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As Defined by Regulation, What Is Fireworks Flash Powder?

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Although widely used, the term "flash powder" is poorly defined; there is nothing even approaching universal agreement about exactly which pyrotechnic formulations are and are not fireworks flash powders. This would be of some concern under any circumstance; however, it is the use of the term—flash powder—in regulations that greatly magnifies the problem. One might expect that an agency choosing to use the term "flash powder" in their regulations would have a responsibility to provide a reasonably precise definition for it; if not providing a generally applicable definition, then at least a definition for use within the context of the regulations. Unfortunately, this is not the case. Consider the definition published by of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF or BATFE), the primary regulating authority for the manufacture, storage and use of explosives in the US:

> *55.11 Meaning of terms. Flash Powder. An explosive material intended to produce an audible report and a flash of light when ignited, which includes but is not limited to oxidizers such as potassium chlorate or potassium perchlorate, and fuels such as sulfur and aluminum.*[1]

Note that this definition depends on the "intended" use of the material. This leads one to ask, "intended by whom"; presumably that is the possessor of the pyrotechnic composition (i.e., its maker or the user of the composition). Thus if the possessor of a pyrotechnic composition intends that it be used to "produce an audible report and a flash of light" (and meets the general ingredient requirements) then it is a flash powder. Conversely then, if another possessor of a composition of the **same** formulation does **not** intend it to produce an audible report and a flash of light, then by this definition it must logically be concluded that the composition is **not** a flash powder under ATF regulations. Obviously this is a problem, one should not need to look into the mind of the possessor to determine whether something is a flash powder or not. There should be some objectively quantifiable characteristic (or set of characteristics) that definitively establishes whether something is or is not flash powder, at least for the purpose of regulation.

In the ATF's definition, even if "intended to produce" was replaced with "capable of producing", that does not really solve the problem. This is because just about any pyrotechnic composition is capable of producing an audible report and a flash of light under some set of conditions. For example, consider a Black Powder maroon; upon functioning, this certainly produces both "an audible report and a flash of light", yet it is most doubtful that anyone would classify Black Powder as a flash powder.

It is useful that the ATF provides, to some extent, additional guidance elsewhere in their regulations that further defines the nature of flash powder. The ATF includes flash powder as one example in a list of high explosives.[2]

> *55.202 Classes of explosive materials. (a) High Explosives. Explosive materials which can be caused to detonate by means of a blasting cap when unconfined, (for example dynamite, flash powders and bulk salutes).*[1]

Note that the ATF does not qualify their inclusion of flash powders as high explosives, such as by saying some, many, or most flash powders are high explosives. Accordingly, the ATF has established another necessary condition for a pyrotechnic composition to qualify as a flash powder under their regulations. In addition to the pyrotechnic composition being "intended to produce an audible report and a flash of light", it must also be a high explosive (i.e., it "can be caused to detonate … when unconfined"). Unfortunately, the only way to determine whether or not a pyrotechnic composition detonates when unconfined (i.e., whether or not the pyrotechnic composition qualifies as a flash powder[5]) is to perform a fairly difficult (i.e., expensive) test. There is another point that needs to be considered regarding the performance of a detonation test, specifically, what is the quantity of material being tested. Consider the following pyrotechnic composition generally rec-

ognized to be a flash powder, a composition with 70% fine grained potassium perchlorate and 30% pyro-aluminum. In relatively small quantities, when unconfined this composition will burn without producing an explosion, and if there is no explosion, it certainly did not detonate. Logically then, such small quantities of this composition must not be a flash powder, even though larger quantities of this same composition might be shown to be capable of detonating when unconfined.[2]

If one seeks additional guidance from other authoritative sources regarding an objectively quantifiable definition of flash powder, little if any additional information is found. For example, in their training materials, the Pyrotechnics Guild International uses the definition,

> *Flash Powder. Explosive composition intended for use in firecrackers and salutes. Flash powder produces an audible report and a flash of light when ignited.*[9]

In their fireworks construction standard, the American Pyrotechnic Association does not use the term flash powder. They define two terms "explosive composition" and "pyrotechnic composition". Of these two terms, fairly clearly flash powder is included within the definition of explosive composition.

> *2.6.1 Explosive Composition. Any chemical compound or mixture, the primary purpose of which is to function by explosion, producing an audible effect (report) in a fireworks device.*[10]

Both of these definitions still require one to consider the use to which a pyrotechnic composition will be put, in addition to one or both, producing a flash of light and a report. Unfortunately, none of these definitions provide an objectively quantifiable measure that can be used to establish whether a given pyrotechnic composition is or is not flash powder.

