Standard Practice for Expert Opinions on the Interpretation of Primer Gunshot Residue (pGSR) Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry

Gunshot Residue Subcommittee
Chemistry Scientific Area Committee
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed

Standard Practice for Expert Opinions on the Interpretation of Primer Gunshot Residue (pGSR) Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry

Prepared by
Gunshot Residue Subcommittee
Version: 1.0
March 2020

Disclaimer:

This document has been developed by the Gunshot Residue Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science through a consensus process and *proposed* for further development through a Standard Developing Organization (SDO). This document is being made available so that the forensic science community and interested parties can consider the recommendations of the OSAC pertaining to applicable forensic science practices. The document was developed with input from experts in a broad array of forensic science disciplines as well as scientific research, measurement science, statistics, law, and policy.

This document has not been published by a SDO. Its contents are subject to change during the standards development process. All interested groups or individuals are strongly encouraged to submit comments on this proposed document during the open comment period administered by ASTM International (www.astm.org).

Standard Practice for Expert Opinions on the Interpretation of Primer Gunshot Residue (pGSR) Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry

1. Scope

1.1 This document applies to persons who present expert opinions regarding primer gunshot residue analysis results.

1.2 This document defines the range of opinions that are based upon the existence of a body of published scientific literature. This document does not address all possible circumstances that may be encountered when giving an expert opinion.

1.3 This document cannot replace knowledge, skill, or ability acquired through appropriate education, training, continued competency, and experience. It should be used in conjunction with professional judgment.

1.4 The use of this document presumes that the data on which an opinion is being offered was obtained under requirements of ASTM E1588 or a comparable published standard.

2. Referenced Documents

2.1 ASTM E1588, Standard Practice for Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry, ASTM International, West Conshohocken, PA, 2017, www.astm.org. **(1)**

3. Terminology

3.1 See ASTM E1588

3.1.1 The term "pGSR", when used in this document, refers to particles that are classified as characteristic of primer gunshot residue as defined in ASTM E1588.

3.2 OSAC Lexicon

4. Significance and Use

4.1 This document is of use to persons who present expert opinions regarding primer gunshot residue analysis results and to provide guidance to those in the legal community who use such opinions.

5. Procedure:

5.1 The following topics address a broad range of primer gunshot residue related knowledge. Statements made regarding the following and any additional topics regarding primer gunshot residue must be based on scientific studies and literature with broad community acceptance, published literature and relevant experience in the field.

5.2 Formation

5.2.1 pGSR particles are created by rapid heating and chemical transformation of the components of the ammunition during the discharge of a firearm, followed by the rapid

dispersal of these components in the gases escaping from the firearm, and the rapid cooling of these materials to the point of solidification. **(4)**

5.2.2 Most of the materials that are incorporated into pGSR particles are derived from the primer of the ammunition, along with materials from the projectile and the cartridge case.

5.2.3 The process of pGSR formation does not yield specific ratios of each of the elements in the original primer. Instead, there is chaotic mixing that produces a wide range of component ratios among particles produced in a single discharge. Elemental composition may vary from area to area within a single particle.

5.2.4 There is a great range of overlap in compositions of particles produced by different ammunitions that use similar formulations for their primer.

5.2.5 The residues that are released from a firearm during discharge can incorporate elements that have been left behind on the interior of the firearm from a previous discharge, leading to a mixture of particle compositions being emitted. **(5)**

5.2.6 The identity of the specific ammunition from which a given pGSR particle was generated cannot be definitively determined. However, a comparison between the composition of the pGSR found on a sample source and that in the spent ammunition can be used to conclude that the ammunition could be or could not be the source of the pGSR.

5.2.7 The identity of the specific firearm from which a given pGSR particle was generated, including the type, manufacturer, and caliber, cannot be determined by pGSR analysis.

5.2.8 In general, the morphology of pGSR particles is spheroidal and does not have a crystalline appearance. The majority of pGSR particles detected are >1 μm in diameter. However, size and morphology can vary greatly and should not be the primary criteria for identification.

5.2.9 There is no means of determining when a given pGSR particle was formed.

5.3 Deposition of pGSR

5.3.1 pGSR that is airborne can deposit on a person or item that is present. **(6)**

5.3.2 The deposit of pGSR particles is impacted by environmental conditions. Such factors that affect deposit of pGSR include proximity, weather, air flow, humidity, and indoor versus outdoor environments.

5.3.3 pGSR particle deposit in controlled conditions occurs in the proximity of a discharged firearm. **(7)**

5.3.4 The specific distance that an individual or object was located from a firearm at the time of discharge cannot be determined from the pGSR findings.

