Explosives Composition Report

1. Amatol

Amatol is a mixture of Ammonium Nitrate (see below) and Trinitrotoluene (see below) in the ratio of 80/20 percent. It is a highly efficient explosive that has a price advantage in its manufacture. Amatol has all the properties of both of its constituents. Health concerns are the same as for both chemicals.

2. ANFO (Ammonium Nitrate/Fuel Oil)

This explosive is a mixture of 94% Ammonium Nitrate and 6% Fuel Oil (or Diesel). It is an extremely powerful explosive that gives of large quantities of nitrous fumes in the form of Nitrous Oxide. This explosive must be initiated using Detonating Cord (see below) or Gelignite or some other Nitroglycerine based explosive. Ammonium Nitrate can be further enhanced to improve its insensitivity with Kieselguhr (Diatomaceous Earth) thus making a much safer product. Ammonium Nitrate is now being mixed with other chemicals to produce new ANFO like explosives. Examples of these chemicals are TNT-Water or Ammonium Nitrate/Molasses/Water to form slurry type explosives that flow easily into blast holes.

Inhalation: (for Ammonium Nitrate)

May cause irritation to the respiratory tract; symptoms may include coughing, sore throat, and shortness of breath. At high temperatures, exposure to toxic Nitrogen Oxides decomposition products can quickly cause respiratory problems. Inhalation of large amounts causes systemic acidosis and abnormal hemoglobin.

Ingestion: Large oral doses of nitrates may cause dizziness, abdominal pain, vomiting, bloody diarrhoea, weakness, convulsions, and collapse. Harmful if swallowed. May cause methemoglobinemia resulting in cyanosis.

Skin Contact: Causes irritation to skin. Symptoms include redness, itching, and pain.

Eye Contact: Causes irritation, redness, and pain.

Chronic Exposure: Small repeated oral doses of nitrates may cause weakness, depression, headache, and mental impairment.

3. ASA Mixture

ASA is a mixture of Lead Azide, Lead Styphnate and Aluminium Powder. This combination is extremely sensitive being about 50 times more sensitive than TNT. It is used as an initiating explosive to fire larger and stronger explosive products. A long and convoluted chemical process involving Sodium metal, Ammonia, Nitrous Oxide and Lead Acetate is used to manufacture Lead Azide. The resultant chemical is very sensitive and is modified with Lead Styphnate to make it more stable. Aluminium powder is added to increase the temperature of the initiated explosion to ensure a flame hot enough for a complete detonation of the main explosive. ASA may have graphite mixed with it to increase sensitivity.

Health Hazard Data for Lead Azide.
Health hazard acute and chronic: acute: eyes: may cause irritation, possible corneal injury. Skin: may cause irritation & dermatitis. Inhalation: may cause nasal & respiratory irritation. Ingestion may cause fatal poisoning. Toxicity of Lead Azide has been linked to Azomide radical as well as presence of Lead. Major symptoms of Azide poisoning are severe hypotension & paralysis. (effects of overexposure). Signs/Symptoms of Overexposure are symptoms of lead poisoning including loss of appetite, anaemia, sleep disorders, & fatigue. Lead appears on the US Navy Occupational Chemical Reproductive Hazard List. Consult appropriate health professionals concerning latest hazard list information & safe handling & exposure information.

Signs, Symptoms and Effects of Exposure to Lead Styphnate
Inhalation Acute: May cause irritation to nose, throat, upper respiratory tract and lungs. The irritant effects may lead to bronchitis. Headache, a fall in blood pressure, weakness, convulsions, and collapse may occur. Severe poisoning may impair vision by damaging the optic nerve. Chronic: Inhalation may cause damage to central and peripheral nerves, blood, kidneys, and the foetus. Male reproductive function may be impaired. Damage to nerves can result in reduction in motor nerve and muscle function. Anaemia may result due to interference by lead of haemoglobin synthesis. Lead has been identified as an animal carcinogen; it may produce cancer in humans. Chronic exposure may lead to lead poisoning, known as "Plumbism", causing gingival lead line and an accumulation in body tissues.
Skin Acute: Irritation. Although highly unlikely, this material can be absorbed through the skin to produce effects similar to those listed for acute inhalation exposure. Chronic: The effects would be similar to those listed under chronic inhalation exposure.
Eye Irritation with conjunctival redness and discharge. There are no reports of permanent damage from exposure directly to the eye.
Ingestion Acute: The effects would be similar to those listed under acute inhalation exposure in addition to gastrointestinal tract irritation. Chronic: The effects would be similar to those listed under chronic inhalation exposure.

