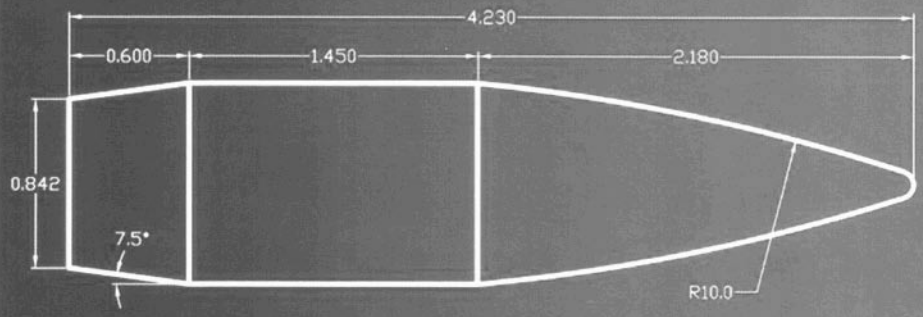
Applied Ballistics for Long Range Shooting

Understanding the elements and application of external ballistics for successful long range target shooting and hunting.

By Bryan Litz



G7 Standard Projectile
Dimensions in calibers

Applied Ballistics for Long Range Shooting

By Bryan Litz

Copyright © 2009 by Applied Ballistics, LLC

All rights reserved. Printed in the United States of America. No part of this publication may be reproduced or distributed in any form or by any means, without the prior written permission of the publisher.

ISBN 978-0-615-27661-8

1st Edition

Published by:
Applied Ballistics, LLC
15071Hanna Ave NE
Cedar Springs, MI 49319

Table of Contents

Acknowledgments xi

Introduction 1

PART 1: THE ELEMENTS OF EXTERIOR BALLISTICS 1

Chapter 1: Some Fundamentals 7

Chapter 2: The Ballistic Coefficient 13

Chapter 3: Gravity Drop 41

Chapter 4: Uphill/Downhill Shooting 55

Chapter 5: Wind Deflection 63

Chapter 6: Gyroscopic Drift 89

Chapter 7: The Coriolis Effect 101

Chapter 8: Using Ballistics Programs 107

Chapter 9: Getting Control of Sights 131

Chapter 10: Bullet Stability 147

Summary of the Elements 165

PART 2: BALLISTIC PERFORMANCE ANALYSIS 142

Chapter 11: Interesting Facts and Trends 171

Chapter 12: Example Performance Analysis 195

Chapter 13: Generalized Score Shooting Analysis 211

Chapter 14: Lethality of Long Range Hunting Bullets 229

Chapter 15: Hit Probability for Hunting 261

PART 3: PROPERTIES OF LONG RANGE BULLETS .. 234

Chapter 16: Anatomy of a Bullet 273

Chapter 17: Using the Experimental Data 285

.224 Caliber (5.56 mm) 331

Berger .224 cal 70 grain VLD 332

Berger .224 cal 73 grain BT 333

Berger .224 cal 75 grain VLD 334

Berger .224 cal 77 grain BT 335

Berger .224 cal 80 grain VLD 336
Berger .224 cal 82 grain BT 337
Berger .224 cal 90 grain VLD 338
Berger .224 cal 90 grain BT 339
Sierra .224 cal 52 grain MatchKing 340
Sierra .224 cal 55 grain FMJ 341
Sierra .224 cal 69 grain MatchKing 342
Sierra .224 cal 77 grain MatchKing 343
Sierra .224 cal 80 grain MatchKing 344
Sierra .224 cal 90 grain MatchKing 345
Nosler .224 cal 52 grain CC 346
Nosler .224 cal 55 grain Ballistic Tip 347
Nosler .224 cal 77 grain CC 348
Hornady .224 cal 40 grain Vmax 349
Hornady .224 cal 50 grain Vmax 350
Hornady .224 cal 55 grain Vmax 351
Hornady .224 cal 52 grain Amax 352
Hornady .224 cal 75 grain Amax 353
Hornady .224 cal 80 grain Amax 354
Hornady .224 cal 68 grain BTHP 355
Lapua .224 caliber 69 grain Scenar 356
DRT .224 caliber 79 grain Frangible 357
.243 Caliber (6mm) 359
Berger .243 cal 90 grain BT 360
Berger .243 cal 95 grain VLD 361
Berger .243 cal 100 grain BT 362
Berger .243 cal 105 grain BT 363
Berger .243 cal 105 grain VLD 364
Berger .243 cal 108 grain BT 365
Berger .243 cal 115 grain VLD 366
Sierra .243 cal 70 grain MatchKing 367
Sierra .243 cal 80 grain Blitz 368
Sierra .243 cal 95 grain MatchKing 369
Sierra .243 cal 107 grain MatchKing 370

