Richard Nakka's *Experimental Rocketry* Web Site

The following listing represents books and articles that I have collected over the years as part of my technical reference library. These suggested titles may serve as useful sources of information for anyone interested in experimental rocketry, or rocketry in general. Some titles are available in any good library, others in engineering or technical libraries. Some are probably out of print, and some of the really older ones have likely been relegated to library archives. A couple have not been published, but I've included them anyway. And others are available for downloading on the web.
The list is not necessarily in any particular order.

- Rocket Propulsion Elements George P.Sutton Wiley Publ.
  The rocket engineers bible. Describes in detail the theory of rocket engines with regard to propellant chemistry and combustion (liquid and solid), nozzle theory, and flight performance, as well as testing. Indispensable for the basic formulations regarding the engineered design of rocket motors.

- Rocket Manual for Amateurs Bertrand R.Brinley Ballantine Books
  One of the first books published (1960) on amateur rocketry. Worthwhile reading, if only for its historical significance, and the fact that it covers a broad range of topics regarding the field of experimental rocketry (basic design, propellants, testing, launching site design, tracking and evaluation of data, etc). Tends to get carried away, however, with the safety aspect of rocketry. He probably (inadvertently) does experimental rocketry something of a disservice in the process. Well, his propellant of choice is the zinc powder/sulphur, which is probably as hazardous as amateur propellants go, simply because its a powder.

- Topics in Advanced Model Rocketry Gordon K.Mandell MIT Press

Cover dynamics of rocket flight, aerodynamic stability and trajectory analysis. Intended for model rockets, but just as applicable to experimental rockets. Highly mathematical, its useful for anyone who wants to fully examine the complex nature of rocket flight. I've mainly found it useful mainly for the good section on aerodynamic drag. Includes a very good section on calculation of a rocket's CP (by Barrowman method) and CG.

- Handbook of Model Rocketry G.Harry Stine Wiley Publ.
  Although written for model rocket enthusiasts, this book contains lots of useful information that is just as applicable to experimental rockets, such as ignition systems, launching techniques, stability, altitude tracking, payloads, and recovery systems. And the information is very well presented and explained.

- 50 Model Rocket Projects for the Evil Genius Gavin D.J Harper; McGraw-Hill, 2006 NEW
  Despite its peculiar title, this book is worthwhile for those who wish to get more out of model rocketry than your average kit-builder. Welcome emphasis is placed on building parts from "scratch" as an alternative to simply buying "off-the-shelf". This approach to the hobby serves as an excellent transitional step from model rocketry to amateur experimental rocketry (AER), for those who later wish to pursue the ultimate in scratch-built rocketry. This book encourages the reader to explore beyond the conventional, through projects such as a self-made wind tunnel, launch controller, rail launcher, rocket cameras, flight computer, apogee sensors and other sensor projects. Details tend to be minimal, although this is likely intentional, leaving the reader to gain more benefits (and rewards) from the projects by using their own resourcefulness. A couple of nice touches to the book are the numerous historical accounts relating to various aspects of rocketry, and the emphasis placed on the importance of math to the rocketry hobby.

- The Rocket Files 2nd Edition Joseph T. Jimmerman NEW
  This book is intended for anyone interested in general rocketry, and covers a broad base of topics. The fundamentals of rocket design are explained, which is then applied to basic model rocketry, as well as more advanced rocketry including HPR and amateur experimental rocketry. Also discussed are concepts such as staging and clustering, launch pads, payloads, experiments, telemetry and alternative rockets. Although intended primarily for those who are new to hobby rocketry, this skillfully written book is enjoyable to read even for those who are at a more advanced stage of the hobby.
  Available for ordering through the Western Space Technology website

- Retro Rockets -- Experimental Rockets, 1926-1941 Peter Alway NEW
  This hardcover book provides an overview of many key experimental rockets that were developed (and in most cases flown) by the early rocketry pioneers, such as Goddard, Winkler, Von Braun, and groups such as ARS, VfR and GIRD. Includes many historic photos and also basic drawings of these rockets. Although intended primarily for the rocket modeler, I bought this book out of my own interest in the history of technology, especially rocketry. Very interesting reading and also enlightening, especially for those of us who endeavour to design and build our own

experimental rockets!

