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Tech Tips

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Ignition Potential of Rifle Bullets

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In January 2013, the U.S. Department of Agriculture Forest Service's Rocky Mountain Research Station and National Technology and Development Centers performed experiments to evaluate the potential for rifle bullets to ignite organic matter after striking hard surfaces. Outdoor target shooting is often suspected as a wildfire cause, but investigators currently do not have adequate scientific data to support this conclusion. The purpose of this study was to determine if ignitions are possible under worst-case circumstances and to identify the physical process by which ignitions can occur.

Experiments were performed in an environmentally controlled indoor chamber, which simulated critical fire weather conditions. Fourteen commonly-used rifle bullets in commercial cartridges[1] with varying size and core/jacket composition (steel, lead, and copper) were fired at a hardened steel plate at a distance of 35 yards. After impact, bullet fragments were deflected into a collector box filled with oven-dried peat moss. Bullet impact and fragmentation were observed using high speed videography, and the temperature of bullet fragments in the collection box was measured using a thermal infrared camera and temperature-sensitive paint. For each bullet type, five consecutive rounds were fired at the plate, after which the peat moss was monitored to determine if smoldering ignitions were present. Experiments were replicated multiple times to evaluate repeatability, with nearly 500 rounds fired in total.

[1] Cartridges used were 7.62x54R, 7.62x51 (.308 Winchester), 7.62x39, and 5.56x45 (.223 Remington)

Ignitions were consistently observed with bullets made from steel components (core or jacket) and solid copper. Bullet weight did not affect the likelihood of ignition. Temperature measurements indicated that some bullet fragments exceeded 1,400 °F. Ignitions were most common with solid copper bullets, which produced the largest fragments. Lead core/copper-jacketed bullets were less likely to cause ignition.

When a bullet strikes a hard surface, its energy of motion (kinetic energy) is converted to thermal energy (increase in temperature) through deformation and fragmentation. The size, shape, and time of flight of fragments are important factors in their ability to transfer sufficient heat to the fuel bed to cause ignition.

The results of this study indicate that ignition from rifle bullets impacting hard surfaces is possible under critical weather conditions and with a receptive fuel bed in close proximity.

Key Points

- ❏ Rifle bullets striking hard surfaces can lead to ignition of organic material.
- ❏ Tests were performed under conditions simulating critical fire weather (100-110 °F, 7-10 percent relative humidity) and using a highly receptive fuel bed (oven-dried peat moss with 3-5 percent fuel moisture).
- ❏ Ignitions were regularly observed for bullets with steel components (core or jacket) and solid copper bullets.

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- ❏ Bullet fragments achieved temperatures of 1,200-1,400 °F.
- ❏ Very small fragments can cause ignitions and may be difficult to locate at the origin.
- ❏ Other factors, such as distance to target, target material, fuel type/moisture, and varying temperature/relative humidity have not yet been evaluated.
- ❏ Handgun ammunition, shotgun shells, or other types of ammunition were not tested.

