



WHITE EAGLE
AEROSPACE



Basic Missile Aerodynamics

MAKE YOUR CAREER SOAR

Welcome

Thank you very much for your interest in White Eagle Aerospace. Since our founding in 2006, we have become a trusted leader in professional technical training and education throughout the aerospace industry.

As a fellow aerospace professional with over 45 years of industry experience, I understand the critical need for ongoing technical training in the workplace. White Eagle Aerospace was established in order to meet this pressing need.

For many years, we have recognized a looming crisis in the aerospace workforce. Throughout the industry, there is an increasingly bimodal distribution of aerospace professionals. One end of that distribution contains young, well trained, highly motivated, but very inexperienced professionals. The other end of that distribution involves individuals who have been around for a long time, have a great deal of experience and are on their way out of their chosen profession. This leaves a valley between the two.

Who is going to pass the baton to the upcoming generation of aerospace professionals? Where will they get their knowledge – knowledge that goes beyond academia and even graduate degrees? Much of what they need to know is not available in today's standard university curricula. What they need is:

- Specialized knowledge over a range of disciplines
- Knowledge provided by an experienced expert in the field
- Knowledge conveyed by a master instructor

White Eagle Aerospace recognizes these issues and provides effective solutions for your workforce. We are pleased to present you with this brochure, which outlines our Basic Missile Aerodynamics (BMA) professional short course. Our team of industry experts and master instructors is dedicated to your success. Should you have any questions about our course catalog or desire more information on how we can help MAKE YOUR CAREER SOAR, please contact us today.

Best Regards,



John Terry White,
President/CEO
White Eagle Aerospace



About Our Company

Whether you are new to the aerospace industry or have years of professional experience, we are your provider-of-choice for expert technical training.

Acquiring key knowledge, critical lessons-learned and technical know-how are crucial ingredients for success in today's complex and highly competitive aerospace market. Our nationally-acclaimed short courses cover a wide range of highly useful technical subjects. Each course is delivered by a subject matter expert who is also an expert technical instructor.

We offer you comprehensive technical training in essential topics, with minimal time away from work – all at a price that fits today's tight training budgets.





Target Audience

The Basic Missile Aerodynamics (BMA) short course provides a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles.

This short course is intended for the aerospace professional seeking expert instruction in the fundamentals of missile aerodynamics as applied to airframe design, analysis and test. Course material has direct application across a broad spectrum of missile types. This intensive training program is designed to help participants become more knowledgeable and competent in matters relating to missile aerodynamics.

Aerodynamicists, airframe designers, wind tunnel test engineers, flight test engineers and flight controls specialists will particularly benefit from taking this unique technical training course.

Delivered by a master instructor and subject matter expert with over 45 years of professional aerospace experience, this 4-day intensive training course will provide participants with invaluable real-world knowledge, enhanced understanding and improved competency in this key discipline.

Who Will Benefit

- Aerodynamics Engineers
- Flight Test Engineers
- Airframe Designers
- Launch Vehicle Designers
- Missile Defense Technologists
- Missile Systems Engineers
- Wind Tunnel Test Engineers
- Operations Research Analysts
- Flight Control Specialists
- Flight Simulation Specialists
- Stability and Control Specialists
- Systems Engineers
- Program Managers
- College Students

Group Discounts

White Eagle Aerospace is dedicated to meeting your organization's professional training needs. In order to better serve you, we offer special group discounts rates and on-site training. If you have a group of 15 or more participants, we will bring our nationally acclaimed BMA short course to your location at a discounted rate. Please contact us today to learn how we can help MAKE YOUR ORGANIZATION SOAR!





Course Description

The Basic Missile Aerodynamics (BMA) short course is intended for the aerospace professional seeking expert instruction in the fundamentals of missile aerodynamics as applied to airframe design, analysis and test.

This technical short course provides participants with a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles. They will learn the tenets of basic wing, canard and tail aerodynamic controls, in addition to the rudiments of propulsive thrust vector controls.

