DOWNLOAD PDF MODERN EXTERIOR BALLISTICS

Chapter 1 : Robert L. McCoy Â« Daily Bulletin

Modern Exterior Ballistics is a comprehensive text covering the basic free flight dynamics of symmetric projectiles. The book provides a historical perspective of early developments in the 19th century.

We all suffered a great loss when he passed away, mere months after his book was finished. It is the best up-to-date overview of the math and physics used by modern ballistics engineers that I have come across. As such, it breaks away from the historically interesting, but antiquated techniques used by ballisticians in times when computers were not available and calculating a single trajectory was a substantial effort. The book covers topics that are of interest to both sport shooters and military balisticians. The focus is on dumb lead bullets fired from small arms for the most part. A Note on Math This book contains heavy-duty math throughout. It would be appropriate for a junior or senior level college engineering course, and assumes a solid background in calculus, differential equations, and numerical methods. However, there is a good deal of information that you will understand, and you can usually glean at least some understanding even if you skip the numerous equations. A Note on Typos Unfortunately, the book is poorly edited and riddled with typos, many of which are significant errors in vitally important equations. Fortunately, some smart, dedicated people have combed through them and provided a complete set of corrections, which you can find on the internet here. Make sure you download the corrections and keep a set with your book - it will save you a lot of head scratching. And now, for a chapter by chapter review: A Brief History of Ballistics Chapter one begins with Isaac Newton and takes the reader through a fairly detailed history of ballistics all the way through the efforts of the BRL in the late 20th century and some speculation as to the future of modern ballistics. Along the way, McCoy provides accounts of the origins of the various drag functions, including detailed sketches of the the standard projectiles. A good bit of information on World War II era investigations is given, which one might call the birth of modern ballistics. Shadowgraphs of various projectiles spheres, cylinders, cones, and missiles are also shown with some commentary. The chapter winds down with an overview of post-war progress, including computer simulations and the potential of computational fluid dynamics to provide greater insight. The non-engineer will have no trouble with this chapter. If you paid attention in high school math and physics class, you should be able to follow this chapter. The Vacuum Trajectory Chapter three takes the reader through the basics of what a trajectory looks like in a vacuum - in other words, a trajectory where the only force acting on the bullet is gravity. The math in this chapter is at the college freshman level. A nice section on the effects of firing up and down hills is presented. This will be of practical use, and demands nothing more than a working knowledge of trigonometry. Notes on Aerodynamic Drag One of the more interesting chapters in the book, Chapter Four describes in detail the concept of a drag function, the reasons they exist, and their limitations. Full page shadowgraphs of a bullet transitioning through the transonic range with play-by-play commentary provide a look at why this region is so tricky to navigate in the real world. Among other interesting notes is a section on tracer rounds and the effects the burning pyrotechnic mixture has on drag or more accurately - thrust. This chapter is perfectly accessible by someone without a deep background in mathematics. Some knowledge of fluid mechanics will make it a little more interesting, but is not required. The Flat-Fire Point Mass Trajectory This is where we get to calculate a trajectory in air - but only if we make some simplifying assumptions. The reader will find the derivation of the equations of motion of a projectile in still air without wind. A solution of those equations can be found if one makes the assumption that only small angle of fire trajectories are interesting the flat-fire assumption. This chapter is too basic for practical use, and has limitations that we can get around by using methods in later chapters, but the math is relatively simple - requiring only basic calculus to wade though. This method predates computers substantially, having been pioneered in the early 18th century by Johann Bernoulli. Fancesco Siacci developed an approximate solution to the flat-fire problem, which made solving the equations considerably less labor intensive. Although inadequate for artillery, it provides good accuracy for small arms fire. The Effect of Wind on Flat-Fire Trajectories Finally we get to a matter near and dear to the hearts of long range shooters: McCoy begins the chapter by deriving the equations of motion for a point mass trajectory including wind and a flat-fire