- The Potassiumnitrate-Sugar Propellant Antoon Vyverman 1978?
  Well researched treatise on this propellant, covering theoretical analysis, preparation and rocket construction, as well as engine testing.
  Available for ordering through the VRO website

- Simulation of Potassium Nitrate-Sugar Rocket Motors Antoon Vyverman 2002
  Fascinating article that investigates the unexpected behaviour of several rocket motors powered by the sugar-based propellants. Using a specially written computer program, Tony strives to simulate the performance behaviour of these motors through the introduction of 'ignition delay', grain 'cracks' and erosive burning.
  Available for download from the Amateur Rocketry Links Library website (PDF format)

- The Rocket Handbook for Amateurs Lt.Col. Charles M.Parkin, Jr. 1959
  This book is a compilation of articles written by different authors, and as such, the topics covered are quite diverse -- solid propellant rockets, liquid propellant rockets, satellite orbit geometry, human factors in space flight (not quite sure what this has to do with amateur rocketry...), building and testing of rockets, fuel pump and turbine design, cryogenics, etc. Most of the material is quite briefly presented and is rather elementary (except the section on pumps and turbines...which is WAY too advanced for the beginner!). However, the section on designing solid propellant rockets is quite well written, and may be of value to someone just starting out in this endevour. Bear in mind, this book is quite dated ("Man has now accepted a challenge as old as himself -- the conquest of space")!

- Experimental Composite Propellant Terry W.McCreary, Ph.D., 2000
  This book provides an excellent introduction to experimental composite propellants. Topics covered include preparation of a simple starter propellant (basically, AP/PBAN), basic motor construction, static testing, flight motor design, and modification of the starter propellant to achieve various goals (e.g. performance, burn rate) or effects (e.g. smoke, sparks). Includes comprehensive appendices: e.g. nozzle construction, igniters, polymer chemistry (which I found to be particularly interesting), vacuum processing, sources for materials, and lots more.
  Read the Review (or order) at Rocketry Online or contact the author at prfesser@hotmail.com

- Solid Propellant Rocket Motor Design and Testing R.A.Nakka 93 pages
  This is my B.Sc. graduation thesis that presents the theory behind solid rocket motor design and in particular, the performance of the KNO3-sucrose powered B-200 motor with regard to theoretical v.s. testing results. Topics covered include combustion analysis and nozzle flow theory, including derivation of the equations employed in nozzle and motor design. Analysis of two-phase flow with resulting modified performance equations. A description of the test equipment and methods used to compare the delivered performance of the motor to that predicted by theory.
  Available for download in pdf format: Downloads
  *Now also available in **high resolution** pdf format (10 Mb total). E-mail me if interested.* NEW

- Designing Rocket Motors James E.Lanier Gas Dynamics Lab

This booklet presents a condensed version of the theory of experimental rocket motor design and testing in simplified terms.

- Theoretical Evaluation of Chemical Propellants Roger Wilkins Prentice-Hall
  An advanced textbook for determining the theoretical performance of propellants. Sounds enticing, but much of the mathematics are well beyond my capabilities.

- Propellant Chemistry Stanley F.Sarner Reinhold Publishing
  Another advanced textbook for determining the theoretical performance of propellants. Has some useful information on determining chemical equilibrium of combustion products. Also, has extensive information on propellant binders, fuels, and oxidizers (solid and liquid).

- Mechanics and Thermodynamics of Propulsion Philip G.Hill Addison-Wesley Publ.
  Good text for studying the theoretical performance of rocket propellants and combustion, as well as nozzle flow theory. Discusses in detail the effects of smoke particles in the exhaust (2-phase flow), important for many amateur propellants.