Medical Conditions Aggravated by Exposure to Lead Styphnate
Anaemia, cardiovascular and respiratory disease
Acute Target Organ Toxicity: Damage to central nervous system, blood, lungs and eyes.
Chronic Target Organ Toxicity: Inhalation of lead can cause damage to the blood, central and peripheral nervous systems, and kidney. Lead inhibits the production of haemoglobin, the material in the blood that carries oxygen. Anaemia may result. Lead also causes damage to peripheral nerves resulting in a decrease in motor nerve and muscle function.
Reproductive and Developmental Toxicity: Lead has been shown to affect foetal development and reduce male reproductive function. Lead crosses the placenta and may affect the foetus causing birth defects, mental retardation, behavioral disorders, and death during the first year of childhood.

4. CE (Composition Explosive)

CE is an explosive that is used as an intermediary between the detonator and the main charge. It is used to boost the shockwave of the detonator so that it will initiate the more insensitive explosive. CE is Coal Tar based explosive via Nitro-Benzene and Aniline. Its chemical name is N-Nitro-N-Methyl-2,4,6-Trinitraniline, known as Tetryl. It is made by the action of Nitrating acid on a solution of Dimethyl Aniline in concentrated Sulphuric Acid.

Effects on Humans:

Tetryl is a potent skin sensitizer, a respiratory sensitizer, and an irritant of the skin and upper respiratory tract in humans. Tetryl is also toxic to the liver and blood on chronic exposure. Initially, Tetryl produces acute irritation of the nasal and pharyngeal mucous membranes, with coughing and nosebleeds; however, in some instances, these effects may not occur until as late as the third month of workplace exposure [ACGIH 1986, p. 568.1(88)]. Irritation may progress to itching, swelling, redness, and oedema of the eyelids, nasal folds, cheeks and neck; papules and vesicles may also develop. The severest form of sensitization dermatitis may involve massive generalized oedema with partial obstruction of the trachea caused by swelling of the tongue [Hathaway, Proctor, Hughes, and Fischman 1991, p. 541]. Most of these effects occur between the 10th and 20th days of exposure, and removal from exposure leads to rapid abatement of mild symptoms and, after 3 to 10 days, disappearance of physical signs [Hathaway, Proctor, Hughes, and Fischman 1991, p. 541]. In some workers, exposure to Tetryl dust has caused asthma-like symptoms of severe coughing; in such cases, removal from exposure is necessary [ACGIH 1986, p. 568.1(88)]. Chronic exposure to unspecified concentrations of Tetryl causes systemic poisoning that is manifested as digestive disorders, chronic hepatitis, and central nervous system irritation [Hathaway, Proctor, Hughes, and Fischman 1991, p. 541]. Anaemia of either the marrow depression or deficiency type has also been observed in chronically exposed workers [Hathaway, Proctor, Hughes, and Fischman 1991, p. 541]. Tetryl has been reported to cause irreversible liver damage and death following heavy exposure; no cases of systemic poisoning have been reported at concentrations below 1.5 mg/m3 [Hathaway, Proctor, Hughes, and Fischman 1991, p. 541].

5. Cordite

Cordite is manufactured by mixing dried Guncotton (see below) with Nitroglycerine (see below), by hand, in a rubber lined canvas bag. The paste is then mechanically kneaded for several hours in acetone. Mineral jelly is added and the kneading repeated. This dough is then formed into the types of products required. Cordite is used, primarily, in rifle cartridges, artillery shells and solid rocket motors. When burnt they produce large quantities of Carbon Dioxide, Carbon Monoxide, Steam, Nitrogen and Oxides of Nitrogen. Some of these chemicals recombine to form Nitrogen Peroxide. Small quantities of Vaseline and Diphenylamine are added to stabilise Cordite. Further moderants such as Camphor, Castor Oil, or wax are sometimes added to reduce the speed of the explosion.

6. Cordtex and Primacord (Detonating Cord)

Cordtex and Primacord are both names for the same product. They are essentially a tube with a core of Penta-erythri-tetranitrate (PETN)(see below). This is an extremely powerful explosive that detonates at the rate of 6500 - 7000 metres per second. The casing (or tube) is made from an inner core of textile braid followed by a plastic (Polyethylene) jacket. Wrapped around this is another close woven textile casing.

