

	EXP-PM 2.1 Low Explosives Introduction & Information	
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	Document Manager: Cheryl Lozen	Approved By: Ryan Larrison

2.1.1 Introduction

Low explosives are energetic materials that produces an explosion through a deflagration process, in which the reaction is propagated through the unreacted material by the rapid spread of flame and hot gas. Reaction velocities of low explosives tend to be less than 1,000 m/s.

Common types of low explosives include but are not limited to: Black Powder, Pyrodex/Triple Seven (or other black powder substitutes), Smokeless Powder, Flash Powder and ANFO/slurries/emulsions.

The following procedures are applicable to both intact and post blast residues but can also be applied to bulk and trace amounts of intact explosives that may be recovered from potential suspects or suspect's location.

2.1.2 Safety Considerations

Members of the bomb squad shall open any containers such as pipes, bottles and large firecrackers suspected of holding low explosive powders.

Use small amounts of unburned/unreacted powders during analysis. Ignition tests should be performed in a fume hood when possible.

2.1.3 Black Powder

Composition:

- potassium (or possibly sodium) nitrate, charcoal and sulfur

Deflagration Products:

- Potassium sulfate, potassium carbonate, potassium sulfide, potassium thiocyanate, potassium hydrogen carbonate (or potassium bicarbonate), potassium nitrite, potassium thiosulfate, potassium hydrogen sulfate, sulfur, carbon

Commercially manufactured black powder is normally glazed with graphite and will be of consistent size and usually appear homogenous. If the black powder has been improvised, it will likely not be glazed and will show variation in size of the particles and may appear heterogeneous.

Black powder is generally sized by "grade". Grade refers to the particle sizes. The general size of the particles of black powder can indicate the grade as follows:

GRADE	MESH SIZE	MILLIMETERS	INCHES
Blasting	4-8	4.760 - 2.380	0.1874 – 0.0937
Cannon	6-12	4.760 – 1.680	0.1874 – 0.0661

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FG	12-16	1.680 - 1.190	0.0661 – 0.0468
FFG	16-30	1.190 - 0.595	0.0468 – 0.0234
FFFG	20-50	0.841 - 0.297	0.0331 – 0.0117
FFFFG	40-100	0.400 - 0.149	0.0157 – 0.0059
Meal (Fuse)	100-200	0.149 - 0.074	0.0059 – 0.0029

2.1.4 Pyrodex, Triple Seven and other black powder substitutes

Pyrodex

Composition:

- potassium nitrate, potassium perchlorate, sulfur, sodium benzoate, cyanoguanidine, charcoal

Deflagration products commonly encountered:

- potassium sulfate, potassium chloride, potassium carbonate, potassium sulfide, potassium thiocyanate, potassium hydrogen carbonate (potassium bicarbonate), potassium nitrate, potassium chlorate, potassium thiosulfate, potassium hydrogen sulfate, sulfur, carbon

Triple Seven

Composition:

- potassium nitrate, potassium perchlorate, sodium benzoate, cyanoguanidine, sodium 3-nitrobenzoate and charcoal.

Deflagration Products commonly encountered:

- Potassium chloride, potassium carbonate, potassium hydrogen carbonate, potassium nitrite, potassium chlorate, carbon
- NOTE - - the MSDS for Triple Seven lists sulfides as one of the byproducts

Pyrodex and Triple Seven have a similar microscopic appearance which is gray lumpy granules. Upon close microscopic examination, white crystalline particles may be observed. In some instances, pale yellow crystalline particles may be observed which could indicate sulfur being present.

Many different types of black powder substitutes exist and should be considered. Many other black powder substitutes will contain ascorbic acid (Vitamin C).

Other Black Powder Substitutes

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Trade Name (year manufacture, manufacturer, major components)

- *Golden Powder* (1985, potassium nitrate and ascorbic acid)
- *Black Mag or Arco Black Mag Powder* (Arco Powder Co., 1996/1997, potassium nitrate, potassium perchlorate, ascorbic acid)
- *Black Canyon Powder* (Legend Products Corp., 1996/1997, potassium nitrate and ascorbic acid)
- *Clean Shot Powder* (Legend Products Corp., 1999, similar contents as Black Mag containing potassium nitrate, potassium perchlorate and ascorbic acid)
- *Clear Shot Powder* (GOEX Inc., 2001, potassium nitrate and cooked sugars)
- *American Pioneer Powder* (*American Pioneer Powder, Inc, 2002, potassium nitrate, potassium perchlorate and ascorbic acid*)
- *Pinnacle Replica Powder* (*GOEX Inc., 2004, potassium nitrate, potassium perchlorate and ascorbic acid*)
- *Jim Shockey's Gold* (*American Pioneer Powder, Inc., 2005, potassium nitrate, potassium perchlorate and ascorbic acid*)
- *Black Mag '3* (Arco Powder Co., 2006, re-release of Black Mag Powder, potassium nitrate, potassium perchlorate, ascorbic acid)
- *White Hots* (IMR Legendary Powders, 2011, unknown components)

2.1.5 Flash Powder (Pyrotechnic Powders)

Composition:

- Oxidizer (usually a perchlorate salt but could also be a chlorate or nitrate salt)
- Fuel (metal flake/powder such as aluminum or magnesium, sulfur, antimony sulfide and/or carbonaceous filler material)

Deflagration Products:

- Varies depending on the above components used in the composition of the powder

These powders can be commercially produced or improvised powders. Crystalline inclusions may be present and the homogeneity of the sample may indicate whether it was commercially produced or improvised.