- Jet Propulsion Engines O.E. Lancaster Princeton University Press
  Another good text for studying the theoretical performance of rocket propellants and combustion, as well as nozzle flow theory. Good section on burnrate characteristics of rocket propellants.

- Solid Rocket Propulsion Technology Alain Davenas Pergamon Press
  Another good text for studying the theoretical performance of rocket propellants and combustion, as well as nozzle flow theory. Detailed section on solid propellant combustion and internal ballistics of motors. Also, good section on the testing of rocket motors and burnrate determination utilizing strand burners.
  Published in France, it provides for a European (and thus metric) approach to these topics.

- Handbook of Chemistry and Physics Weast CRC Press, 58th Ed.
  Invaluable source of chemistry and thermodynamic data required for propellant performance analysis.

- Fluid-Dynamic Drag Sighard F.Hoerner published by author, 1958
  A wealth of practical information on aerodynamic drag for just about any structure or body. I've used it for estimating drag coefficients of my rockets and parachutes. Covers subsonic, transonic, supersonic and hypersonic drag.

- Detonation and Two-Phase Flow S.S.Penner American Rocket Society Series
  A technical paper covering analysis of two-phase flow in rocket exhaust (mixture of gases and smoke particles).

- Analysis and Design of Missile Structures E.F.Bruhn Tri-State Offset Co.
  Covers structural analysis and design of rockets, including fuselage sizing and motor casing design.

- Parachute Recovery Systems Design Manual (NWC TP 6575) T.W.Knacke Para Publishing
  A wealth of information on the design, analysis, and selection of parachute recovery systems. Includes detailed information on recovery system concepts, parachute performance, force and stress analysis, materials, component design, aerodynamics (including supersonic parachutes), stability, inflation concept, reefing, deployment techniques, multiple parachute systems, opening and snatch forces, drogue and pilot chutes, and much more. Indispensable for anyone considering parachute design and/or fabrication.

- Fundamentals of Solid-Propellant Combustion K.K.Kuo & M.Summerfield AIAA publication
  A collection of papers dealing with the topic of solid propellant combustion, in particular, historical and state-of-the-art developments (as of 1984) pertaining to the understanding of the process. Topics covered include the chemistry of ignition and combustion of AP-based propellants, flame-spreading and ignition transient, steady-state burning (burn rate laws, influence of additives, mesa and plateau effects), various combustion models of composite propellant, metallized propellant chemistry, erosive burning, combustion instability and smokeless propellants. Although much of the mathematics and chemistry are beyond my understanding, this nearly 900 page book made for interesting "reading", as it provided valuable insight into the chemical and physical processes involved in the remarkably complex processes that occur in the burning process we take largely for granted.

- Introduction to Fluid Mechanics Fox&McDonald Wiley
  Best engineering textbook I've come across regarding understanding the fundamentals of compressible fluid flow (as in rocket nozzles).

- Guided Missiles Fundamentals AF Manual 52-31 USAF, 1957
  An introductory text on rockets (missiles) including basic rocket engine theory, aerodynamics and guidance. Minimal technical value, unless you are interested in guidance systems.

- Merck Index Merck Publishing Group
  Good source of chemical physical data.

- The Amateur Scientist C.L.Stong Simon & Schuster, 1960
  A collection of really advanced science projects from Scientific American dating back to the early sixties (would you believe--"an astrophysical laboratory in your backyard", "how to cultivate harmless bacteria", "how to tranquilize a rat", "peanut-butter jar nuclear cloud chamber", "a simple magnetic resonance spectrometer", "homemade atom smasher", "bathtub aerodynamics", "amateur x-ray machine", and a few "after dinner experiments", to boot !). And a chapter on amateur rocketry. Strictly speaking, not a lot of useful information, but I treasure my now yellowed copy of this book, despite the fact that its beginning to fall apart. The chapter on amateur rocketry lit the spark in me and set me on the road to the world of experimental rocketry.

