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Indoor Pyrotechnics – A Brief Cautionary Message

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The forensic science community has had a long-standing interest in the analysis of the residues deposited after the deployment of devices whose operation involves a controlled explosion. For example, testing for the residues of the compounds of lead, barium, and antimony, used in the primer of small-arms ammunitions, may be required on the hands and clothing of individuals to determine whether they may have discharged, or otherwise had contact with, a firearm. As an extension of research in the area of gunshot residue analysis, recent work dealing with the examination of residues from various pyrotechnic devices [1–3] has revealed some trends in the chemical composition of the residues of pyrotechnic devices. A survey of the composition of the starting components and residues from 150 small, consumer grade pyrotechnic devices purchased in the United States revealed that more than 30% of the devices contained some proportion of lead, 5% contained antimony, and 80% contained barium.[3] These devices included fountains, wheels, and ground spinners that are likely to be used in family fireworks displays in close proximity to the spectators.

An examination of 18 consumer grade pyrotechnic devices, manufactured around the world and submitted for testing prior to acceptance for marketing in Canada, revealed that more than 60% contained lead, 50% contained antimony, and more than 75% contained barium.[24] Further, another device, designed for use as a proximate audience item and marketed as appropriate for indoor use, was found to contain lead, barium, and antimony.[2,4]

Many of the products of combustion of pyrotechnic devices will be released as gasses rather than particulates (i.e., smoke), and the method for residue analysis used in this study does not permit a conclusion regarding what proportion of the starting material consisted of heavy metals, but the widespread finding of lead in these devices, particularly in a device designated for indoor use, is a concern.

The particular item designated for indoor use is apparently no longer being sold, so the primary concern is not the current use of these items by unsuspecting pyrotechnists.[5] Rather the concern is that some suppliers have sold (and possibly still are selling) items for indoor use, without knowing whether their chemical ingredients are suitable for indoor use.

As Canadian regulations do not permit the use of lead in indoor devices, it is unlikely that any domestic manufacturer would declare a product containing lead compounds as appropriate for indoor use.[6] Lead has been observed in devices from a number of countries in the world and it is possible that the specific item in this instance was manufactured abroad and only repackaged and labeled in the US.

This occurrence serves as a reminder to importers of proximate audience pyrotechnics intended for indoor use that regulations on the composition of pyrotechnic devices are not universal and that they have a responsibility to verify whether or not the products of combustion from those items are reasonably safe and in compliance with local regulations.

Notes and References

1) P. V. Mosher, M. J. McVicar, E. D. Randall, E. H. Sild, **"**Gunshot Residue-Similar Particles Produced by Fireworks", *Canadian Society of Forensic Science Journal*, Vol. 31, No. 2, 1998, pp 157–168.

2) M. J. McVicar, "Gunshot Residue-type Particles Produced by Consumer-Grade Fireworks", presentation at the Canadian Soci-

ety of Forensic Sciences 47th Annual Meeting, Ottawa, Ontario, 2000.

3) M. Trimpe, "Analysis of Fireworks for Particles of the Type Found in Gunshot residue (GSR)", presentation at the American Academy of Forensic Sciences 53rd Annual Meeting, Seattle, Washington, 2001.

4) Residue particles from this device were identified using an automated scanning electron microscope operated in backscatter imaging mode. This mode allows the system to screen out organic debris particles and light elements, such as carbon, sulfur, aluminum, etc., to search for the presence of heavier elements. Using energy dispersive X-ray spectroscopy (EDS), a total of approximately 9200 particles were analyzed for the chemical elements they contained. Of these particles, it was found that a little over 25% of them consisted of lead, antimony, barium, or some combination thereof. Lead particles accounted for the majority of this group of particles.

5) As some pyrotechnists might have some of these items in their inventories, note that the item was labeled as "Glittering Crackle Mine". If they wish, anyone having items with this name may contact author Kosanke at 970-245-0692 for further identifying information.

6) In the US, according to NFPA-1126 (*Standard for the Use of Pyrotechnics before a Proximate Audience*), responsibility for deciding what chemical compositions are acceptable for use in indoor proximate audience pyrotechnics is left with the manufacturer (or importer). However, approval of indoor proximate audience pyrotechnic devices for transportation is facilitated by a manufacturer following the requirements of APA 87-1 (Standard for Construction and Approval for Transportation of Fireworks, Novelties and Theatrical Pyrotechnics), which does not include lead compounds on the list of Standard Fireworks Chemicals. The effect is that an indoor pyrotechnic device using a lead compound requires a more costly and involved method to obtain approval for transportation. The net result is that, while the use of lead compounds in indoor proximate audience pyrotechnics in the US is not expressly prohibited, it is discouraged.