simplification that permits a nice analytical solution the equation that lets one calculate wind deflection. This short chapter requires an understanding of differential equations, and is frankly, not that interesting, unlike the next chapter. The Point-Mass Trajectory This chapter is the meat of the book, at least practically speaking. In chapter eight, McCoy shows how to calculate a trajectory based on the point mass model without a flat fire assumption. This chapter is the basis for the Bison Ballistics Point Mass Calculator , although I used a different numerical solver than he suggests. Also included are a wide range of example calculations that will be interesting to all readers. The chapter ends with a discussion of the differences between point mass calculations and the Siacci method, a discussion of the Coriolis effect, and finally, a BASIC program that calculates a point mass trajectory. The code is littered with typos, presumably from the OCR software used to scan it, and BASIC makes my head want to explode when compared with modern languages. This is the grand-daddy ballistics model of them all. It calculates the complete motion of a bullet - displacement and rotation in all three directions. The math in this chapter is as bad as it gets. The 6-DOF model requires huge amounts of measured data analogous to a BC for every bullet, and that data is simply not available to most of us. Nonetheless, there are some interesting and significant effects that get uncovered by the 6-DOF model that will not show up in the point mass 3-DOF model - the effects due to bullet spin and yaw. The chapter ends with a simplification of the 6DOF model the so called Modified Point Mass Model that allows for the calculation of spin drift and some of the yaw-based drag effects. Liniarized Pitching and Yawing Motion of Rotationally Symmetric Projectiles In another mathematically dense chapter, McCoy examines the pitching and yawing of a spinning bullet. The interesting part of this chapter is the discussion of gyroscopic and dynamic bullet stability. On the other hand, it is helpful to see that there are indeed two requirements for stable bullet flight, and that unstable may not mean exactly what you think it does. This chapter is a continuation of chapter 10 that discusses the effects of yaw and spin on bullet trajectory. Specifically, that means epicyclic swerve the corkscrew flight path , spin drift, and aerodynamic jump more on this in the next chapter. The take-away from this chapter is that drift and epicyclic swerve, while interesting, are not terribly large effects when compared with aerodynamic jump. Lateral Throwoff and Aerodynamic Jump This is the most interesting chapter in the book. Lateral throwoff is the effect whereby a bullet with an off-center center of gravity or a bullet that yaws in-bore "jumps" off the bore centerline when it exits the muzzle, resulting in an angled trajectory in other words, poor accuracy. Aerodynamic jump causes a similar change in the flight path, but for different reasons. Aerodynamic jump is caused by wind, unbalanced bullets, and in-bore yaw. A fascinating consequence of aerodynamic jump is that a cross wind will cause a vertical deflection that can get particularly nasty when firing out the side of an airplane. The take away from this chapter is to buy the best bullets you can, and to use the slowest twist that will stabilize them. Nonlinear Aerodynamic Forces and Moments This chapter is the most difficult to understand in the entire book. Honestly, I lost interest in this chapter because it delves so deeply into what, to me, is only of academic interest. Perhaps I will return to it at a later date with more enthusiasm. Measurement of Aerodynamic Forces and Moments A nice recovery for those who lost track of their sanity in chapter thirteen, this chapter goes into the details of measuring all the things that you need to make use of the 6-DOF model. Topics include the measurement of forces in a wind tunnel, inducing yaw, and yawsonde testing a method that uses light from the sun to measure yaw. It does not dive deeply into any one topic, but provides enough clues that the reader will know where to look next. And if you do have copies of any of those papers, please send them my way! You can find it on Amazon. Damon Cali is the creator of the Bison Ballistics website and a high power rifle shooter currently living in Nebraska.

DOWNLOAD PDF MODERN EXTERIOR BALLISTICS

Chapter 2 : Modern Exterior Ballistics | Download eBook PDF/EPUB

Modern Exterior Ballistics is a comprehensive text covering the basic free flight dynamics of symmetric projectiles. The book provides a historical perspective of early developments in the 19th century, the technology leading to World War I and that through World War II into the modern post-war era.