A second article has been prepared addressing the subject of what is flash powder.[11] That follow-on article considers some technical issues relating to the production of "an audible report and a flash of light". It also suggests an approach that might be taken to provide an objectively quantifiable and relatively easy way to determine which pyrotechnic compositions are and which are not fireworks flash powders.

References and Notes

1) Federal Explosives Law and Regulations, ATF p 5400.7 (09/00).

2) Note that one can make the case that there is a lack of research identified by the ATF to support their assertion that flash powders are high explosives.[3] In fact, the most recent and comprehensive published research concluded that the flash powders that were tested (including the most common flash powder formulation) do not detonate and are not high explosives.[4] Nonetheless, for the purpose of the discussion in this article, the ATF's declaration that flash powder is a high explosive will be accepted.

3) K. L. Kosanke, "ATF's Classification of Flash Powder", *Fireworks Business*, No. 158, 1997; also in *Selected Pyrotechnic Publications of K.L. and B.J. Kosanke, Part 4 (1995 through 1997)*, Journal of Pyrotechnics, 1999.

4) A. Hahma, "On the Deflagration of Al – $KClO_4$ – Mixtures", *Proceedings of the 3rd International Symposium on Fireworks*, 1996.

5) One of the universally accepted laws of logic is that, if a premise is true, then the contrapositive[6] of that premise is also true.[7, 8] Applying this logic law to the quoted text from the ATF regulations, if it is true that flash powders are high explosives, then any pyrotechnic composition that is **not** a high explosive must **not** be a flash powder.

6) "To form the contrapositive of a given proposition we replace its subject term by the compliment of its predicate term and replace its predicate term by the compliment of its subject term."[7]

7) I. M. Copi, *Introduction to Logic*, 6th ed., 1982.

8) J. G. Kemeny, J. L. Snell, and G. L. Thompson, *Introduction to Finite Mathematics*, 3rd ed., 1974.

9) *Display Fireworks Shooter Certification Study Guide*, Pyrotechnics Guild International, 2003.

10) *Standard for the Construction and Approval for Transportation of Fireworks, Novelties,*

and Theatrical Pyrotechnics, American Pyrotechnic Association, APA 87-1, 2001.

11) K. L. Kosanke and L. Weinman, "From a Technical Standpoint, What is Flash Powder?", *Fireworks Business*, No. 246, 2004; also in *Selected Pyrotechnic Publications of K. L. and B. J. Kosanke, Part 7 (2003 and 2004)*, Journal of Pyrotechnics, 2006.

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An Interesting New Design???

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It is difficult to argue that the quality of Chinese fireworks has not improved greatly over the past 25 years. However, that is not to say that on occasion, one still does not encounter quality related problems, sometimes so extreme that it is hard to believe. The photo in Figure 1 is of a 3-inch (75-mm) aerial shell and is such an example. (The authors encountered this shell several years ago, while working briefly in Australia.) Based on the location of the shell's cross-matched time fuse and suspender ring, the lift cup has clearly been attached to the side of the aerial shell. One might suspect that this was an attempt at a cleaver new design, were it not for the fact that this shell would not fit into a 3-inch mortar, and that the other 71 shells in the case had been constructed normally. Before seeing this shell, who would have believed that such an incredibly obvious error could ever have been made by a worker attaching lift cups, and if made, how could it have escaped the notice of the worker packaging shells to make it through any quality control process!

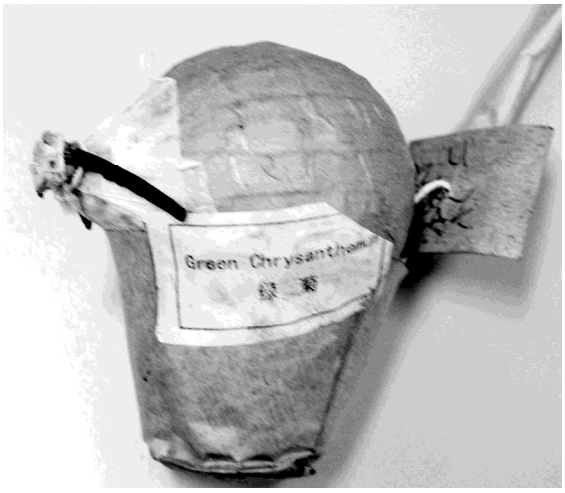

Figure 1. Photograph of one uniquely constructed 3-inch (75-mm) aerial shell.