DTAC .243 caliber 115 grain BTHP 371
DTAC .243 caliber 117 grain 372
Nosler .243 cal 70 grain Ballistic Tip 373
Nosler .243 cal 80 grain Ballistic Tip 374
Nosler .243 cal 95 grain Partition 375
Hornady .243 caliber 58 grain Vmax 376
Hornady .243 caliber 65 grain Vmax 377
Hornady .243 caliber 75 grain Vmax 378
Hornady .243 caliber 87 grain Vmax 379
Hornady .243 caliber 85 grain Interbond 380
Hornady .243 caliber 87 grain BTHP 381
Hornady .243 caliber 100 grain BTSP 382
Hornady .243 caliber 105 grain Amax 383
Lapua .243 caliber 90 grain FMJBT 384
Lapua .243 caliber 90 grain Scenar 385
Lapua .243 caliber 105 grain Scenar 386
JLK .243 caliber 105 grain VLD 387
25 Caliber (.257" diameter) 389
Berger 25 caliber 115 grain VLD 390
Sierra 25 caliber 100 grain Match King 391
Sierra 25 caliber 117 grain Pro Hunter 392
Nosler 25 caliber 115 grain Ballistic Tip 393
Hornady 25 caliber 87 grain Spitzer 394
Hornady 25 caliber 110 grain Interbond 395
Hornady 25 caliber 117 grain SST 396
Barnes 25 caliber 115 grain TTSX FB 397
.264 Caliber (6.5mm) 399
Berger .264 caliber 120 grain BT 400
Berger .264 caliber 130 grain VLD 401
Berger .264 caliber 140 grain VLD 402
Berger .264 caliber 140 grain short BT 403
Berger .264 caliber 140 grain Long Range BT 404
Berger .264 caliber 140 grain BT 405
Sierra .264 caliber 120 grain Pro Hunter 406

Sierra .264 caliber 107 grain MatchKing 407
Sierra .264 caliber 123 grain MatchKing 408
Sierra .264 caliber 142 grain MatchKing 409
Nosler .264 caliber 120 grain Ballistic Tip 410
Nosler .264 cal 140 grain Custom Competition 411
Hornady .264 caliber 95 grain Vmax 412
Hornady .264 caliber 129 grain SST 413
Hornady .264 caliber 140 grain Amax 414
Lapua .264 caliber 108 grain Scenar 415
Lapua .264 caliber 139 grain Scenar 416
Lapua .264 caliber 144 grain FMJBT 417
JLK .264 caliber 140 grain VLD 418
.264 caliber 136 grain Hoover 419
.270 Caliber (.277") 421
Berger 270 caliber 130 grain VLD 422
Berger 270 caliber 140 grain VLD 423
Berger 270 caliber 150 grain VLD 424
Sierra 270 caliber 115 grain MatchKing 425
Sierra 270 caliber 135 grain MatchKing 426
Sierra 270 caliber 150 grain Game King 427
Nosler 270 caliber 140 grain Ballistic Tip 428
Nosler 270 caliber 140 grain Nosler Partition 429
Hornady 270 caliber 110 grain Vmax 430
Hornady 270 caliber 130 grain Interbond 431
Hornady 270 caliber 140 grain BTSP Interlock 432
Hornady 270 caliber 150 grain SP Interlock 433
.284 Caliber (7mm) 435
Berger .284 caliber 168 grain VLD 436
Berger .284 caliber 180 grain VLD 437
Berger .284 caliber 180 grain BT 438
Sierra .284 caliber 150 grain Game King 439
Sierra .284 caliber 175 grain Game King 440
Sierra .284 caliber 168 grain MatchKing 441
Sierra .284 caliber 175 grain MatchKing 442

