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The Classification of Jacketed Sporting Rifle Bullets

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ABSTRACT: A twelve-parameter classification system for jacketed sporting rifle bullets that allows the examiner to gather and record systematically data that can be used to identify the manufacturer, design, weight, and cartridge loading of damaged and intact bullets is presented. The twelve parameters are an identification number, manufacturer, weight, diameter, cartridge, base design, length of bearing surface, color, shape, location and description of crimping cannelure, location and description of other cannelures, and miscellaneous notes.

KEY WORDS: criminalistics, ballistics, classifications

Jacketed sporting rifle bullets can be classified and, in many instances, identified by the use of a twelve-parameter classification system. This system allows the examiner to either estimate or positively identify the bullet's manufacturer as well as its weight, design, and, under some circumstances, the specific cartridge into which it was loaded. This information may be used to locate the vendor and purchaser of reloading components or factory-loaded ammunition and to eliminate many models of weapons because of their not being chambered for the identified cartridge. Also, the examiner can duplicate or approximate the loading in the laboratory to obtain the best exemplars for testing purposes. The twelve parameters used in this system are these:

(1) an identification number,
(2) manufacturer,
(3) weight,
(4) diameter,
(5) cartridge,
(6) base design,
(7) length of bearing surface,
(8) color,
(9) shape,
(10) location and description of crimping cannelure,
(11) location and description of other cannelures, and
(12) miscellaneous notes.

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Individual Parameters

Identification Number

Bullets purchased as reloading components or removed from factory-loaded cartridges are identified by a unique serial number. Bullets received as evidence are identified by case and evidence item numbers. All the exemplar bullets and most of the evidence bullets are stored in laboratory files, and the remaining evidence bullets are returned to the submitting agencies after they have been measured and photographed.

Manufacturer

Bullets from loaded cartridges are identified according to the cartridge headstamp, and reloading components are identified by the manufacturer's name. When the same bullet is sold as a reloading component and used in a factory-loaded cartridge a note is made under "Miscellaneous Notes."

Bullet Weight

All bullet weights are expressed in avoirdupois grains, the units most commonly used for sporting rifle bullets (1 grain = 60 mg).

Diameter

To avoid any confusion with cartridge designations, all bullets are measured and recorded in thousandths of an inch (0.001 in. = 25 μm).

Cartridge

Factory-loaded cartridges from which bullets are removed are identified according to their headstamps, and in those cases in which several designations can be used for the same cartridge, an appropriate note is made under "Miscellaneous Notes." Cartridges without a cartridge identification on the headstamp are measured and filed according to the most commonly used sporting designation, for example, ".308 Winchester" instead of "7.62 NATO."

Base Design

Bullet bases are divided into six major categories: flat, recessed, concave, boattail, exposed core, and compound. Examples of five of these types are shown in Fig. 1; an exposed core is not shown.

Flat bases are formed by a plane perpendicular to the sides of the bullets. The intersection of the base and the sides of the bullets is usually rounded, and the diameter of this round is used to further divide this type of base into three groups: those with rounds having radii less than 0.015 in. (designated F1), those having radii between 0.015 and 0.030 in. (designated F2), and those having radii greater than 0.030 in. (designated F3).

Recessed bases are flat bases that have a shallow, flat-bottomed central indentation.

Concave bases are flat bases with a concave central indentation.

Boattail bases have a straight-sided tapered surface between the bullet sides and the base plane. This tapered surface is measured in thousandths of an inch between the side of the bullet and the base plane, and the measurement is recorded as BTxxx, where xxx is the length of the surface. The angle between the tapered surface and the bullet's side

