

## ANALYSIS OF UNEXPLODED ORDNANCE (HIGH EXPLOSIVES)

High explosives can be broken down into four categories:

- Organic high explosives, such as RDX, PETN, TNT and HMX
  - Dynamite
  - Blasting agents, slurries, and emulsions
  - Primary (initiating) high explosives
- A. *Organic high Explosives* are primarily nitroaromatics (TNT), nitramines (RDX), or nitrate esters (NG, PETN). They can be found as free flowing crystalline powders (PETN in detonating cord), solid case material (TNT booster), homogeneous mixtures (RDX and TNT in “military dynamite”) or in an organic matrix (RDX in C-4). The following tests are used to identify the explosive in question:
- Visual / Microscopic Appearance - Describe color, consistency, and general physical appearance.
  - Chemical Analysis - The sample is analyzed by FTIR, XRD, GC/MS, or TLC with appropriate confirmatory analysis.
  - Matrix or Binder - When appropriate, the polymeric matrix and/or plasticizer (binder) should be identified by using FTIR or GC/MS
- B. *Dynamites* are considered only those formulations containing any combination of the organic nitrate esters NG, EGDN, MTN and DEGDN. In addition to the ingredients listed, common commercial dynamites contain carbonaceous filler material, inorganic oxidizing agents such as ammonium and sodium salts, and in some instances sulfur, nitrocellulose, salts or microballoons. the following tests are used to identify the xplosive in question:
- Visual / Microscopic Appearance - Describe color, consistency, presence of prills, sulfur particles and fillers.
  - Chemical analysis - Nitrate esters are confirmed by an organic solvent extract by GC/MS or TLC with appropriate confirmatory analysis.
- C. *Blasting Agents, Slurries and Emulsions* include ANFO, binary explosives, watergel, emulsions and a number of other explosives. The majority of these contain ammonium nitrate as the oxidizing agent combined with a sensitizer and/or fuel. The following tests are used to identify the explosive in question:
- Visual / Microscopic Appearance - Describe color, consistency and general physical appearance.
  - Chemical Analysis - The identification of the inorganic oxidizing agent(s) is confirmed by the use of SEM/EDAX, CE, XRD and spot tests with appropriate confirmatory analysis. The identification of the sensitizer, if present, is typically an amine salt (such as ethylene diamine dinitrate, monomethylamine nitrate or hexamine nitrate), aluminum powder or microballoons. The identity of the amine salt is established using a chromatographic or appropriate instrumental analysis (TLC, GC/MS and CE with appropriate confirmatory analysis). The identification

of the fuel (typically a petroleum distillate such as diesel in ANFO, nitromethane in binary explosives or a high molecular weight oil or wax), if present, is identified by FTIR or GC/MS.

D. The primary high explosives are shock, flame and friction sensitive materials typically composed of styphnates, azides, or fulminates, organic diazo compounds (diazodinitrophenol), HMTD, TATP, or other organic peroxides. the following tests are used to identify the explosive in question:

- Visual / Microscopic Appearance - Describe color and general physical appearance.
- IST (Ignition Susceptibility Test) - When appropriate, a VERY small particle is ignited and the burning characteristics are described.
- Chemical Analysis - FTIR or XRD is sufficient to identify most primary explosives. In some situations a chromatographic or second appropriate instrumental analysis (TLC or XRF) may be required. Mass spectrometry is useful for peroxide explosives. In cases involving unusual or novel explosives where reference materials are not available, additional examinations may be necessary to fully characterize the material.