7. Fulminated Mercury

Mercury Fulminate is a salt of an organic acid. It is used in cap compositions for the ignition of propellants and in detonators to initiate explosive charges. Mercury Fulminate is prepared by dissolving Mercury in concentrated Nitric Acid and pouring the warm solution into Alcohol. When the chemical reaction ceases grey crystals of Mercury Fulminate will settle out. When dried these crystals are very sensitive to shock, heat, friction, electric spark or when contacted by other chemicals, particularly metals.

8. Gelignite and Derivatives

Gelignite and its derivatives are a mixture of Nitroglycerine, Collodion or Gun Cotton, Potassium Nitrate, Wood Meal, Sodium Carbonate and Kieselguhr (Diatomaceous Earth). Dynamites are basically the same products made by different manufacturers. AN Gelignite has the Potassium Nitrate replaced by Ammonium Nitrate. Similarly SN Gelignites have Sodium Nitrate in place of the Potassium Nitrate. To take into account the freezing aspects of Gelignite (the Nitroglycerine becomes more sensitive) other antifreeze chemicals are added. These include Nitroglycol, Diglycerine Tetranitrate and some Nitrotoluenes.

Effects of overexposure to Gelignite and its derivatives

Ingestion, inhalation or absorption through skin contact may cause headache, nausea, blood vessel dilation, vomiting and convulsions. In extreme cases, death may occur. Gelignite is a slight irritant to the skin and eyes. If ingested, medical advice should be sort if persistent headaches or chest pains occur. The Nitric Esters are coronary vasodilators.

9. Guncotton (Wet & Dry)

Guncotton is made chiefly from cotton waste, a by-product of cotton spinning mills. The cotton is cleaned with Coal Tar Benzene and successively treated with alkaline, bleaching and acid liquors. The cotton is then nitrated using a very strong Nitric Acid bath. When the reaction stops in the nitrating bath, the cotton is removed and cleaned thoroughly with a water bath. The newly formed guncotton tends to be unstable. It is further boiled in water to increase its stability. This is wet Guncotton and must be kept moist.

Dry Guncotton is fairly sensitive and must be handled with due care. It is used extensively in torpedoes and mines, both aerial and naval. However, it is being replaced by more stable explosives in these applications.

10. Nitrocellulose

Nitrocellulose is very similar to Guncotton. However the degree of Nitrating is not to the same extent. It therefore contains a mixture of Cellulose Trinitrate (Gun cotton) and Cellulose Dinitrate (Collodion cotton). The chemical mixture does not explode, but burns very fiercely producing a large amount of gas in the form of Carbon Dioxide, Carbon Monoxide and Oxides of Nitrogen. It is commonly used in military applications for ammunition in small arms, larger calibre weapons and special engine starting cartridges.

11. Nitroglycerine

Nitroglycerine (or more correctly Glyceryl Trinitrate) is made from slowly pouring Glycerine into a prepared bath of concentrated Nitric and Sulphuric Acids. This product is the basis of most of the military and commercial explosives in use today. Nitroglycerine is very poisonous if taken internally. Contact with the skin or by inhalation will result in a "fracteur headache", a very severe form of Nitro-headache. The product will also cause drowsiness. Nitroglycerine is too sensitive to handle. It is, therefore, gelatinised by addition of other chemicals to desensitise it and make it safer to handle. When Nitroglycerine explodes it releases large quantities of Carbon Dioxide, Water, Nitrogen, Oxygen and some Oxides of Nitrogen.

12. PE 3 & PE4 (Plastic Explosives)

PE3 & PE4 are highly plasticised RDX (see below) based explosives. The plasticisers in the explosive consist of 80% liquid Paraffin and 20% Lithium Sterate. Added to these is 1% Pentaerthritol Diolate (Lead free). They are used in exactly the same way as Plastergel (see below). They are restricted to use by the military forces only. In addition to the properties Nitroglycerine based explosives, they are also water proof and resistant. This enables them to be used underwater. See other Nitroglycerine based explosives for any hazards or safety information.

13. PETN

Pentaerythritol Tetranitrate (PETN) is a compound commonly used industrially in the manufacture of detonating fuse and therapeutically as a vasodilator. PETN is prepared by nitration of Pentaerythritol in the presence of highly concentrated Sulphuric Acid. Chemically it is a tetragonal holohedra from Acetone plus Alcohol. It is soluble in acetone. Practically insoluble in water (1.5 /ml) and sparingly soluble in alcohol, ether. Does not reduce Fehling's solution (difference in Erythrityl Tetranitrate). Caution: Explodes on percussion. More sensitive to shock than TNT. For medicinal purposes it is diluted with an inert ingredient, usually lactose, to prevent accidental explosions. Uses are mainly in a manufacture of detonating fuse (Primacord); a waterproof textile filled with powdered PETN. Therapeutic Category: Vasodilator.