- Rocket Propellant Handbook Kit & Evered, 1960

This book describes a hundred or so chemicals which have been used (or have potential to be used) for rocket propellants, both liquids and solids. Included are the physical and chemical properties required for thermodynamic or other calculations. As well, performance figures are given. Also discussed are *pressurizing gases*, with physical properties given for the more common ones (N2, He and air). Propellant chemicals considered include: aluminum, ammonia, Boron, Fluorine, Hydrazine, Hydrogen, Hydrogen Peroxide, Lithium, Potassium Nitrate, Ammonium Nitrate, Nitric Acid, Nitrous Oxide, Oxygen, Ammonium Perchlorate, Potassium Perchlorate, water, Alcohols, Benzene, Nitromethane, Nitroglycerin, Petroleum, Polyester, Polysulphide, Polyurethane, Rubber, Paraffins, Methane, Ethane, Propane, Octane, Acetylene, and many others.

- Basic Rocketry Aerodynamics Hans Olaf Toft
  Excellent introduction to rocketry aerodynamics and stability. Lift, drag, angle of attack, stability, Mach number, Reynolds number, Drag coefficient (Cd), Lift coefficient (Cl), Centre of Pressure (CP), (subsonic & supersonic), Centre of Gravity (CG), and relationship between CP and CG for a stable rocket, aerodynamic drag, wind effects, Static Stability Margin.
  HTML format seen at the DARK website

- Hazards of Chemical Rockets and Propellant Handbook CPIA Publication No.194 (1972)
  A comprehensive three volume set of handbooks intended as a source of information and basic guidelines for the processing, handling, storage and transportation of chemical propellants and ingredients.
  Volume I covers "General Safety & Design Criteria", which includes exposure limits, fire hazards and prevention, disposal, and hazard identification and evaluation.
  Volume II covers Solid Propellants, and includes hazards analysis and detailed techniques for evaluation (e.g. tests for sensitivity to self-heating, impact, friction, static discharge, impingement, dust explosibility). Data is given for the chemical, physical and hazardous properties of several fuels and oxidizers. Manufacturing processes are discussed, with emphasis on hazards identification and reduction.
  Volume III covers Liquid Propellants and provides detailed chemical, physical and hazards properties of several liquid fuels and oxidizers, including monopropellants. Storage and transportation is also discussed in detail.
  This handbook is a must for anyone considering rocket propellant research.

- Astronautic Structures Manual NASA
  This document (Volume I, II, and III) presents an extensive compilation of methods in aerospace structural design and stress analysis. The three volumes represent a total of over 2500 pages! *Available for download from the MSFC website (pdf format)*

- Transonic Drag Measurements of Eight Body-nose Shapes NACA RM L53K17
  A very interesting report on the transonic drag coefficients of various "supersonic" nosecone shapes, such as conical, parabolic, power function, and Von Karman. The range of Mach numbers (0.8 to 1.25) is of particular interest to those amateur rocketry enthusiasts designing high-performance rockets. Which shape is best? As it turns out, there is not a simple answer...

Available for download from the Marshall TRS website (pdf format)

- Solid Rocket Motor Metal Cases NASA SP-8025
  This NASA technical report covers design criteria for rocket motor casings, including failure modes, material properties, design safety factors, loading, structural analysis, structural dynamics, and testing (destructive and nondestructive).
  Available for download from the Marshall TRS website (pdf format)

- Solid Rocket Motor Performance Analysis and Prediction NASA SP-8039
  A useful NASA technical report that covers design criteria for SRM's (solid rocket motors). It describes the basic equations and methods of analysis that should be used in the design of an SRM. Included are predictions for thrust, chamber pressure, specific impulse, flow-field modeling, transient (ignition, start-up and tailoff) behaviour, burning-front progression, nozzle performance, factors that cause performance losses in actual motors due to : two-phase flow, heat loss, nozzle divergence, and flow separation. Also covered are prediction of motor mass and balance v.s. time, scaling with BEM's (ballistic evaluation motors), propellant density determination, propellant burning rate measurements, and an excellent section of augmentation of burning rates.
  Available for download from the Marshall TRS website (pdf format)