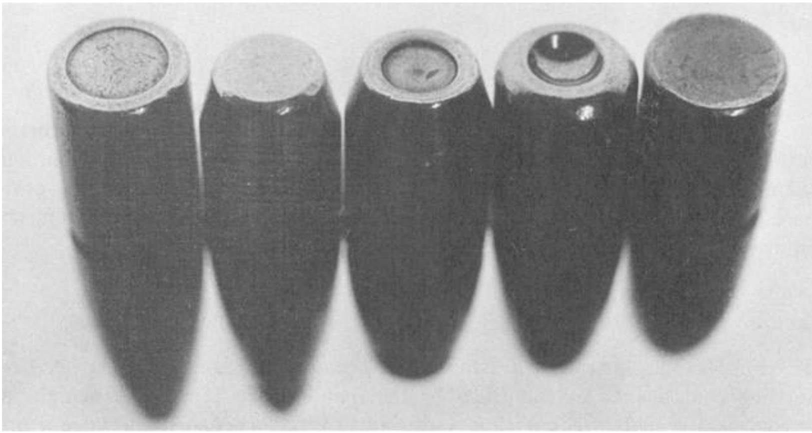

FIG. 1—*Types of bullet bases:* (left to right) *recessed, boattail, compound, concave, and flat.*

is not measured because it cannot be accurately measured on most fired and damaged bullets.

Exposed core bases consist of a visible lead core surrounded by the bullet jacket.

Compound bases usually involve a boattailed bullet with an indentation in the base plane. Figure 1 shows a bullet with a combination of boattail and recessed bases.

Length of Bearing Surface

The length of the bearing surface is measured from the plane of the base to the forward end of the land impressions on fired bullets. On unfired bullets, two measurements are made and recorded: the first is from the plane of the base to the point on the nose of the bullet where the diameter is equal to the nominal bore diameter of the weapon in which it would be fired plus 0.001 in.; the second is from the plane of the base to the point on the nose where the diameter is equal to the nominal bore diameter minus 0.001 in.

Color

The exterior surface color of the bullet is recorded. Brass-colored bullets are identified as being "yellow"; most others are "silver." If the surface color results from a thin plating of metal, a note is made under "Miscellaneous Notes."

Shape

Bullet shapes are recorded according to their manufacturer's designation, such as "spire" or "semi-point"; this is not the most efficient nomenclature for describing bullet designs, but it is the most useful one for communicating with manufacturers, vendors, and investigators. Fired and damaged bullets are usually identified according to the appearance of the inner surface of the jacket near the bullet nose; those with pronounced longitudinal wrinkles indicative of significant compression are designated "pointed"; because this designation is highly subjective and is of minor importance, it may be omitted.

Crimping Cannelure

The location of the cannelure into which the mouth of the cartridge case is crimped is measured from the base plane to the center of the cannelure. The description of this cannelure is limited to "knurled" or "plain."

Other Cannelures

Other cannelures are located and described in the same way that the crimping cannelure is located and described.

Miscellaneous Notes

Letters or logos on the base, odd cartridge designations, elemental composition, and unusual bullet features such as plastic or bronze points are noted under the "Miscellaneous Notes" section.

Examination Procedure

Bullets to be examined must first be cleaned and prepared for examination by a procedure such as that previously described [*1*].

The color, diameter, base design, and length of the boattail surface can be determined by observation and direct measurement.

The length of the bearing surface and the locations of the cannelures can also be measured, but such measurements require additional preparation and, depending on the amount of distortion, may have to be determined as the sum of the lengths of small segments of the bullet jacket. Measurements of chordal distances of concave surfaces are the most common source of error and invariably yield results smaller than the true value. Bending the metal to approximate the original shape of the bullet before any measurements are made minimizes this problem. The simplest way to make a determination of bearing length is to measure along one of the edges of a land impression. This creates a negligible error and eliminates the need to estimate the longitudinal axis of the bullet.

The shape of the bullet can be estimated from the interior surface of the jacket at a point near the nose. Because the metal is significantly compressed at this point during the final shaping of the bullet, the interior surface usually shows a coarse texture with distinct wrinkles parallel to the longitudinal axis. Round-nosed or flat-pointed bullets exhibit fewer and less pronounced wrinkles. Figure 2 shows a comparison of the interior surface of a pointed bullet and a round-nosed bullet.

