Reporting of Forensic Primer Gunshot Residue (pGSR) Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry (SEM/EDS)

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

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Prepared by
Gunshot Residue Subcommittee
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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).

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To:	**Subcommittee E30.01**
Tech Contact:	**David Freehling, dfreehling@ncdoj.gov, 919-582-8920**
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Ballot Action:	**Proposed New ASTM Standard**
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Standard Practice for

Reporting of Forensic Primer Gunshot Residue (pGSR) Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry (SEM/EDS)

1. Scope

1.1 This practice covers the scope of information to be contained in formal, written technical reports that expresses the results and conclusions of the scientific or technical expert with respect to pGSR analysis by SEM/EDS.

1.2 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM consensus process.

1.3 *This practice does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user when applying this practice to establish appropriate safety and health practices and deter- mine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:

2.1.1 E620 Practice for Reporting Opinions of Scientific or Technical Experts.

2.1.2 E1732 Terminology Relating to Forensic Science

2.1.3 E1588 Practice for Gunshot Residue Analysis by Scanning Electron Microscopy/Energy-Dispersive X-Ray Spectrometry.

2.2 SWGGSR Guide for Primer Gunshot Residue Analysis by Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry.

3. Terminology

3.1 The terms listed below apply specifically to this document.

3.1.1 Background sample *n* - A recovered sample from a source that has not knowingly been exposed to pGSR that allows for threshold values to be calculated.

3.1.2 Candidate particles *n* - Particle(s) classified by the instrument software based on detection of appropriate constituent elements as potential pGSR.

3.1.3 Confirmed particles *n* - Particle(s) relocated, analyzed, and classified by the analyst as pGSR based on appropriate constituent elements and morphology.

3.1.4 Threshold *n* – A value, based on a comprehensive background sample study and data interpretation, below which the number of pGSR particles identified cannot be considered interpretable in associating the recovered sample with the discharge of a firearm or contact with a source of pGSR.

4. Significance and Use

4.1 This practice is designed to be utilized by scientific or technical experts with regard to pGSR detection and analysis when issuing final reports. This practice does not include all topics specifically covered in the above referenced documents

5. Report

5.1 The report reflects the conclusions based on scientific results. These conclusions are based on the classification of particle data as defined in E1588 and the SWGGSR Guide.

5.2 Pertinent Information. Satisfy the requirements of E620, Section 4.7, by listing:

5.2.1 The discipline specific technique. See 5.2.3

5.2.2 The general examinations conducted, including the generic class and type of instrumentation used. See 5.2.3

5.2.3 The methodology or procedure performed.

5.2.3.1 e.g. “Exhibit 1 was examined by SEM/EDS for the presence of pGSR particles based on elemental composition and morphology.”

5.2.4 It is recommended that the results of the examination include the quantity and elemental constituents of the confirmed pGSR particles present. State this information in the report using terms accepted by the pGSR scientific community. If using the terms “characteristic”, “consistent”, and “commonly associated” with pGSR in lieu of reporting elemental constituents, define these terms in the report, appendix, or within supporting records (**25**). .

5.2.5 For laboratories that use threshold values, state that value in the written report.

5.2.6 Regarding the estimated uncertainty of measurement in pGSR, several factors have been identified that affect the number of pGSR particles present on a recovered sample. Some of these factors are listed in 5.6.1 through 5.6.3.

5.3 Descriptive Information. Meet the requirements of E620, Section 4.7, and, in addition,

5.3.1 If errors are detected in an issued report, issue an amended report that contains the reasons for the amendments. Indicate that it is an amended report and include the date of the original report.

5.3.2 Indicate on the report if the report is a supplemental report and include the date of the original report.

5.4 Report Examples. Meet the requirements of E620, Section 4.9. The examples listed below do not purport to show all possible reporting styles and can be subject to modifications.

5.4.1 Results based on confirmed particles detected on the recovered sample, either consistent with, or characteristic of pGSR.

5.4.1.1 (Numerical Value) particles characteristic of pGSR and/or (numerical value) particles consistent with pGSR were confirmed on the (sample source).

5.4.1.2 (Numerical Value) particles containing lead, barium, and antimony were confirmed on the (sample source).

5.4.1.3 At least (threshold value) particles characteristic of pGSR were confirmed on the (sample source). [1]

5.4.1.4 (Numerical value) particles containing (elemental constituents) were confirmed on the (sample source).

