Corrections and Additions to

A Look at Drag Models in Old Small Arms Firing Tables

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Norderstedt 2006, ISBN 978-3-8334-6697-7

Corrections

Page 7, 3rd line from bottom: 21.5 Newton corresponds to about 4 pounds force, not 2 pounds.

Page 13, line 8: read *actually* for *actuallly*.

Page 21 and 104: reference [55] should be replaced by [63]. I discovered that Snipercountry does no longer present the Gx models as drag coefficient tables, but as resistance function formulas. The tables in the form used for my book are still available on [63], which is the ballistics website of J.B. Millard.

Page 36: the bottom table does not refer to caliber .30 AP bullet M2. I overlooked that the weight Hatcher gives on page 400 of his book for the AP bullet (172 grains or 11.15 grams as used in the calculation) is not correct for the AP M2 bullet, which weighs 166 grains (10.75 grams) maximum. This results in lower form factors. The important conclusion here, namely that Ingalls is the best fit, remains unaffected by this correction.

Page 53, line 4: read *perfectly* for *pefectly*.

Page 59, table: the label should read *.276 Pedersen* not *.267 Pedersen*.

Page 66, last paragraph: the .303 Mark VII was introduced in 1910, not in 1907.

Additions

Page 21

The actual projectile types which BRL used for obtaining the drag models can now be identified based on [61]:

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G2   3.3 in. shell Type 155 (experimental)
G3   3 in. AA shell Mark IX, fuze Mark III
G4   75 mm HE shell Mark IV, (long) point detonating
     fuze Mark III
G5   based on two slightly different projectiles:
     3.3 in. steel shell Mark II (Mach 2 and above)
     75 mm HE shell Mark IV (below Mach 2)
     both with point detonating fuze Mark V
G6   3 in. HE shell Type 1915, base detonating fuze
     Mark V
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The data above makes it clear that *none* of the BRL drag models have any direct relation to small arms bullets.

[61] also contains drawings of these projectiles (and those for G7, G8), but with no dimensions. While Robert MCCOY in [34] shows the British projectiles for G7 and G8 as usual with driving bands, this contemporary report shows them *without* driving bands. There are three grooves visible at the corresponding location on the shell body. It could be that the driving bands were designed to be stripped or thrown off the projectile after it left the muzzle. Absence of a driving band would make these projectiles externally more similar to small arms bullets than the other shells are. Another contemporary drawing showing G7 and G8 projectiles without driving bands

can be found in [57].

In [61] drag models G2 through G8 are called J2 through J8. From [58] it seems that G2 started as drag model J, without any number. These texts do not mention whether the letter J has any special meaning (like G being derived from Gâvre).

Page 45 and 75

Data from 1897 for another round nosed bullet was found. In [60] a firing table for the 6.5 mm Italian Carcano is reprinted. Alas only three values fall within the supersonic range. FORMFAK reports SIACCI as the best fitting model and a rather large standard deviation of 0.0267. Assuming an air desity of 1.206, the form factor is 0.8793. This is the second largest value among the round nose bullets for which data is available. The bottom part of the table on page 75 therefore becomes:

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   0.7244   SIACCI    6.7    RN   6.5 mm m/94
   0.7921   SIACCI    8.1    RN   7.9 mm Patrone 88
=> 0.8793   SIACCI    6.7    RN   6.5 mm M91 Carcano
   0.9138   SIACCI    6.7    RN   6.5 mm Scherpe No. 1
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Page 74

I took another glimpse at more modern data. To me there is no doubt that the G7 model was used by the U.S. Army also for the 7.62 mm M80 and 5.56 mm M193 bullets. An analysis of the downrange velocities given in [59] yields an excellent fit to the G7 model for both calibers. The data in [59] is averaged from 50 ammunition lots made by two manufacturers (Lake City, Twin Cities). FORMFAK computed, assuming an ICAO atmosphere, for G7:

Bullet	Form factor	StdDev
7.62 mm M80	1.1041	0.0017
5.56 mm M193	1.2414	0.0051

On the other hand, Karpov applied G5 in 1944 [62], when analyzing ammunition in calibers .50 and .30 *manufactured for aircraft use*, irrespective of bullet type (Ball, AP, Incendiary, Tracer), boattailed or not. G5 was also applied in 1955 by Davis to a boattailed 68 grain .22 bullet in his ground-breaking study [64].

References

[57] HITCHCOCK, H.P.: *Aerodynamic Data for Spinning Projectiles.* Aberdeen: Ballistic Research Laboratories, 1947. Report No. 620; 154 pages; AD-800469

[58] HITCHCOCK, H.P.: *Aerodynamic Nomenclature and Formulas, Conversion Factors and Drag Functions.* Aberdeen: Ballistic Research Laboratories, 1938. Report No. 111; 6 pages; AD-491790 (NTIS copy partly illegible)

[59] MALINOSKI, Frederick A.; Niemirow, Jerzy: *The Effect of Statistical Velocity Variation on the Gaussian Bivariate Probability of Hit for Small Caliber Systems.* Philadelphia: Frankford Arsenal, 1975; AD-A016865

[60] RIEPE, Wolfgang: *Il Novantuno Mannlicher-Carcano.* Herne: VS-Books, 2006; p. 302 (Text is in German)

[61] THOMAS, Richard N.: *Some Comments on the Form of the Drag Coefficient at Supersonic Velocity.* Aberdeen: Ballistic Research Laboratories, 1942/1945. Report No. 542; 43 pages; AD-494220 (NTIS copy partly illegible)

[62] KARPOV, B.G.: *Ballistic Coefficients of Small Arms Bullets of Current Production.* Aberdeen: Ballistic Research Laboratories, 1944. Report No. 478; 25 pages; AD-491936

[63] Website, relocated in 2010 to:
www.jbmballistics.com/ballistics/downloads/downloads.shtml

[64] DAVIS, William C.: *An Investigation of an Experimental Caliber .22 High-Velocity Bullet for Rifles.* Aberdeen: Development and Proof Services, 1955; AD-101401 (NTIS copy partly illegible)

19 Jul 2010