5.3.5 The direction or angle that a firearm was pointed during discharge cannot be determined.

5.3.6 The relative likelihood of a particular deposition method cannot be determined. (**8)**

5.4 Transfer

5.4.1 pGSR can be transferred from one surface to another by physical contact. **(2)**

5.4.2 The nature of the surfaces that are in contact with each other (texture, presence/amount of contaminant material) can impact the degree of pGSR transfer. **(9)**

5.4.3 The specific rate of transfer cannot be determined or calculated.

5.4.4 The time of transfer cannot be determined.

5.5 Retention/Persistence

5.5.1 pGSR removal is dependent upon:

5.5.1.1 pGSR particles may be removed from surfaces through physical contact

5.5.1.2 Type of physical activity. **(9)**

5.5.1.3 Level of physical activity, frequency and degree of contact with other surfaces. **(7)**

5.5.1.4 Nature of the surfaces (the retaining surface, the removing surface, and surface orientations).

5.5.1.5 Exposure of the GSR bearing surface to liquids.

5.5.1.5.1 Washing /showering. **(7)**

5.5.1.5.2 Exposure to inclement weather conditions.

5.5.1.5.3 Blood / body fluid loss.

5.5.2 If undisturbed, pGSR particles can remain indefinitely, such as on stored clothing.

5.5.3 The number of confirmed pGSR particles cannot be used to determine the time of a shooting or an individual's involvement in a shooting event.

5.6 Specificity/Other Sources

5.6.1 Other uses of explosive primer material exist and can generate pGSR particles with elemental indicators. **(10)**

5.6.2 Firearm discharges produce particles comprised of combinations of two of the three elements: lead, barium and antimony. Sources of these particles other than firearms discharges have also been confirmed. Such particles are found in primer residue, but also may originate from other sources. **(6)**

5.6.3 Statements may be made regarding particles not considered pGSR in relation to specific and unusual ammunition with reference to a scientific study or published literature accompanying the conclusions. Limitations of potential non-firearm sources must be clearly noted.

5.6.4 Particles comprised of a single element may be generated from a firearm discharge; however, there are many non-firearm sources of these particles. In isolation such particles have little use for interpretation of GSR results in the absence of a reference sample.

5.7 Clothing/Vehicles/Inanimate Objects

5.7.1 The presence of pGSR on a garment does not provide any information about who was wearing the garment during a shooting event.

5.7.2 The time pGSR is deposited on an inanimate object cannot be determined.

5.7.3 It cannot be determined whether deposited pGSR is from a primary, secondary, or tertiary transfer.

5.8 Overall Conclusion Based on the Confirmation of pGSR.

5.8.1 The presence of pGSR on a person is the result of one or more of the following actions: **(11)**

5.8.1.1 Discharge of a firearm.

5.8.1.2 Being in the vicinity of a firearm discharge.

5.8.1.3 Coming into contact with a surface or exposure to an environment bearing pGSR.

5.8.2 The number of confirmed pGSR particles cannot be used to determine which of the above scenarios is most likely.

5.8.3 The absence of pGSR on a person may be the result of one or more of the following;

5.8.3.1 An individual had no association with a firearm.

5.8.3.2 pGSR was not deposited on the individual.

5.8.3.3 pGSR was not retained on the individual.

5.8.3.4 pGSR was not recovered from the surface sampled.

5.8.3.5 pGSR was not detected on the collection device.

References:

(1) ASTM E1588-17, Standard Practice for Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry, ASTM International, West Conshohocken, PA, 2017, www.astm.org.

(2) Wolten, G. M., Nesbitt, R. S., Calloway, A. R., Loper, G. L., and Jones, P. F., "Final Report on Particle Analysis for Gunshot Residue Detection," Report ATR-77 (7915)-3, Aerospace Corporation, Segundo, CA, 1977.

(3) Niewoehner, L., et al., "New Ammunitions for the German Police". SCANNING - The Journal of Scanning Microscopies, Vol. 27, No. 2, 2005, p. 69.

(4) Basu, S., "Formation of Gunshot Residues," Journal of Forensic Sciences, JFSCA, Vol. 27, No. 1, Jan. 1982, pp. 72-91.

(5) Zeichner, A., Levin, N., and Springer, E., "Gunshot Residue Particles Formed by Using Different Types of Ammunition in the Same Firearm," Journal of Forensic Sciences, JFSCA, Vol. 36, No. 4, July 1991, pp. 1020-1026.

(6) Schwoeble, A.J., and Exline, D. Current Methods in Forensic Gunshot Residue Analysis. 2000.

(7) Gerard. R. et al. "The Long Range Deposition of GSR and the Mechanism of its Transportation." Canadian Society of Forensic Science Journal, Vol. 44, No. 3, 2011, pp 97-104.

(8) Basu, S., "Fundamental Studies of Gunshot Residue Deposition by Glue-Lift," Journal of Forensic Sciences, JFSCA, Vol. 42, No. 4, 1997, pp. 571-581.

(9) Kilty, J. W., "Activity after Shooting and Its Effect on the Retention of Primer Residue," Journal of Forensic Sciences, Vol. 20, No. 2, April 1975, pp. 219-230.

(10) Berk, R.E., "Automated SEM/EDS Analysis of Airbag Residue. II: Airbag Residue as a Source of Percussion Primer Residue Particles," Journal of Forensic Sciences, Vol. 54, No. 1, 2009, pp. 69-76.

(11) Wright DM, Trimpe MA, Summary of the FBI Laboratory's Gunshot Residue Symposium. May 31-June3, 2005. Forensic Science Communication. 2006; 8 (3).