Flash powders typically have a microscopic appearance of fine gray or metallic powder. White crystalline particles and other inclusions may also be observed in the powder.

Refer to attached [Standard Fireworks Chemicals table \(click to see attachment\)](#) (American Pyrotechnics Association (APA) - APA STANDARD 86-1)

2.1.6 Smokeless Powder

Composition:

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The composition of smokeless powders can vary but are primarily composed of the following:

- Single-based: nitrocellulose
- Double-based: nitrocellulose and nitroglycerine
- Triple-based: nitrocellulose, nitroglycerine and nitroguanidine

Additional components of smokeless powder include:

- Plasticizers (dibutyl phthalate, diethyl phthalate, dimethyl phthalate and triacetin)
- Stabilizers (ie. Diphenylamine, ethyl centralite and methyl centralite)
- Burn modifiers / Flash inhibitors (dinitrotoluene and potassium sulfate)
- Lubricant (graphite)

Deflagration Products:

- Nitrocellulose and/or nitroglycerine and/or nitroguanidine
- Note – Inorganic ions such as potassium nitrate, sodium sulfate, potassium nitrate, barium nitrate and other inorganic salts maybe used in the process of manufacturing of smokeless powder and may be present in post blast residue. Further, nitrate, sulfate, hydrogen sulfide, chloride, and nitrite may appear as a result of the reactions for treating the cellulose to obtain nitrocellulose

These powders normally will have specific shape such as (but not limited to): disc, perforated disc, ball, flattened ball, rod/cylinder, tube, lamel, clump, irregular flake. Some also include color such as a red dot on the flakes contained in Hercules Red Dot and a green dot on the flakes within Hercules Green Dot. Smokeless powders may or may not be glazed.

2.1.7 Blasting Agents, Slurries, Emulsions

This class primarily includes blasting agents (BA), water gels (slurries), and emulsions. Most of these contain ammonium nitrate as the oxidizing agent which is combined with a fuel. A sensitizer may be present.

Blasting agents (BA) are typically composed of **ANFO** (Ammonium Nitrate and Fuel Oil). A typical mixture is 94% Ammonium Nitrate and 6% Fuel Oil.

The fuel is typically a petroleum distillate such as diesel fuel or kerosene, nitro-methane (in binary explosives), aluminum, or a high weight molecular oil or wax.

A sensitizer is typically an amine salt such as monomethylamine nitrate, ethylene diamine, hexamine nitrate or microballoons. Microballoons may be composed of either plastic or glass.

Usual Composition:

Fuel

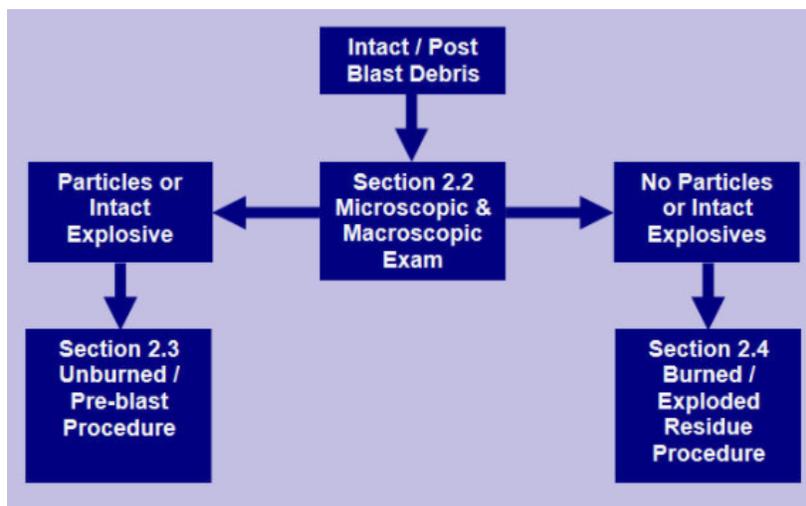
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- Petroleum distillate (diesel fuel in ANFO), nitromethane (Binary), aluminum and high molecular weight oil/wax

Sensitizer

- Typically amine salt (monomethylamine nitrate, ethylene diamine dinitrate or hexamine nitrate) or microballoons

2.1.8 Analysis Flow Chart



2.1.9 References

[ASTM E2998-16 Standard Practice for Characterization and Classification of Smokeless Powder](#)

Goodpaster J. and Keto, R., "Identification of Ascorbic Acid and Its Degradation Products in Black Powder Substitutes", JFS May 2004, Vol. 49, No. 3, pg 523 – 528

Fadala, Sam, "Blackpowder Loading Manual, Expanded 4th Edition", 2004, ISBN: 0-87349-574-8

Heramb, Robert M. and McCord, Bruce R., "The Manufacture of smokeless Powders and their forensic Analysis: A Brief Review", forensic Science Communications, April 2002 – Volume 4 – Number 2

[Pyrodex Identification](#) - Analysis flowchart example - U.S. DoJ F.B.I. Instrumental Analysis of Explosives and Explosives Residues course

[Low Explosives Pre-combustion Formula and Combustion Products and Residues chart](#) - ATF document - from U.S. DoJ F.B.I. Instrumental Analysis of Explosives and Explosives Residues course

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[Common Low Explosives by Composition and Expected Inorganic Residue chart](#) - U.S. DoJ F.B.I.
Instrumental Analysis of Explosives and Explosives Residues course