Identification of Bullet Origin

Most of the bullets manufactured in the United States are made of brass-colored metal, and only a few of these have an exterior plating of silver-colored metal; therefore, silver-colored bullets are probably of foreign origin, and those most commonly encountered are manufactured in Sweden by Norma. In Wyoming and its surrounding states, only a few vendors sell this brand of ammunition, and most of that sold is for rifles chambered for foreign military cartridges; finding a silver-colored bullet in these states is therefore an excellent investigative clue.

Only one manufacturer, Remington, is likely to be the source of a recessed-base bullet with a diameter of 0.243 in. or greater. A few non-Remington bullets with this type of base have been encountered, but all were more than 20 years old, and only one Remington

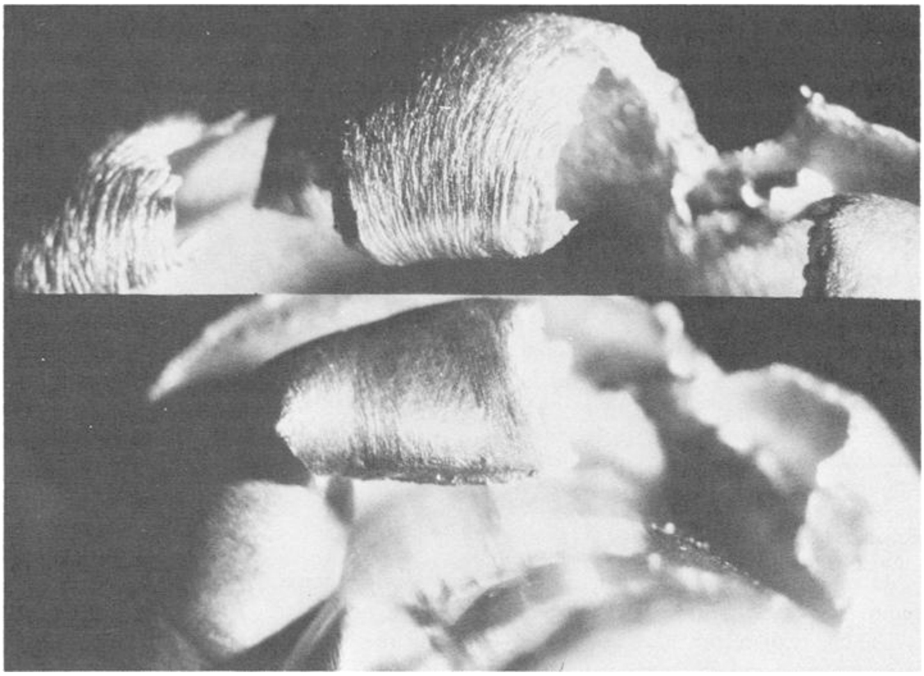

FIG. 2—*Interior forward surfaces of a pointed bullet jacket* (upper) *and a round-nose bullet* (lower).

bullet has been found to have another base design. (All the 120-grain "Core-lokt" bullets in a box of .25-06 cartridges purchased in 1977 had flat bases.)

Federal cartridges are the most common U.S. source of factory-loaded boattailed bullets. Their bullets are manufactured by Sierra and differ only in the absence of cannelures on the bullets sold as reloading components. The damaged evidence bullet shown in Fig. 3 is a 7-mm Sierra bullet. From the measurements of this bullet, particularly those regarding the base, the identification cannelure (defined below), and the weight, it can be identified as one that was factory-loaded into a Federal 7-mm Remington Magnum cartridge; knowing the class characteristics of the weapon from which this bullet was fired and the specific cartridge for which it was chambered allowed the examiner to make an estimate of the manufacturer and model of the rifle used in the crime.

Exposed-core bases on expanding point bullets have been found only on Nosler bullets. A few cartridges factory-loaded with Nosler bullets have been seen, but these bullets are usually encountered as reloading components.

Speer and RWS bullets with initials or emblems on the bases have been encountered. The Speer "Grand Slam" bullets have the initials "GS," and the RWS bullets have a shield logo. Examples are shown in Fig. 4.

