable to obliteration efforts.

- Recommend mechanisms to facilitate information sharing on obliteration and forensic recovery, both informal and structural, between forensic experts. Especially where these experts are based in the same region, particular obliteration modalities may be commonly experienced or responses to new approaches highlighted.
- Encourage Member States to report data on obliterated markings to appropriate international frameworks. For States parties to the Firearms Protocol, this includes making regular seizure data available to report to the UNODC Illicit Arms Flows Questionnaire. The UN PoA national reporting template could be further amended to identify forensic capacity and assistance requests.

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