Please click button to get modern exterior ballistics book now. This site is like a library, you could find million book here by using search box in the widget. Schiffer Pub Limited Format Available: Modern Exterior Ballistics is a comprehensive text covering the basic free flight dynamics of symmetric projectiles. The book provides a historical perspective of early developments in the 19th century, the technology leading to World War I and that through World War II into the modern post-war era. Historical topics include the first ballistic firing tables, early wind tunnel experiments, the development of free flight spark ranges and the first supercomputer, ENIAC, which was designed to compute artillery trajectories for the U. Army Ballistic Research Laboratory. The level of the text requires an undergraduate education in mathematics, physics, and mechanical or aerospace engineering. The basic principles of ballistic science are developed from a comprehensive definition of the aerodynamic forces that control the flight dynamics of symmetric projectiles. The author carefully starts with the basic vacuum point mass trajectory, adds the effects of drag, discusses the action of winds, simple flat fire approximations, Coriolis effects and concludes with the classic modified point mass trajectories. Included in the discussion are analytical methods, change of variables from time to distance, numerical solutions and a chapter on the Siacci Method. The Siacci Method provides a historical perspective for computing flat fire trajectories by simple quadrature and is used in the sporting arms industy. The final six chapters of the book present an extensive physical and mathematical analysis of the motion of symmetric projectiles. The linearized equations of angular and swerving motion are derived in detail. The effects of mass asymmetry, in-bore yaw, cross wind and launch in a slipstream are discussed. Special consideration is given to the derivation and explanation of aerodynamic jump. These subjects are then expanded to include a complete chapter on nonlinear aerodynamic forces and moments. The final chapter in the book presents an overview of experimental methods for measuring the flight dynamics of projectiles. The extensive collection of data on projectiles from small arms to artillery used to substantiate calculations and examples is alone a valuable reference. The ultimate joy of the book is the incomparable comprehensive set of flow field shadow graphs illustrating the entire spectrum of projectile flight from subsonic, through transonic and supersonic. The volume is a necessary addition to any undergraduate or graduate course in flight dynamics.

Chapter 3 : Modern Exterior Ballistics by Robert McCoy

In , Robert McCoy gave the shooting sports community a gift - his book, Modern Exterior Ballistics: The Launch and Flight Dynamics of Symmetric www.nxgvision.com all suffered a great loss when he passed away, mere months after his book was finished.

It runs on all modern Windows Win98 and greater computers. In addition to the usual tables and graphs of drop, velocity, and windage, Modern Ballistics has these unique features: Most long range shooting instructors refer to your gun having a "Zero" that depends on the altitude, temperature, bullet velocity, and ballistic coefficient of the bullet. The gun is constant with respect to the environment. The drop of the bullet changes, not the scope setting. This scope setting is referred to as the "Sight Angle" and is unique to Modern Ballistics. This unique way of looking at exterior ballistics makes a dramatic simplification to practical application of modern computing power to the solution of predicting the path of the bullet once it leaves the muzzle of your firearm. Generate probabilities of hits. These are based on your wind error estimates, muzzle velocity standard deviations, and inherent accuracy of the load in the gun. Simulate the sight picture. See various target shapes and sizes with different types of iron and optical sights at user selected range, and conditions. See how your hold must vary at yards versus yards. Change the wind, altitude, temperature or other conditions and compare your hold compared to the ideal hold calculated by the computer. Enable the tracer simulation to see the entire path of the bullet from your muzzle to the target and beyond. Watch it arc up and curve with the wind on its way to a distant target. Simulate the effect of wind estimation errors and shots per group on the total size of your groups. Use this program and find out. Compare the use of a somewhat inaccurate but wind resistant cartridge with that of a more accurate but less wind resistant cartridge -- under what conditions would you chose one or the other? Windows Phone Field Ballistics. What is useful for your desktop computer in your home is not what you need in the field trying to make a shot at a moving target yards away on a cold day far from your training range. Using the same powerful and unique Sight Angle way of solving the exterior ballistics problems you can get your ballistics solutions via your Windows Phone. Field Ballistics was written especially for Windows Phone. Use the same fast and accurate algorithms in Modern Ballistics anyplace or time you with your Windows Phone. Note to Law Enforcement -- Restrictions This powerful program is not for everyone. We will not sell this program to government law enforcement entities that deny basic human rights, such as the right to keep and bear arms. For this reason all national government law enforcement agencies are prohibited from using this program. See the Restrictions page for more details. Please keep in mind that this restriction is not aimed at the individual LEO. A very high percentage of the law enforcement community are in support of the individual right to keep and bear arms and the Bill of Rights in general. It is the politicians that do not appreciate it and demand the LEO enforce these unjust laws. As an individual you are welcome to use this program. It may not be used on any computer associated with law enforcement in national government or in restricted states.