The bearing length of land impressions can be correlated with the weight of the bullet. Figure 5 shows the relationship of bullet weight to bearing length for 150- and 180-grain bullets with a diameter of 0.308 in. Measurements for boattailed bullets were not included in these data. Other bullet weights were not included because the most commonly encountered bullets are of these weights. Other bullet weights have similar distributions and are considered when the possible bullet weights are estimated. Other factors such as bullet

FIG. 3—*Federal 7-mm Remington Magnum boattail bullet.*

FIG. 4—*Identifying marks stamped on the bases of RWS* (left) *and Speer* (right) *bullets.*

shape usually assist in evaluating the data; for example, most 180-grain bullets are pointed, but 170-grain bullets are not.

Very accurate measurements on bullets such as the 0.243-in. bullet shown in Fig. 6 can yield accurate bullet weights; less accurate measurements on bullets such as the 0.308 bullet shown in Fig. 7 yield a possible weight range—in this case 150 to 165 grains.

Using graphic data such as those included in Fig. 5c, one can quickly estimate a bullet's weight if given its diameter and bearing length. This estimate can be statistically evaluated by using data such as those given in Table 1. (Data in this table are shown only for bullet weights where ten or more exemplars have been measured.) A quick

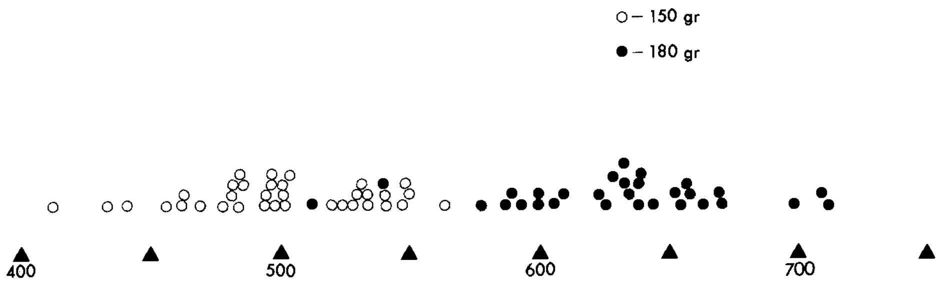

FIG. 5—*Bearing lengths of various 150- and 180-grain bullets of 0.308-in. diameter.*