5.4.2 Results based on the absence of confirmed particles detected on the recovered sample, either consistent with, or characteristic of pGSR.

5.4.2.1 No characteristic pGSR particles were detected on the (sample source).

5.4.2.2 No particles confirmed as either characteristic of or consistent with pGSR were detected on the (sample source).

5.4.2.3 (Numerical value) particles characteristic of pGSR were confirmed but were below the established threshold level to be considered interpretable based upon previously conducted background studies.[1]

5.4.2.4 (Sample source) contained particles characteristic of background samples.

[1] For use by laboratories with an established threshold value. Laboratories must be able to provide the supporting background sample study and data interpretation which the threshold value is based on, if requested. An Appendix to the report can be used to detail the specific number and classification of particles detected.

5.4.3 Inconclusive/indeterminate results indicate to the reader that no conclusion can be drawn based on the analytical data obtained. This result could be due to, but is not limited to contamination, unusual particle populations, and/or unusual elements present in particles. Further testing could be warranted for a more definitive conclusion to be reached (**25**).

5.4.3.1 The particles on the (sample source) do not allow the analyst to form an opinion, due to _____.

5.4.3.2 The presence of [atypical element(s)] in combination with lead, barium, and antimony is uncommon. Therefore, no conclusions can be reached regarding this sample unless a spent cartridge is submitted for comparison.

5.4.3.3 Characteristic pGSR particles were detected on the negative control. No conclusion can be reached regarding the particles recovered from the (sample source).

5.5 Conclusions and limitations

5.5.1 Conclusions are drawn from the identification of characteristic pGSR particles on a recovered sample from a person. Include wording clarifying that the person discharged a firearm, was in the vicinity of a firearm discharge, or came in contact with something that had pGSR on it. The number of confirmed particles cannot be used to determine which of these scenarios actually occurred.

5.5.1.1 The subject discharged a firearm, handled a discharged firearm, was in proximity to a discharged firearm, or contacted an object with pGSR on it.

5.5.1.2 pGSR can be deposited on the hands by circumstances such as: discharging a firearm, handling a firearm, being in proximity to the discharge of a firearm, or coming into contact with an object or person(s) that has pGSR on it.

5.5.2 Conclusions are drawn from the identification of pGSR particles on a recovered sample from an inanimate object. Address the potential that at some time in the history of the item, it was in the vicinity of a firearm during discharge or had pGSR transferred to it.

5.5.2.1 (Sample source) contacted a pGSR related item or was in proximity to a discharged firearm.

5.5.2.2 The (sample source) of the (sample source)/the (sample source) belonging to (sample source) could have been in the vicinity of a discharged firearm or had pGSR transferred to it.

5.5.3 Conclusions are drawn from the identification of consistent pGSR particles on a recovered sample from a person. Include wording clarifying that the

person discharged a firearm, was in the vicinity of a firearm during discharge, or was exposed to a source of pGSR. Additionally, state that the particles could have originated from a non-firearm source.

5.5.3.1 Consistent pGSR can be deposited on the hands by circumstances such as: discharging a firearm, handling a firearm, being in the proximity to the discharge of a firearm, coming into contact with an object that has pGSR on it, or received from a non-firearm source.

5.5.4 Conclusions are drawn from recovered samples in which pGSR evidence is absent from the sample source. Include wording clarifying that the sample source could have been exposed to pGSR but the pGSR particles were not present when the recovered sample was collected or the sample source could have no association with the discharge of a firearm. Do not confuse the absence of pGSR particles with inconclusive interpretations. The absence of pGSR particles can support the theory that an item was not exposed to pGSR.

5.5.4.1 There is no indication that the (sample source) has any association with the discharge of a firearm. However, the absence of pGSR particles is not corroboration that a person did not discharge a firearm. If (sample source) did discharge a firearm, then pGSR particles were not deposited, were removed by activity, or were not detected.

5.5.4.2 There is no indication that the (sample source) came into contact with pGSR or was in the vicinity of a firearm during discharge. If (sample source) was, then the pGSR was not deposited, not detected, or removed.

5.5.5 No conclusions can be drawn from a sample with inconclusive results that are based on the analytical data.

5.5.5.1 No determination can be made from the (sample source) (, for the following reason(s) _____). Submission of appropriate additional evidence could yield conclusive findings.