- Solid Propellant Selection and Characterization NASA SP-8064 (106 pages)
  An interesting report that provides an overview of the propellant characterization and selection process. Included are discussions of contemporary propellant types (and the performance properties of each), factors that affect efficiencies, internal ballistic properties (burn rate & pressure exponent), mechanical properties and hazard ratings. Also discussed are performance characterization such as delivered specific impulse, combustion efficiency and residence time, chamber pressure, flame temperature, nozzle efficiency (in particular, the significant effects of two-phase flow), density impulse, burning rate modification and reproducibility, pressure sensitivity of burning rate, modification of pressure exponent, temperature sensitivity of burning rate, burning rate measurements (e.g. strand burner), erosive burning and oscillatory combustion. The final topics discussed are the characterization of mechanical properties, viscoelastic and thermal properties, failure properties, shelf life, hazard characterization (impact, friction, spark, autoignition, detonation and toxicity).
  Available for download from the Marshall TRS website (pdf format)

- Solid Rocket Motor Igniters NASA SP-8051
  An interesting NASA technical report that covers design criteria for rocket motor igniters. Covers fundamentals of the ignition process: initiators, energy release systems, ignition theory, heat transfer, hardware, electroexplosive devices, pyrogens, prime charges, output charges, and pressurization of motor chamber due to output charge combustion.
  Available for download from the Marshall TRS website (pdf format)

- Solid Rocket Motor Nozzles NASA SP-8115
  This report details the steps involved in the design of a rocket nozzle. Covered are

topics such as entrance and exit angles, nozzle throat inserts (including graphite washers), erosion rate, slagging, thermal liners and insulators, structural aspects of nozzle design, o-ring seals, attachment concepts, plugs, as well as heat transfer considerations. Contains some nicely detailed figures of nozzle cross-sections of some well known rockets such as Polaris, Pershing, Minuteman, as well as the leviathan 260 inch SL-3 motor. Although topics are covered briefly, the information is both interesting and informative.

For a complete listing of NASA SP-8000 series Technical Reports, see:
Links to over 100 NASA Space Vehicle Design Reports

- Design of Axisymmetric Exhaust Nozzles by Method of Characteristics Incorporating a Variable Isentropic Exponent NASA TR R-33
  E.Costilow Guentert & H.E.Neumann, 1959 NEW
  This article discusses a method to design "bell-shaped" nozzles by use of the *method of characteristics*, which is a technique for designing shock-free nozzles by application of a linearized solution of the supersonic flow equations.

- Equations for the Design of Two-Dimensional Supersonic Nozzles NACA RM E8B02
  I.I.Pinkel, June 1948 NEW
  This early report on rocket nozzle design presents equations and charts applicable to the "method of characteristics" for supersonic nozzle design.

- Performance of Several Method-of-Characteristics Exhaust Nozzles NASA TN D-293
  J.M.Farley & C.E.Campbell, 1960 NEW
  This report compares measured performance data for three "Method-of-Characteristics" nozzles and one 15 degree conical nozzle at pressure ratios up to 130, and expansion ratios varying from 10 to 25.

- Performance of Several Conical Convergent-Divergent Rocket-type Exhaust Nozzles NASA TN D-467
  C.E.Campbell & J.M.Farley, 1960 NEW
  This report compares performance data for conical nozzles at pressure ratios up to 120, divergence angles of 15, 25 & 29 degrees, and expansion ratios varying from 10 to 25.