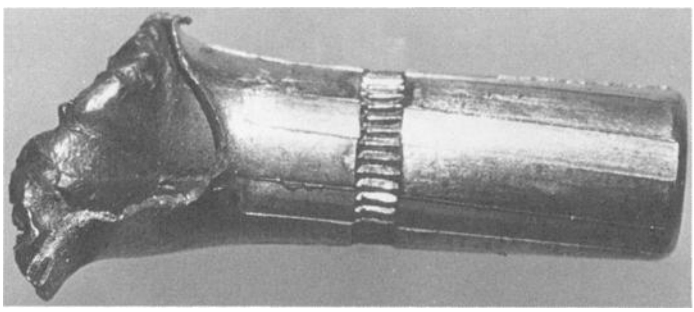

FIG. 6—*Fired 0.243-in.-diameter, 100-grain bullet.*

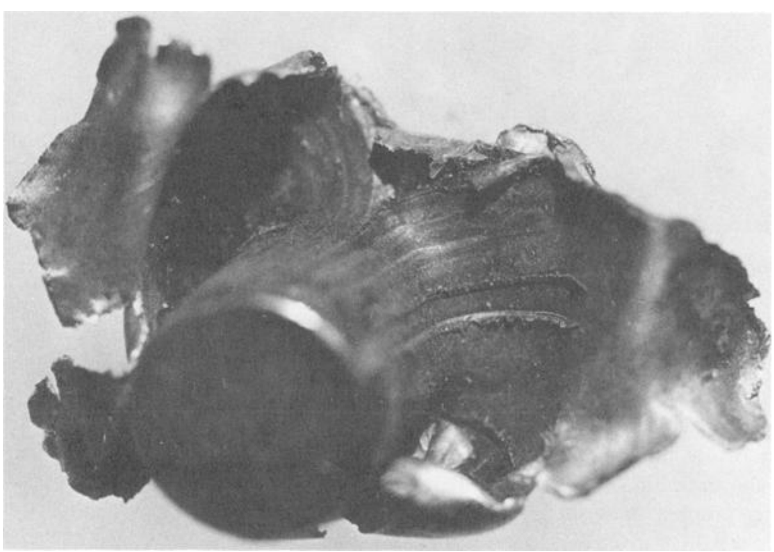

FIG. 7—*Fired 150- to 165-grain, 0.308-in.-diameter bullet.*

method for determining the weight of a bullet from its diameter and bearing length is to use a factor that can be multiplied by the bearing length to yield an approximate weight; these factors have been calculated for several bullet diameters and are shown in Table 2.

The crimping cannelure is usually the only cannelure on a bullet, but its presence is of some value in deciding whether a bullet is factory-loaded or hand-loaded. For bullets having a diameter of 0.243 in. or greater, 91% of the factory-loaded bullets examined were cannelured; only 32% of the reloading components were cannelured.

Where two or more cannelures have been found on a bullet, the widest has always been the crimping or "case" cannelure. (Bullets with narrow crimping cannelures may be encountered; they would, however, be most unusual.) Narrow knurled cannelures between this one and the base are designed to hold the core in the jacket, and those cannelures between the crimping cannelure and the nose are identification rings to enable the weight of the bullet to be determined while it is loaded in the cartridge. The bullet shown in Fig. 3, for example, has a crimping cannelure and an identification cannelure.

A few bullets with lathe-turned crimping cannelures will be found. One of these bullets is shown in Fig. 8. All the bullets are 180-grain "Silver-tip" bullets of 0.308-in. diameter. Two of them have extra cannelures to secure the core to the jacket.

Cannelures may not be particularly valuable for determining the cartridge from which a bullet is derived. Variables such as seating depth and the number and location of cannelures result in nonuniformity among bullets in various lots of nominally identical

TABLE 1—*Average bearing lengths and standard deviations σ for selected bullet weights and diameters.* [a]

Diameter, in.	Weight, grain	Average Bearing Length, in.	σ, in.
0.223	45	0.249	0.010
0.223	50	0.287	0.023
0.223	55	0.333	0.009
0.243	80	0.411	0.033
0.243	100	0.584	0.032
0.270	130	0.553	0.029
0.270	150	0.684	0.030
0.308	150	0.502	0.039
0.308	180	0.626	0.048

[a] 1 grain = 60 mg; 1 in. = 25.4 mm.

TABLE 2—*Average ratio* R *of bullet weight (grain) and bearing length (in.).* [a]

Bullet Diameter, in.	*R*, grains/in.
0.223	168.7
0.243	181.6
0.257	199.4
0.264	214.0
0.277	232.1
0.284	239.9
0.308	303.6

[a] 1 grain = 60 mg; 1 in. = 25.4 mm.

cartridges loaded by the same company. Some of the variations encountered are illustrated by the 180-grain "Silver-tip" bullets shown in Fig. 8; these bullets were removed (left to right) from .30-40 Krag, .300 Savage, .300 Savage, .308 Winchester, .30-06, .30-06, and .300 H & H Magnum cartridges.

The bullet shown in Fig. 9 may serve as an example of how identifying a bullet can be a valuable investigative aid. Removed from one of several elk that had been shot and abandoned, the bullet was coded and compared to the Remington 175-grain bullet loaded only in the 7-mm Remington Magnum cartridge (Table 3).

Identifying the cartridge used in the crime by manufacturer and bullet weight and, from the class characteristics, the manufacturer of the rifle allowed the warden who investigated the case to check the records of local vendors and locate a suspect who eventually pleaded guilty.

