(continued)

Primary explosives are generally used in electric and percussion primers (blasting caps) to start a detonation. In an electric primer, a small resistance wire (called a bridgewire) is heated by the flow of current through the wire. This ignites an ignition mix which in turn ignites the primary explosive which quickly builds to a detonation. A percussion primer operates in the same manner except impact and friction energy are used to ignite the primary explosive.

The most commonly used primary explosives are lead azide and lead styphnate. The general characteristics of these two types are listed in the Explosives Data Table of Figure 2. As noted, lead styphnate is somewhat more sensitive than lead azide due to the lower explosion temperature and higher sensitivity to impact.

Figure 2
EXPLOSIVES DATA TABLE (REFERENCE 1)

EXPLOSIVES COMPARISON CRITERIA	*PRIMARY* LEAD AZIDE	*EXPLOSIVES* LEAD STYPHNATE	*SECONDARY EXPLOSIVES* PETN	RDX	TNT	HNS
Reaction Temperature	340^{o} C*	282^{o} C *	225^{o} C **	260^{o} C **	475^{o} C **	350^{o} C **
Impact Sensitivity ***	5 inches	3 inches	6 inches	8 inches	14 inches	13 inches
Detonation Velocity	5180 M/sec	5200 M/sec	8300 M/sec	8180 M/sec	6640 M/sec	6800 M/sec
Static Discharge	.007 Joules	.0009 Joules	.06 Joules	N/A	.06 Joules	N/A

* Detonates.
** Rapid burn or deflagration if confined
*** Impact sensitivity values are based on a test using a 2 kg weight.

SECONDARY EXPLOSIVES: Secondary explosives are less sensitive to most initiation stimuli than primary explosives. The initiation of secondary explosives generally require the shock wave energy from a primary explosive. Secondary explosives will not detonate when subjected to a spark, flame, or a hot wire as will a primary explosive. Secondary explosives have the highest energy outputs of any explosive and are used for blasting, demolition, or fragmentation type applications where a high energy shock wave is desirable.

The common secondary explosives are:

- PETN (Pentaerythritol Tetranitrate)
- RDX (Cyclotrimethylenetrinitramine)
- TNT (Trinitrotoluene)
- HNS (Hexanitro stilbene)

The general characteristics of secondary explosives are compared with those of primary explosives in the Explosives Data Table of Figure 2. Even though the reaction temperature of PETN and RDX is less than lead azide and lead styphnate, the propagation of a detonation shock wave when PETN or RDX is heated to its melting point will not occur as in primary explosives. Local heating of PETN or RDX to their explosion temperature can cause a deflagration under certain confined and continuous conditions, in general however, only local melting of the powder next to the bridgewire will occur with no explosion. The effects are similar when subjected to spark, flame, or friction. A shock wave is required to reliably initiate a secondary explosive.

PROPELLANTS: Propellants differ from primary and secondary explosives in that their prime objective is to deflagrate. By deflagrating, propellants build up relatively high pressures without the presence of a higher velocity shock wave. This allows work to be performed by the pressure increase and does not cause fracturing of the containment chamber. For example, if PETN were used in a rifle, the barrel would shatter, whereas black powder burns such that the pressure buildup accelerates the bullet out of the barrel.

Examples of generally used propellants include:

- Black Powder
- Smokeless Powder
- Nitrocellulose/Nitroglycerin compositions (double based propellants)

The characteristics of propellants are described differently than primary and secondary explosives. The general characteristics of propellants are: Burn rate-which is a function of pressure. Heat of combustion-calories per gram. Force-foot pounds per pound.

A standard type of smokeless powder has the following characteristics: Burn rate-.053 inches/sec at 1000 psi. Heat of combustion-1100 calories/gram. Force-375,000 foot pounds per pound.

It is possible to cause some propellants to detonate. In general, this can occur if the propellant is subjected to a relatively high energy shock wave from a secondary explosive and when containment or reinforcement is present. Although this is an unstable condition, it must be considered in component design.