Chapter 4 : JBM Bibliography

"Modern Exterior Ballistics" is a technical book, largely aimed at professionals with a technical background. However, Bob was a committed shooter. However, Bob was a committed shooter.

The Primer Along with the evolution of the metallic cartridge case and more efficient propellants, some reliable method of igniting the package was required. This is the job of the primer. This was no small accomplishment, considering that the flintlock ignition system had dominated the firearms world for over two hundred years. Credit for the invention of the percussion cap is somewhat obscure, with claims having been made by a long list of English, French, German and Swiss experimenters. Joshua Shaw, an English born American immigrant, is generally given credit for having developed the first metallic percussion cap in In use, this cup was placed on a nipple beneath the firearms hammer. This sent a jet of hot gases through a flash hole in the nipple, igniting the primary charge of black powder, and discharging the ball out the muzzle of the firearm. In a modern cartridge, each of these different components is still present, albeit in a single, self-contained unit. The percussion cap has since become the primer. The nipple, originally part of the firearm, is now located either in the case Berdan or the primer in the form of the anvil Boxer. The chamber walls, which held the powder, have now been supplemented with a fixed cartridge case. Today, there are two basic priming systems in use worldwide for metallic cased small arms ammunition. Designated as either Boxer or Berdan, they are named after their respective designers. In a perverse quirk of fate, the priming system used in England and throughout much of the rest of the world was developed by an American, Col. The predominant priming system used here in the U. The two systems are not at all interchangeable, and must not be confused. The primary difference between the two is the placement of the anvil, the point against which the priming compound is crushed. The Berdan system utilizes an integral anvil, formed into the base of the primer pocket. Additionally, Boxer primed cases utilize a single, fairly large, centrally located flash hole, making them eminently suitable for reloading. Berdan primed cases, on the other hand, normally have two or more smaller flash holes, located at various points around the anvil. This makes it impossible to decap Berdan cases as easily and efficiently as Boxer primed cases. While Berdan brass can be reloaded, decap-ping the cases is much more time consuming, and requires specialized equipment that is not commonly available. Essentially, reloading Berdan cases is not worth the effort if Boxer primed cases can be purchased or formed. The Berdan system has seen little use here in the U. They should be discarded after use, and never mixed with Boxer primed cases. Since Berdan primers are little used and rarely encountered here in the U. Primer Composition One ingredient that proved to be a great source of trouble in early priming compounds was fulminate of mercury. Easy to manufacture and very sensitive, fulminate of mercury was the basis for most early percussion caps and primers. The real problems began when brass cartridge cases and smokeless propellants began to see widespread use. Upon firing, the mercury in the primer amalgamated with the brass, chemically attacking and weakening the case. As long as black powder was the primary propellant used in small arms ammunition, this effect was minimized by the milder primers then in use, and the lower operating pressures inherent to this type of propellant. When smokeless propellants became more prevalent, the damage caused by mercuric primers immediately began to create major difficulties. While the mercury caused no damage to the firearm itself, cases fired with this type of primer became brittle, rendering them useless for further reloading. The damage was caused instantly upon firing, could not be prevented, and could not be corrected afterwards. Mercury was soon identified as the culprit, and was promptly eliminated. Corrosion was also a major problem in black powder firearms, due in part to the nature of the propellant itself, but largely to the qualities of the priming compound used in most early percussion caps and primers. Potassium chlorate, used as an oxidizer, was a primary ingredient in most of these mixes. Upon firing, some of this is deposited in the bore in the form of potassium chloride. Being very similar to ordinary table salt, potassium chloride is extremely hygroscopic, which is to say it attracts and holds moisture. Naturally, this causes rusting in short order. As potassium chloride is soluble in water, but not by most conventional bore solvents, its removal required very specific bore care techniques. Since most bore solvents were not effective in dissolving or removing this residue, some