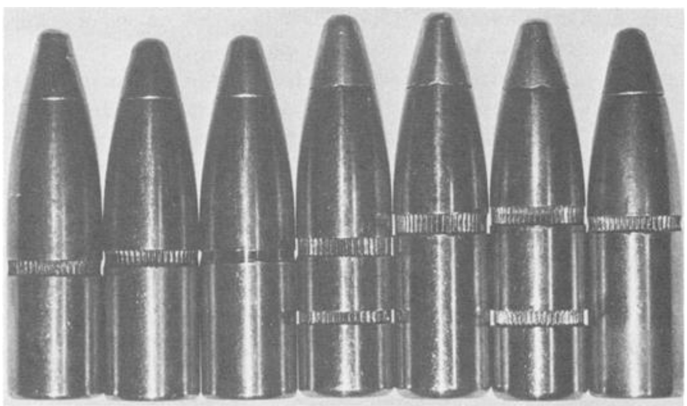

FIG. 8—*"Silver-tip" bullets, 180 grain and 0.308 in. diameter, removed from* (left to right) *.30-40 Krag, .300 Savage, .300 Savage, .308 Winchester, .30-06, .30-06, and .300 H & H Magnum cartridges.*

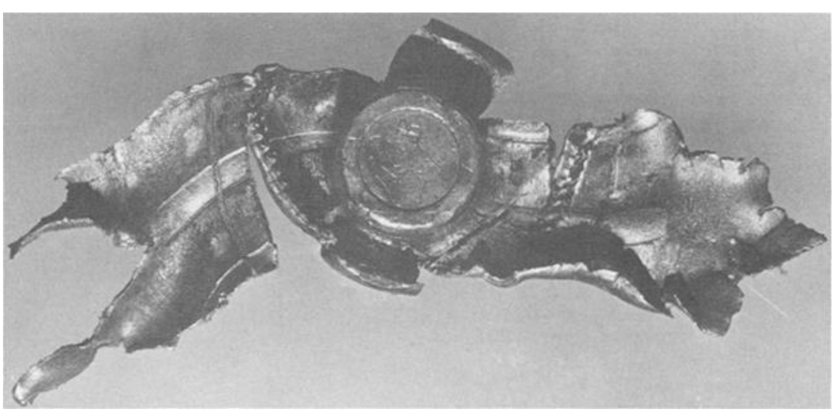

FIG. 9—*Fired 175-grain, 7-mm Remington Magnum bullet manufactured by Remington.*

TABLE 3—*Classification of bullet shown in Fig. 9.* [a]

Parameter	Exemplar	Evidence
1. Identification number	53	78267-1
2. Weight, grain	175	not measured
3. Manufacturer	Remington	unknown
4. Diameter, in.	0.284	0.285
5. Cartridge	7-mm Remington Magnum	unknown
6. Base	recessed	recessed
7. Bearing length, in.	0.672	~0.68
	0.705	...
8. Crimping cannelure, in.	0.555 (knurled)	~0.49 (knurled)
9. Other cannelures, in.	0.624 (plain)	~0.61 (plain)
10. Color	yellow	yellow
11. Shape	semi-point, "Core-lokt"	point (probable)
12. Miscellaneous Notes	loaded only in 7-mm Remington Magnum	...

[a] 1 grain = 60 mg; 1 in. = 25.4 mm.

Conclusions

The use of this twelve-parameter system to identify jacketed sporting rifle bullets has been used to locate possible offenders by examining the records of weapon and ammunition sales. Unusual circumstances such as the use of uncommon bullets or the use of several different loadings have, in several cases, created a single suspect from among many purchasers of ammunition and components.

Comments

The inclusion in this paper of the data compiled for the several hundred bullets in this laboratory's files is not possible; these coded data will, however, be provided to anyone who requests them from the Firearms Identification Section of the Wyoming State Crime Laboratory.

Reference

[1] Booker, J. L., "The Examination of the Badly Damaged Bullet," *Journal of the Forensic Science Society*, Vol. 19, 1979, in press.

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