



WHITE EAGLE
AEROSPACE



Basic Missile Aerodynamics

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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

Basic Missile Aerodynamics (BMA) is for those seeking a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles.

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. |