As an integral feature of the course, instruction explores the specifics of designing for low drag, high maneuverability and favorable stability and control characteristics. Participants will learn about vehicle 6-DOF aerodynamic force and moment models, airframe component airloads, atmospheric models, and mass property models. The vital interrelationship among the disciplines of wind tunnel testing, flight simulation and flight testing is clearly explained and stressed.

The course of study includes a consideration of the unique aspects of projectile aerodynamics with particular emphasis on vehicle static, dynamic, and gyroscopic stability. Aeropropulsive phenomena explained include Jet Interaction (JI) and rocket motor plume effects. The key topic of Store Carriage and Separation is also addressed from the standpoints of analysis, test and safety certification.

Key Course Topics

- Coordinate Systems
- Wing Control
- Canard Control
- Tail Control
- Thrust Vector Control
- Component Airloads
- 6-DOF Aero Models
- Power-Off Base Drag
- Power-On Base Drag
- Plume Effects
- Wind Tunnel Testing
- Flight Testing
- Stability and Control
- Maneuverability
- Aerodynamic Drag
- Aerodynamic Damping
- Atmospheric Models
- Jet Interaction Effects
- Store Separation
- Dynamic Stability
- Control Panel Loads
- Stage Separation
- Aerodynamic Heating
- Flight Simulation
- Historical Flight Programs





Course Outline

The **Basic Missile Aerodynamics (BMA)** short course is an intensive 4-day training program that provides a maximum training experience to aerospace professionals with minimum time away from work.

Basic Missile Aerodynamics Module Overview

Day	Module	Lecture Title	Key Topics
1	1	Missile Coordinate Systems	Body Axis System, Maneuver Axis System, Panel Axis System, steering control schemes, axis transformations.
	2	Missile Flight Controls	Steering policies, aerodynamic controls, control surface types, thrust vector controls, attitude control systems.
	3	Missile Stability and Control	Center-of-mass, center-of-pressure, static margin, static stability, stability and control diagrams, dynamic stability.
2	4	Missile Component Airloads	Airframe maneuvers, aerodynamic interference, body alone, combined wing, combined tail, single panel loads.
	5	Zero-Lift Drag Estimation	Pressure drag, shear drag, excrescence drag, nose types, body transition types, fin shape types, body-wing-tail.
	6	Aerodynamic Force and Moment Modeling	Equations of motion, modes of motion, nonlinear aerodynamics, linear aerodynamics, aero derivatives.
3	7	Wind Tunnel Testing	Dynamic similarity, wind tunnel types, force and moment testing, models, data acquisition, data corrections.
	8	Aero Force and Moment Extraction From Flight	Equations of motion, trajectory reconstruction, missile instrumentation, meteorological data, uncertainties.
	9	Projectile Aerodynamics	Dynamic stability, epicyclic motion, tricyclic motion, yaw of repose, aerodynamic jump, magnus effects.
4	10	Aerodynamic Heating	Conduction, convection, radiation, heat flux rate, total heat load, thermal protection systems, shock interactions.
	11	Store Carry and Separation	Store categories, carriage criteria, separation criteria, analysis methods, ground test methods, aero prediction.
	12	Advanced Topics	Rocket motor plume effects, jet-interaction effects, aerospike aerodynamics, asymmetric vortex shedding.



Aerospace History

Much has transpired during the 100-plus years of powered flight. We are both the beneficiaries and stewards of the technological progress that previous generations have bequeathed to us.

However, many professionals in today's aerospace workforce have little knowledge of the key people, events and innovations that comprise the history of their own profession. While we cannot live in the past, we must learn from it if we are to be successful now and in the future. Further, like our predecessors, we must protect and preserve this legacy knowledge for succeeding generations.

It is for these reasons that White Eagle Aerospace strongly emphasizes aerospace history in its technical short courses. This is done through the mediums of special presentations, videos and field trips. The Basic Missile Aerodynamics (BMA) short course features several key historical programs.