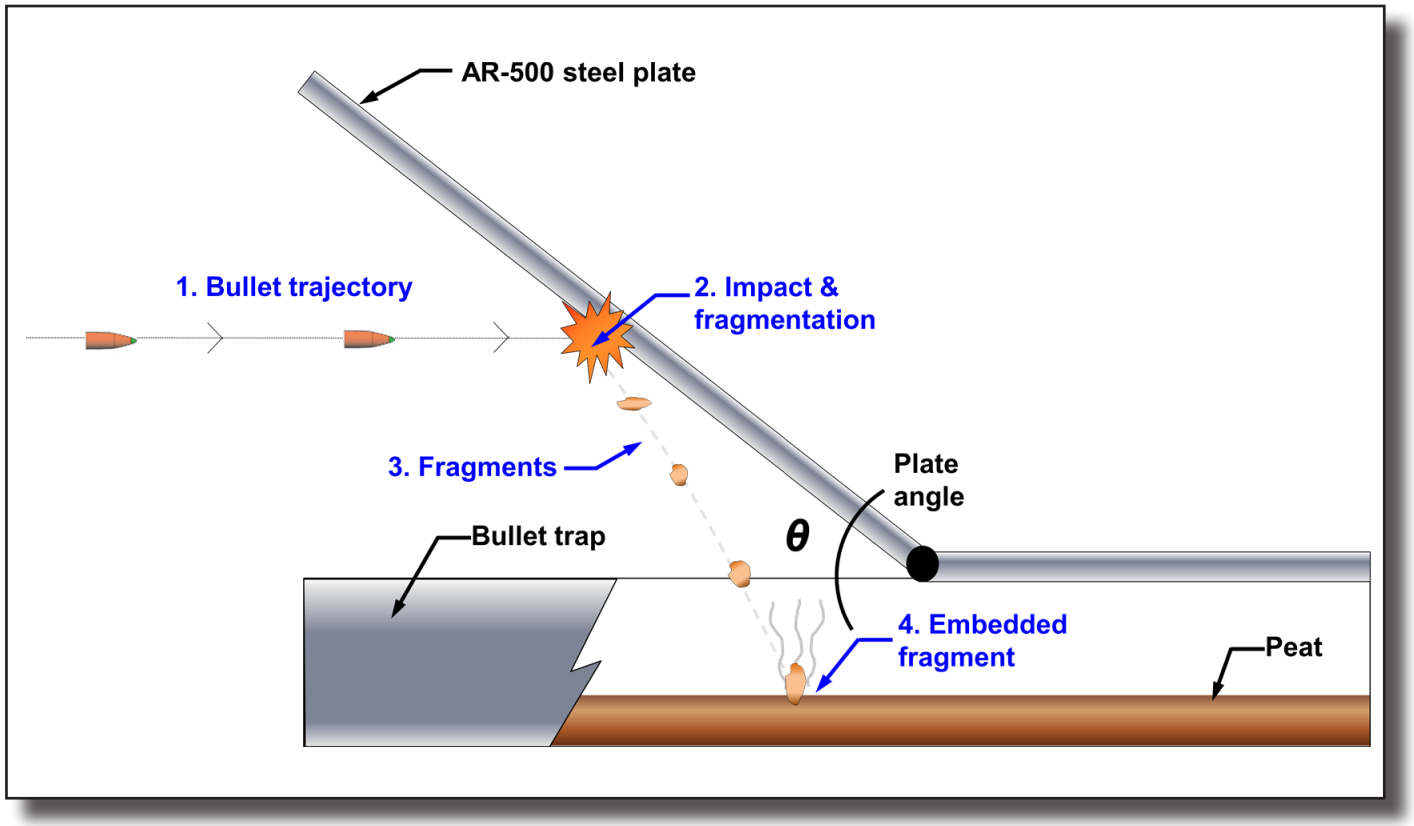

Figure 1—Experimental setup.

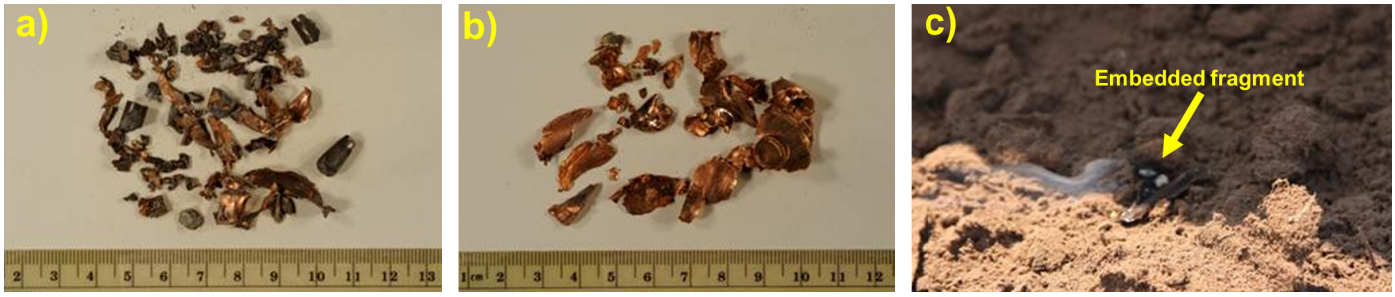

Figure 2— (a) Fragments from 7.62 by 54R steel core/steel jacketed bullet;(b) Fragments from 7.62 by 51 solid copper bullet; (c) Example of smoldering ignition from embedded bullet fragment.