5.5.6 No conclusions can be drawn from the identification of particles that are commonly associated with pGSR. This includes lead, barium, or antimony particles found in isolation in the absence of characteristic and consistent pGSR particles. An exception to this might include finding high levels of small spherical lead particles that can be shown to originate from bullet or pellet debris or from a primer comprised of a lead-based compound only, supported by analysis of a reference sample. In most circumstances, however, such particles shall not be reported as potentially having originated from the discharge of a firearm.

5.5.7 Include the details of the elements and combinations of elements that are being considered in making a conclusion if a comparison of results to known ammunition is conducted. Indicate these particle types could originate from other ammunitions, unless the ammunition in this case is manufactured for a unique application, such as ammunition with taggant elements.

5.5.8 An explanatory statement or page can accompany the report if it assists the reader in understanding the information provided. Examples of the statements are listed below.

5.5.8.1 Microscopic particles containing any combination of lead, barium, or antimony are known to be associated with pGSR. If possible the known firearm and ammunition should be submitted if further testing is desired.

5.5.8.2 The absence of detected pGSR particles does not preclude the association of (sample source) with the discharge of a firearm.

5.5.8.3 Victims of a gunshot-related injury can have particles of pGSR present.

5.5.8.4 Published studies have shown that residue from certain fireworks, brake pads, air bag detonators, or percussion grenades can contain pGSR-like particles. However, there are typically elemental indicators that exclude these particles from being identified as pGSR.

5.5.8.5 Law enforcement officers, active duty military personnel, hunters, or firearm enthusiasts could be a source of pGSR.

5.5.8.6 Secondary and tertiary transfers are possible. However, the frequency of these occurrences is currently unknown.

5.5.8.7 pGSR is not specific to a particular firearm or ammunition.

5.6 Remarks/Additional Information that can be included in the report. Specific references for a topic are listed in Section 6.

5.6.1 Primary Transfer Considerations: Factors that can influence the number of particles deposited or influence the lack of particles if known that the subject discharged a firearm.

5.6.1.1 Formation: (**17, 21, 22, 24, 26, 27, 30**)

5.6.1.1.1 Type of firearm.
5.6.1.1.2 Physical condition of firearm.
5.6.1.1.3 ~~5.6.1.1.3~~ Caliber of firearm.
5.6.1.1.4 ~~5.6.1.1.4~~ Type of ammunition.

5.6.1.2 Deposition: (**1-4, 10, 11, 16, 20, 23, 27, 28**)

5.6.1.2.1 Amount of pGSR present.
5.6.1.2.2 Number of rounds fired.
5.6.1.2.3 Proximity to a discharging firearm.
5.6.1.2.4 Time of discharge to time of collection.
5.6.1.2.5 Physical barrier preventing deposition of pGSR (gloves, hands in pockets, etc.)

5.6.1.2.6 Environmental conditions (wind, rain, etc.).

5.6.1.3 Retention: (**11, 18, 19, 27, 28**)

5.6.1.3.1 Washing/wiping of hands.

5.6.1.3.2 Excessive perspiration.

5.6.1.3.3 Blood on hands.

5.6.1.3.4 Activity of subject.

5.6.1.4 Collection: (**8, 29**)

5.6.1.4.1 Condition of sampling surface being tested.

5.6.1.4.2 Proper training of collection personnel.

5.6.1.5 Analysis Factors

5.6.1.5.1 As the test methods do not represent an exhaustive search of the sample, it is recognized that not all particles will be detected.

5.6.1.5.2 Limit of detection.

5.6.1.5.3 Performance of SEM/EDS system.

5.6.1.5.4 Presence of material on adhesive surface of sampling device that is obscuring pGSR.

5.6.2 Secondary Transfer Considerations: Factors that can influence the number of particles deposited or influence the lack of particles if known that the subject did not discharge a firearm (**5-7, 12, 13, 15, 25**).

5.6.2.1 Being in physical contact with an individual who has recently discharged a firearm.

5.6.2.2 Being in physical contact with an inanimate object that has recently been in contact with a discharged firearm.

5.6.2.3 Wearing an item of clothing that has been in proximity to or in contact with a discharged firearm.

5.6.3 Tertiary Transfer Considerations: Factors that can influence the number of particles deposited or influence the lack of particles if known that the subject did not discharge a firearm (**14, 15**).

5.6.3.1 Being in physical contact with an inanimate surface that was recently in contact with an individual who discharged a firearm.

5.6.3.2 Being in physical contact with an individual who was recently in contact with an individual who discharged a firearm.

6.0 References

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