- Nike-Tomahawk Assembly and Handling Procedures (prep. for NASA GSFC, 1967)
  Highly insightful look into how professional sounding rockets are prepared for launch (the Nike-Tomahawk is a two-stage, solid propellant, fin stabilized sounding rocket).

- Aeroballistic Characteristics and Flight Test Results for Hawk and Nike-Hawk Sounding Rocket Vehicles L.W. Gurkin & H.C.Needleman
  This article compares flight test predictions to actual flight data for the Hawk (single stage) and Nike-Hawk (two stage) sounding rockets. Included in this report

are vehicle description, mass and c.g. data, aerodynamic data such as c.p., force/drag characteristics, as well as roll and ballistic trajectory data.

- NEAR Technical Report TR-002-B/00 Jan-Erik Rønningen
  This report provides a technical description of the NEAR E-1D Rocket System and Alpha RRM600A Rocket Motor. This rocket, designed by the Norwegian group NEAR, is 1600 mm. in length, 75 mm O.D., and is propelled by a 0.534 kg. grain of KN-Sorbitol. Included in this report are detailed drawings of the motor and propellant grain, as well as predicted performance data. Rocket vehicle data includes a brief description of the various components, as well as mass and c.g. data.
  Available for download from the NEAR website (MS Word format)

- NEAR Technical Report TR-003-0/00 Jan-Erik Rønningen
  This report provides a technical description of the NEAR E-1E Rocket System and Alpha RRM600B Rocket Motor. This rocket, designed by the Norwegian group NEAR, is 1600 mm in length, 75 mm O.D., and is propelled by a 0.534 kg. grain of KN-Sorbitol. Included in this report are detailed drawings of the aluminum cased motor and propellant grain, as well as predicted performance data. Rocket vehicle data includes a brief description of the various components, as well as payload, rocket mass and c.g. data.
  Available for download from the NEAR website (MS Word format)

- NEAR Technical Report TR-001-A/00 Jan-Erik Rønningen
  This report provides a technical description of the NEAR SCA2000B Rocket System and Phenix-100C Rocket Motor. This rocket, designed by the Norwegian group NEAR, is 3264 mm in length, 159 mm O.D., and is propelled by a 38 kg., four-segmented grain of KN-Sorbitol. Included in this report are detailed drawings of the motor (P-class) and propellant grain, as well as predicted and actual performance data. Rocket vehicle data includes a brief description of the various components, as well as payload, rocket mass and c.g. data.
  Available for download from the NEAR website (MS Word format)

- Applications of the Simplified Nozzle Flow Theory in Model Rocketry Essay done as a part of The International Baccalaureate Diploma Programme by Lauri Wirola
  An excellent report that investigates the effect of changing the nozzle divergence angle on a rocket motor. Several static firings were conducted on small KN-Sucrose motors with divergence angles of 5, 10, 15, 20, 30 and 45 degrees. Results were compared with respect to the delivered specific impulse in order to determine which provides best performance.
  This essay won first prize (of about 200 entries) in a national science competition.
  Available for on-line viewing at www.saunalahti.fi (link broken?)

- Mechanical Design of Rocket Motors Michael Milling Madsen and Jorgen Franck
  This report covers the structural design of experimental rocket motors, including sizing of the casing, as well as nozzle and bulkhead attachment methods. Also covers nozzle throat inserts and ceramic nozzle design.

Available for download from the DARK website (pdf format)

- The Recovery of Rockets Jorgen Franck (Danish Amateur Rocket Club)
  This report discusses the use of parachutes as a recovery method, and provides details on how to determine parachute drag and descent rates.
  Available for download from the DARK website (pdf format)

- Some Considerations on the use of a Pressurized Tank System for a Rocket Engine R.Sandri, Canadian Aeronautics and Space Journal, Oct.1967
  This report determines the relationship between the mass of a pressurized tank system (for a liquid propellant rocket) and the expulsion pressure. The report concludes that a pressurized tank system is best used with a low combustion chamber pressure.