In cases where the explosive is "home made", PETN is prepared by combining Pentaerythritol (PE), Potassium Nitrate (KNO3) and Sodium Bicarbonate (baking soda) in the presence of Concentrated Sulphuric Acid (+90%)

Signs and symptoms of overexposure for PETN

Eyes: Dust will irritate.
Skin: PETN: May cause skin irritation.
Skin Absorption: Not Applicable
Ingestion: PETN: Human systemic effects by ingestion include dermatitis. Other effects are similar to nitroglycerin, for example, headaches, weakness, and fall in blood pressure. PETN is a vasodilator.
Inhalation: PETN: Effects are similar to nitroglycerin, for example, headaches, weakness, and fall in blood pressure. PETN is a vasodilator. If detonation fumes are inhaled, remove victim to fresh air. If not breathing, give artificial respiration. Seek medical attention.
Carcinogenicity: Not listed by NTP, IARC, or OSHA. Irritant: Causes irritation to skin and eyes. General Toxicity: Moderately toxic by ingestion. Vasodilator. PETN can lower blood pressure. LD50 intraperitoneal mouse dose >5 gm/kg causes arteriolar or venous dilation. TDLo oral man, 1669 mg/kg/8Y-C, dermatitis after systemic exposure.

14. Picric Acid

Picric acid was used quite extensively in aerial munitions up to 1960. From then EOD operatives have come in regular contact with this chemical. Picric Acid (common name Lyddite), or 2,4,6-Trinitrophenol is derived from the Coal Tar chemical Phenol (or Hydroxy-benzene). Because of the usefulness of Coal Tar based chemicals, Picric Acid is an explosive, a dye and was a treatment remedy for burns. Picric Acid is prepared by the mixing of Phenol in concentrated Sulphuric Acid. The resulting Suphonated Phenol is further treated with the addition of concentrated Nitric Acid. Crystalline Picric Acid is deposited, washed in cold water. The final phase is the installation of the chemical in munition casings. This phase is critical in that, should the acid come into contact with any metal, the metal salt forms and any salt of Picric Acid is extremely sensitive and libel to detonate. All munitions have to be coated on the inside with a thick layer of varnish.

Effects of Acute Exposure

Ingestion, Inhalation, Skin, Eye

Causes severe eye irritation. Causes skin irritation. May cause yellow discoloration of the skin and hair. May cause allergic skin reaction (dermatitis, eczema, oedema, desquamation, etc.). Readily absorbed through skin. Inhalation and ingestion can cause irritation to mucous membranes and upper respiratory tract. May cause coughing, fever, headache, nausea, vomiting, weakness, muscle pain, ulceration, bronchitis, nephritis, liver, kidney and blood damage, convulsions, collapse. May cause sensitization by inhalation. Toxic! Causes gastrointestinal irritation. May cause headache, nausea, vomiting, dizziness, fever, prostration, stupor, diarrhoea,

abdominal pain, hematuria, nephritis, anuria, polyuria, hepatitis, albuminuria, liver, kidney and blood damage, convulsions, collapse.

Effects of Chronic Overexposure
May cause dermatitis, skin eruptions, anaemia, diarrhoea, ulceration of the eyes, central nervous system depression (headache, nausea, vomiting, dizziness, etc.), jaundice and severe nephritis, liver, kidney and blood damage. Suspect mutagen. Carcinogenic effects: Not available. Teratogenic effects: Not available. Toxicity of the product to the reproductive system: Not available. To the best of our knowledge the chronic toxicity of this substance has not been fully investigated.

15. Powergel
A gelatinous, Nitroglycerine based explosive that has similar qualities to Gelignite and Dynamite. It has improved power over these two products and is used where a very powerful, but limited explosive is required.

16. Plastergel
This explosive is a high strength, high velocity gelatinous, Nitroglycerine based explosive very similar to Gelignite. It is used for applications where a high degree of plasticity is required. The gelatine and plasticizers are added to make it pliable and able to be moulded into any shape.

17. Quarry Monobel and Derivatives
Quarry Monobel is a non-gelatinous explosive used in the mining, particularly in quarry work. However, with their dryness they cannot be used in areas where there is moisture. It is a Nitroglycerine based explosive with most of the characteristics of Gelignite. It is, however, quite a bit less powerful than Gelignite.