means of eliminating the potassium chlorate was needed. Oddly enough, it took many years and some exhaustive studies to determine what caused the gun corrosion problems experienced in this period. It was not until that Dr. Huff, working for the Bureau of Mines at the request of the War Department, identified chlorate primers as being the source of this corrosion. Having located the agent causing the trouble, the next task was to eliminate it by finding a substitute. This proved to be a long and arduous task, despite the fact that rust-free primers were already in use with several foreign military services around the world. Ordnance was adamant concerning the reliability, storage life and stability of any new compound used in their priming mixtures. Their hesitancy to accept a new mixture was the result of a seemingly minor change on the eve of World War One, which nearly had catastrophic consequences. After this experience, they approached new developments with an understandable degree of trepidation. Eventually a priming compound was developed that omitted the potassium chlorate, using lead tri-nitro-resorcinate instead. This mixture proved to give the stability and reliability demanded by the military, and was finally adopted after extensive testing. On the commercial front, many American manufacturers were already using noncorrosive primers in any of several different mixtures. Corrosive primers may still be encountered, even though their use was discontinued in U. Foreign military surplus ammunition containing corrosive primers often of the Berdan type is still frequently found at discount prices. Considering the problems that may be associated with its use, this ammunition may not be the bargain that it first appears to be. Today, small arms primers have evolved to the point of such extreme reliability that they are often taken for granted. The components used in modern Boxer primers consist of 1 a cup 2 the pellet, or priming mixture 3 the foil, and 4 the anvil. Most manufacturers apply a nickel plating to their primers for appearance sake, giving them their familiar silver coloration. The thickness of the various types has a direct correlation on the strength and sensitivity, largely determining whether it is suitable for a rifle or pistol. The more thinly cupped pistol primer may not hold the pressure of a high intensity rifle load, and may be pierced or blown if used in this type of application. The thicker cups common to rifle primers, on the other hand, may give misfires or accuracy problems if they are used in some pistols. Despite the dimensional similarities between the two types, they should not be interchanged. There are some handgun cartridges that have been designed to use rifle primers, such as the. These, of course, should be used with the primers for which they were originally intended. When using the reloading data, please refer to the Test Components section for information on which primer was used for our load development. As we have seen, all modern primers are both noncorrosive, and non-mercuric. Different amounts, and in some cases different types of priming compound may be used, depending on primer make, size and type. This acts as a shield for the pellet, protecting it from moisture and other disruptive influences that may effect performance or reliability. Some manufacturers color code this disc to aid in identification. However, since there is no standard coding among manufacturers, we recommend discarding any loose primers whose brand and or type has become suspect. In examining a primer, you will note that the anvil extends a few thousandths of an inch above the cup. This is to allow the anvil to slightly compress the pellet when the primer is seated, thus sensitizing the primer. These statements hold true for both large and small sizes and for both rifle and pistol types. Differences between the two include priming composition mixture, cup thickness and sensitivity, and very slight dimensional discrepancies in height. Within these sub-categories, the primers are defined still further, as standard, magnum, and in rifles, benchrest primers. Distinctions between these types vary from brand to brand, but most relate to composition mixtures, intensity and quality control standards during production. Diameters of the two sizes are. With so many different sizes and types available, how does the reloader know which type is appropriate for a given application? The following paragraphs will serve as a general guide for primer selection. In addition, the specific size, brand and type of primer used in our data development is listed under the Test Components heading for each cartridge in this manual. Small pistol primers, either standard or magnum, must not be used for rifle cartridges. They may also be a good choice for non-magnum cartridges when extremely cold shooting conditions are encountered. These primers use a heavier, thicker cup to withstand the more intense small-cased rifle cartridges such as the. Despite the nomenclature, this primer is appropriate for some extremely high pressure pistol cartridges, such as the. They are also appropriate for loading rifle cartridges such as the. They may also prove to be beneficial when very large amounts of powder