- Properties of a Standard Atmosphere ESDU Data Item 77021, 1977 (Amd.1986)
  This item gives properties of a standard atmosphere for altitudes up to 1000 km. Included are tables, graphs and equations for temperature, pressure, density, viscosity, thermal conductivity and speed of sound as a function of geometric or geopotential altitude.
  www.esdu.com

- The Descriptive Geometry of Nose Cones Gary A.Crowell Sr. (1996)
  Ever wonder what exactly is meant by a "tangent ogive" nose cone shape? (I have!). This excellent and informative article describes that and other popular nose cones with regard to geometry and drag characteristics, including shape equations.
  NCEZN2.doc NEW

- Introduction to Solid Rocket Propulsion P.Kuentzmann, Office National d'Etudes et de Recherches Aerospatiales (May 2002)
  Comprehensive NATO funded technical paper presenting the fundamental theory of solid rocket motor propulsion including a summary of state-of-the-art understanding of propellant combustion. Other topics covered include an interesting discussion of flow-structural interaction, which can lead (and has led) to motor failure under certain conditions. Also covered is a section on numerical modeling of motor internal flow aerodynamics.
  Available for downloading from *ftp://ftp.rta.nato.int//PubFullText/RTO/EN/RTO-EN-023/* NEW

- ARS Journals (also Jet Propulsion journals)
  The journals of the American Rocket Society, published during the '50s and early 60's, are a real treat to browse through, and contain many interesting and often useful articles on early research into rocket propulsion (when solutions were obtained analytically rather than by computer!). Wonderful insight into the history of rocket development during that golden era. Kind of hard to get hold of these days, as most technical libraries seem to have them now archived. Amongst the articles that I have collected are:

ARS Journal:

- "A Rapid Method for Estimation of Specific Impulse", January 1950
- "Gamma Large or Small?" , October 1961 (note gamma is ratio of specific heats)
- "Dynamics of Two-Phase Flow in Rocket Nozzles", December 1962
- "Thrust of a Conical Nozzle", March 1959
- "Evaluation of Conical Nozzle Thrust Coefficient" , August 1959
- "Adiabatic Nozzle Flows", June 1961
- "A Rapid Method for Estimation of Specific Impulse", January 1959
- "Gas Particle Flow in an Axisymmetric Nozzle", June 1961
- "Dynamics of Two-Phase Flow in Rocket Nozzles", December 1962
- "Tentative Explanation of Irregular Burning in Solid Propellant Rockets", October 1961
- "Integratable Form of Droplet Drag Coefficient", October 1961
- "Recent Advances in Gas-Particle Nozzle Flows", May 1962
- "Experimental Determination of Thermal Lag in Gas-Particle Nozzle Flow", July 1962
- "Combustion Chamber Pressure Loss", December 1958

Jet Propulsion:

- "Exhaust Nozzle Contour for Optimum Thrust", June 1958
- "An Iterative Method of Determining Equilibrium Compositions of Reacting Gases", April 1958
- "Some Properties of a Simplified Model of Solid Propellant Burning", June 1958
- "Design, Fabrication and Testing of the Vanguard Satellite", April 1958
- "Recent Advances in Solid Propellant Grain Design", July 1959
- "A Practical Mathematical Approach to Grain Design", April 1958
- "The Trajectory of a Rocket with Thrust", July 1958
- "Optimum Rocket Trajectories with Aerodynamic Drag", July 1958
- "Erosive and Strand Burning of Stick Propellants: Theoretical Modeling of Erosive-Burning Processes", July 1990
- "Geometric Analysis of Cylindrical Star Perforated and Tapered Grains", Jan. 1992

Some of these articles are available in PDF file format. Contact me for more information. NEW

"*I had discovered that learning something, no matter how complex, wasn't hard when I had a reason to want to know it.*"
- Homer H.Hickam, Jr., from his memoir Rocket Boys

Last updated April 4, 2008

Return to Top of Page
Back to Home Page