18. RDX
RDX (Research Department Explosive), known as Cyclonite or Cyclomethylenetrinitramine, is an Aniline based explosive. It is regarded as a descendant of Coal, although not from Coal Tar. Cyclonite descends from Coal via Coke - Water Gas - Methyl Alcohol - Formaldehyde - Hexamine to Cyclonite. It is prepared by the action of very concentrated Nitric Acid on a white crystalline substance called Hexamine. It is an explosive of unusual power and brisance, and has been of great use in bursting charges, blasting and initiatory explosives. When detonated it gives vast amounts of Carbon Monoxide, Carbon Dioxide, Water, Hydrogen, and Nitrogen and, under certain conditions, Oxides of Nitrogen.

19. Safety Fuse (Blue and Yellow Sump)
Safety fuse is a fuse for blasting that burns rather than detonates. It does not contain it's own means of ignition, but, is of such strength and construction, and contains an explosive of such quantity that the burning of the fuse will not communicate laterally with other like fuses. The core of these fuses is black powder. Black Powder (or Gunpowder) is a mixture of Carbon, finely ground Sulphur and ground Potassium Nitrate. The burning of Black Powder produces

Potassium Sulphide, Carbon Dioxide and Nitrogen. It further produces Carbon Monoxide, Sulphurated Hydrogen, Methane, Hydrogen, potassium Carbonate and Potassium Sulphate, in small quantities. The only difference between Blue and Yellow Sump Fuse is the burning rate of the Black Powder. The black Powder is wrapped in a sleeve of cotton that is made resistant to oil and water.

20. SheetX 2

SheetX or Formex F4 is composed of PETN (see above) and Rubber (89% / 11%). It is made in sheet or plate form and is used for various anti-terrorist operations. It has the characteristic feel and looks like chewed chewing gum.

21. Semtex

This malleable, easy-to-use explosive was first made in Czechoslovakia, and its manufacture continues in the Czech Republic today, though it is by no means a major source of national income. A favorite with terrorists because it is often overlooked by X-ray machines at airports and is relatively stable, Semtex is difficult to detect using electronic chemical "sniffers." Only trained dogs seem to have any luck in detecting its weak odour. Like its American-made counterpart C-4, Semtex in and of itself is relatively harmless and can be easily handled. A blasting cap or piece of detonating cord is required to set it off. The two main components of Semtex, RDX (Cyclonite) and PETN (Pentaerythritetetranitrate) (both see above), are both powerful explosives in their own right. To these two explosives is added Rubber and Paraffin Oil to give it its malleability. .

22. Thermite

Thermite is essentially a non-explosive that is used in incendiary bombs. The bomb contains an incidental explosive charge to ignite the Thermite. This material is made from finely ground Ferric Oxide and finely ground Aluminium powder. The explosive charge disrupts a container with separated compartments of Barium Peroxide and Magnesium powder. When mixed the two chemicals spontaneously ignite producing a temperature capable of igniting the Thermite. When ignited by the explosive charge and the ignition train, the mixture gives rise to a highly exothermic reaction, the metallic Iron being liberated in an intensely hot molten condition including fuming. Large amounts of Aluminium Oxide and Iron result from the reaction.

22. Torpex 5

Torpex is a mixture of 37-41% TNT, 41-45% RDX (Cyclonite, Cyclomethylene Trinitramine) and 18% Aluminum. Torpex is attractive because of the increased explosive energy and higher detonation velocity of RDX as compared to TNT and the prolongation of the pressure wave by the aluminum. On a weight basis, Torpex is conservatively estimated to be about 50% more effective than TNT as an underwater explosive against ships. However, Torpex is more sensitive than TNT and RDX is expensive and difficult to make safely. Emissions from this explosive are basically the same as for its constituents.

References

1. Blaster's Handbook 15th Ed (1969) Du Pont de Nemours & company Inc Wilmington Delaware, USA.

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4. Explosives for Engineers 2nd Ed (1966) by C. E. Gregory University of Queensland Press St Lucia, Queensland.

5. Primacord Detonating Cord 8th printing (1963) Ensign Bickford Company Simsbury, Connecticut, USA.

6. Explosive User's Guide 3rd Ed (Rev) 1970 Imperial Chemical Industries of Australia and New Zealand Sydney.

7. Handbook of Blasting Tables (1971) Imperial Chemical Industries of Australia and New Zealand Sydney.

Other information about hazards has been taken from the Material Safety Data Sheets where they are available. Private training notes were also used to cover some of the lesser-known explosives.