Featured Programs

- **STANDARD Missile**
- **Lockheed X-7A**
- **AIR-2 Genie**
- **Trident SLBM**
- **Atlas ICBM**
- **Nike Ajax**
- **Saturn V**
- **Nike Zeus**
- **Navaho**
- **BOMARC**
- **THAAD**
- **AMRAAM**





Information at a Glance

The Basic Missile Aerodynamics (BMA) professional short course provides a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles.

This course provides expert instruction in the fundamentals of missile aerodynamics as applied to airframe design, analysis and test. Course material has direct application across a broad spectrum of missile types. Program provides increased knowledge, confidence and competence in matters relating to missile aerodynamics.

Delivered by a master instructor and subject matter expert with over 45 years of professional aerospace experience, this 4-day intensive training course will provide participants with invaluable real-world knowledge, enhanced understanding and improved competency in this key discipline.

Contact White Eagle Aerospace

White Eagle Aerospace
P.O. Box 68371
Oro Valley, AZ 85737
www.whiteeagleaerospace.com
training@whiteeagleaerospace.com
520-219-0526

Key Course Information

- **Instructor:** J. Terry White
- **Duration:** 4 instructional days; 32 instructional hours.
- **Materials:** 1) Comprehensive set of course lecture slides in bound form and 2) DVD containing course lecture slides, images, videos, reference documents and homework solutions.
- **Cost:** \$2,000 for single seat.
- **Registration:** Please visit our website to view the most current Course Calendar. To register for a scheduled course, simply complete and submit the online registration form.
- **Group Discounts:** In order to better serve your organization, we offer special group discount rates and on-site training. For information, please contact Phyllis White at pjwhite@whiteeagleaerospace.com.





J. Terry White

Aerosciences Instructor

John Terry White is president and CEO of White Eagle Aerospace. With headquarters in Oro Valley, Arizona, White Eagle Aerospace is a leading provider of engineering consulting, professional training, historical flight lectures and technical publication services to the aerospace community.

White's over 45 years of professional aerospace experience includes the NASA Space Shuttle Program, NASA X-43A Flight Project, and United States Navy STANDARD Missile Program. During his extensive career, he has served on the engineering technical staff of Rockwell International, General Dynamics Corporation, Hughes Missile Systems Company, NASA Dryden Flight Research Center and Raytheon Missile Systems.

In 2009, White completed a 2-year assignment as manager of the Aerodynamics Department in the Guidance, Navigation, and Control Center at Raytheon Missile Systems in Tucson, Arizona. In this capacity, he was responsible for all aerodynamics work performed at the world's largest tactical missile producer. White resigned from Raytheon in 2010 as an Engineering Senior Fellow in Aerodynamics.

White has authored more than 180 technical papers on a wide variety of aerospace and aerospace subjects. His teaching credentials include 15 years as an instructor in the Aerospace Engineering Department of the California State Polytechnic University, Pomona, 10 years as an instructor in the professional development program at Raytheon and 6 years developing and teaching courses at White Eagle Aerospace. Those who have taken his courses say that White brings an uncommon passion and extensive technical knowledge to the training environment.

White is particularly well known for his inspiring aerospace history lectures and presentations. These "techno-histories" are intense, fast-paced reviews of historically-significant events in United States aerospace history. He has lectured extensively on aerospace history topics at the USAF Test Pilot School, the Society of Experimental Test Pilots, the National Aeronautics and Space Administration, the American Institute of Aeronautics and Astronautics, academia, and industry. White also serves as a motivational keynote speaker for aerospace conferences, business functions, commemorative events, public service organizations, special interest groups, and private business.

Courses Offered

- **Aerodynamics for Engineers**
- **Aerospace Lessons-Learned**
- **Advanced Missile Aerodynamics**
- **Aerospace Vehicle Performance**
- **Basic Missile Aerodynamics**
- **Fundamentals of Earth Reentry**
- **Fundamentals of Gas Dynamics**
- **Fundamentals of Hypersonics**

Contact Information

J. Terry White, President/CEO

Office: 520-219-0526

Email: terry@whiteeagleaerospace.com