are being ignited, as in wildcats such as the. While this is not always the case, it is usually worth experimenting with these primers if the ultimate in accuracy is required. As such, large pistol primers present the same risks as the small pistol primers if they are indiscriminately used in rifle loads. Their use in rifles must be limited to those pistol cartridges that have been chambered in rifle designs, such as the. CCI , Federal No. With their greater power, they may also be a good choice for loads that will be used in subzero climates. Adequate for all but the largest and most difficult to ignite charges, standard Large Rifle primers are probably the best choice for the vast majority of rifle reloading applications. We suggest opting for the magnum primers only after careful consideration of the type of cartridge being loaded, and the circumstances under which the ammunition will be used. It is perhaps worth mentioning that some of this class of primers have been developed for very specific applications. The Federal primer, for example, was designed to reliably ignite the massive powder charges associated with the Weatherby line of magnum cartridges. These should be used as shown in the loading tables, and must not be randomly substituted for standard large rifle primers. With their sharper ignition characteristics, they will frequently give higher pressures than a standard primer used in an otherwise identical load. With the prospect of improved accuracy, match-grade primers deserve some consideration not only for competitive ammunition, but also for those hunting applications that demand extreme accuracy.

Chapter 5 : exterior ballistics

by James B. Millard, "On-line Ballistics" (denoted by M). Note: Many of the corrections below are "cosmetic", such as revised spacings between symbols or commas, and are designed to make the text easier to read.

A Ballistics Bibliography For those of you with an urged to delve deeper into the field of ballistics the following reading list may be of some interest to you. This list was compiled from several sources including bibliographies in some of the books listed, NTIS listings, and recommendations from associates in the various fields. These books and reports were written by various acknowledged experts in the field and not gun rag writers. None are light reading and most are fairly heavy on the math or technical information, but these probably most of the truly important works on the subject. An incredible wealth of ballistics information from the old Frankfort Arsenal, Aberdeen Proving Ground, and other government sources is available through the National Technical Information Service www. The problem is that much of it, such as the ground breaking internal ballistics research done at Frankfort Arsenal in the 40s and 50s was stored when the the projects ended or the arsenals closed down and was never declassified. While a researcher can request declassification the process is long and convoluted and you need a "paid subscription" to NTIS in order to make full use of their search facilities. I have recently been informed that many of these documents may be available online at http: Change the dropdown menu to "Technical Reports" and do some searches for the titles. Thanks to Ben T. Online searches will reveal a plethora of books on the subject of ballistics but keep in mind that many of them may be out of date, especially those published before the s. Please note that I cannot help you locate any of these books or documents. However you might try the inter-library loan program at your local library or the online version http: It does however contain some erroneous assumption in its discussion of terminal ballistics. The corrections are available in PDF format from www. However, the following may be of interest to advanced students. Most of these works came from the Ballistics Research Lab at Aberdeen proving Ground and are probably not commercially available except through the National Technical Information Service. I have listed some of the more interesting titles that I have come across in that book. Carlucci, Donald, Sidney Jacobson, Ballistics: Internal Ballistics, Philosophical Library, Inc. Most of these works came from government organizations and the aerospace industry and are probably not generally available except through NTIS. I have listed some of the more interesting titles that have been brought to my attention. The following have been recommended to me. They are heavy reading. Coat, Colonel James B. Now available in a second printing from Wound Ballistics Review:

Chapter 6 : A Ballistics Bibliography

Modern Ballistics This is the web home of Modern Ballistics: the world's most sophisticated small arms exterior ballistics program for the personal computer. It runs on all modern Windows (Win98 and greater) computers.

Chapter 7 : Corrections to Modern Exterior Ballistics by Robert L. McCoy

Modern Exterior Ballistics - Robert L. McCoy Review by G. Salazar Bob McCoy is widely and properly regarded as the dean of modern ballisticians and this book is his most accessible work.

Chapter 8 : Ebook Modern Exterior Ballistics as PDF Download Portable Document Format

Modern Exterior Ballistics has 10 ratings and 0 reviews. This text covers the basic free flight dynamics of symmetric projectiles. It provides a historic.

Chapter 9 : First Edition of "Modern Exterior Ballistics" by Robert L. McCoy : EBTH

Exterior Ballistics of Small Arms Projectiles, E. D. Lowry, Research Dept., Winchester-Western Division, Olin Mathieson Chemical Corporation, May 4, -- Has some useful formulas and values for various drag functions as a function of velocity.