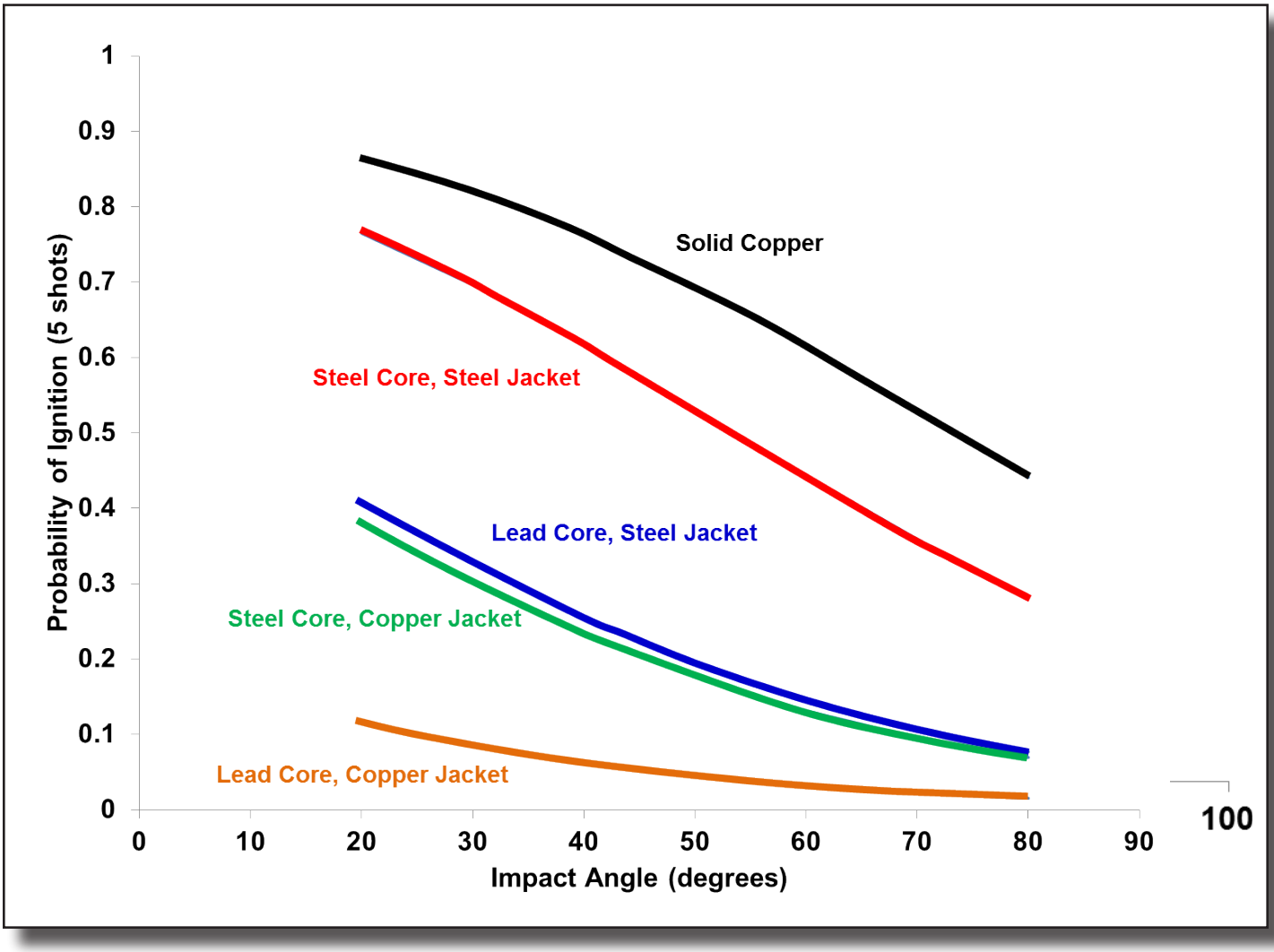

Figure 3—Probability of ignition for various bullets used in the experiment. Impact angle was varied by changing the angle of the steel plate. This probability of ignition applies only for the experiments described here.