Nosler .284 caliber 120 grain Ballistic Tip 443
Nosler .284 caliber 150 grain Ballistic Tip 444
Nosler .284 caliber 150 grain Partition 445
Nosler .284 caliber 175 grain Partition 446
Hornady .284 caliber 120 grain Vmax 447
Hornady .284 caliber 139 grain SP Interlock 448
Hornady .284 caliber 139 grain BTSP Interlock 449
Hornady .284 caliber 154 grain SP Interlock 450
Hornady .284 caliber 154 grain SST 451
Hornady .284 caliber 162 grain Amax 452
Hornady .284 caliber 175 Interlock 453
JLK .284 caliber 180 grain BTHP 454
Barnes .284 caliber 175 TSX 455
.308 Caliber (7.62mm) 457
Berger .308 caliber 155 grain BT 458
Berger .308 caliber 155 grain VLD 459
Berger 155.5 grain BT FULLBORE 460
Berger .308 caliber 168 grain BT 461
Berger .308 caliber 168 grain VLD 462
Berger .308 caliber 175 grain Long Range BT 463
Berger .308 caliber 175 grain VLD 464
Berger .308 caliber 185 grain VLD 465
Berger .308 caliber 185 grain Long Range BT 466
Berger .308 caliber 190 grain VLD 467
Berger .308 caliber 210 grain VLD 468
Berger .308 caliber 210 grain Long Range BT 469
Sierra .308 caliber 155 grain Palma (2155) 470
Sierra .308 caliber 155 grain Palma (2156) 471
Sierra .308 caliber 168 grain MatchKing 472
Sierra .308 caliber 175 grain MatchKing 473
Sierra .308 caliber 180 grain MatchKing 474
Sierra .308 caliber 190 grain MatchKing 475
Sierra .308 caliber 200 grain MatchKing 476
Sierra .308 caliber 210 grain MatchKing 477

Sierra .308 caliber 220 grain MatchKing 478
Sierra .308 caliber 240 grain MatchKing 479
Sierra .308 caliber 165 grain Game King 480
Sierra .308 caliber 180 grain Game King 481
Sierra .308 caliber 200 grain Game King 482
Nosler .308 caliber 125 grain Ballistic Tip 483
Nosler .308 caliber 150 grain Ballistic Tip 484
Nosler .308 caliber 165 grain Ballistic Tip 485
Nosler .308 caliber 180 grain Ballistic Tip 486
Nosler .308 cal 168 grain Custom Competition 487
Nosler .308 caliber 165 grain Partition 488
Nosler .308 caliber 180 grain Partition 489
Nosler .308 caliber 200 grain Partition 490
Nosler .308 caliber 165 grain Accubond 491
Nosler .308 caliber 180 grain Accubond 492
Hornady .308 caliber 155 grain Amax 493
Hornady .308 caliber 168 grain Amax 494
Hornady .308 caliber 178 grain Amax 495
Hornady .308 caliber 208 grain Amax 496
Hornady .308 caliber 150 grain SST 497
Hornady .308 caliber 165 grain SST 498
Hornady .308 caliber 150 grain BTSP 499
Hornady .308 caliber 190 grain BTSP 500
Hornady .308 caliber 168 grain HPBT 501
Lapua .308 caliber 155 grain Scenar 502
Lapua .308 caliber 167 grain Scenar 503
Lapua .308 caliber 185 grain Scenar 504
Lapua .308 caliber 185 grain FMJBT (D46) 505
Lapua .308 caliber 200 grain FMJBT 506
Barnes .308 caliber 168 grain TSX BT 507
Barnes .308 caliber 168 grain TTSX BT 508
Barnes .308 caliber 180 grain TSX BT 509
.308 caliber 155 grain HBC (Australia) 510
PMP .308 caliber 155 grain HPBT (South Africa) 511

DRT .308 caliber 175 grain Frangible 512
DRT .308 caliber 200 grain Frangible 513
.338 Caliber 515
Sierra 338 caliber 250 grain Match King 516
Sierra 338 caliber 300 grain Match King 517
Sierra 338 caliber 250 grain Game King 518
Hornady 338 caliber 225 grain SST 519
Hornady 338 caliber 250 grain BTHP Match 520
Barnes 338 caliber 225 grain TTSX BT 521
APPENDIX 522
Equation 2.1: The Ballistic Coefficient 523
Equation 2.2: The Form Factor 524
Equation 5.1: Lag Time 525
Equation 5.2: Wind Deflection 526
Equation 5.3: Velocity 527
Equation 6.1: Spin Drift 528
Equation 9.1: Aperture Sight Calibration 529
Equation 11.1: Kinetic Energy 530
Equation 14.1: Matunas' Optimal Game Weight Formula 531
Equation 17.1: G7 form factor prediction 532
The Miller Stability Formula 533
The Miller Stability Formula: Velocity Correction 534
The Miller Stability Formula: Atmospheric Correction 535
ICAO Standard Atmosphere 536