

# GLIDER FLYING HANDBOOK

2003

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION  
Flight Standards Service



## PREFACE

The Glider Flying Handbook is designed as a technical manual for applicants who are preparing for glider category rating and for currently certificated glider pilots who wish to improve their knowledge. Certificated flight instructors will find this handbook a valuable training aid, since detailed coverage of aeronautical decision making, components and systems, aerodynamics, flight instruments, performance limitations, ground operations, flight maneuvers, traffic patterns, emergencies, soaring weather, soaring techniques, and cross-country is included. Topics, such as radio navigation and communication, use of flight information publications, and regulations are available in other Federal Aviation Administration (FAA) publications.

This handbook conforms to pilot training and certification concepts established by the FAA. There are different ways of teaching, as well as performing flight procedures and maneuvers, and many variations in the explanations of aerodynamic theories and principles. This handbook adopts a selective method and concept to flying gliders. The discussion and explanations reflect the most commonly used practices and principles. Occasionally, the word “must” or similar language is used where the desired action is deemed critical. The use of such language is not intended to add to, interpret, or relieve a duty imposed by Title 14 of the Code of Federal Regulations (14 CFR).

It is essential for persons using this handbook to also become familiar with and apply the pertinent parts of 14 CFR and the Aeronautical Information Manual (AIM). Performance standards for demonstrating competence required for pilot certification are prescribed in the appropriate glider practical test standard.

This handbook contains all or part of the information found in AC 61-94, Pilot Transition Course for Self-Launching or Powered Sailplanes (Motorgliders). This publication may be purchased from the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, DC 20402-9325, or from U.S. Government Bookstores located in major cities throughout the United States.

The current Flight Standards Service airman training and testing material and subject matter knowledge codes for all airman certificates and ratings can be obtained from the Flight Standards Services web site at <http://av-info.faa.gov>.

The FAA gratefully acknowledges the valuable assistance provided by many individuals and organizations throughout the aviation community who contributed their time and talent in publishing this handbook.

Comments regarding this handbook should be sent to U.S. Department of Transportation, Federal Aviation Administration, Airman Testing Standards Branch, AFS-630, P.O. Box 25082, Oklahoma City, OK 73125.

AC 00-2, Advisory Circular Checklist, transmits the current status of FAA advisory circulars and other flight information publications. This checklist is free of charge and may be obtained by sending a request to U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785. The checklist also is available on the Internet at: [http://www.faa.gov/aba/html\\_policies/ac00\\_2.html](http://www.faa.gov/aba/html_policies/ac00_2.html)



# CONTENTS

## Chapter 1—Introduction to Glider Flying

Gliders—The Early Years . . . . .	1-1
Glider or Sailplane? . . . . .	1-1
Glider Certificate Eligibility Requirements . . . . .	1-2
Aeronautical Decision Making . . . . .	1-2
Origins of ADM Training . . . . .	1-2
The Decision-Making Process . . . . .	1-3
Defining the Problem . . . . .	1-4
Choosing a Course of Action . . . . .	1-4
Implementing the Decision and Evaluating the Outcome . . . . .	1-4
Risk Management . . . . .	1-4
Assessing Risk . . . . .	1-5
Factors Affecting Decision Making . . . . .	1-6
Pilot Self-Assessment . . . . .	1-6
Recognizing Hazardous Attitudes . . . . .	1-6
Stress Management . . . . .	1-7
Use of Resources . . . . .	1-7
Internal Resources . . . . .	1-8
External Resources . . . . .	1-8
Workload Management . . . . .	1-8
Situational Awareness . . . . .	1-9
Obstacles to Maintaining Situational Awareness . . . . .	1-9
Operational Pitfalls . . . . .	1-9
Medical Factors Associated with Glider Flying	1-10
Hypoxia . . . . .	1-10
Hypoxic Hypoxia . . . . .	1-10
Hypemic Hypoxia . . . . .	1-10
Stagnant Hypoxia . . . . .	1-10
Histotoxic Hypoxia . . . . .	1-10
Hyperventilation . . . . .	1-11
Middle Ear and Sinus Problems . . . . .	1-11
Spatial Disorientation . . . . .	1-12
Motion Sickness . . . . .	1-13
Carbon Monoxide Poisoning . . . . .	1-13
Stress . . . . .	1-13
Fatigue . . . . .	1-14
Dehydration and Heatstroke . . . . .	1-14
Alcohol . . . . .	1-15
Drugs . . . . .	1-15
Scuba Diving . . . . .	1-16

## Chapter 2—Components and Systems

The Fuselage . . . . .	2-1
Wings and Components . . . . .	2-1
Lift/Drag Devices . . . . .	2-2
The Empennage . . . . .	2-3
Tow Hook Devices . . . . .	2-4
Powerplant . . . . .	2-4
Landing Gear . . . . .	2-4
Wheel Brakes . . . . .	2-4

## Chapter 3—Aerodynamics of Flight

Airfoil . . . . .	3-1
Angle of Attack . . . . .	3-1
Angle of Incidence . . . . .	3-1
Center of Pressure . . . . .	3-1
Forces of Flight . . . . .	3-1
Lift . . . . .	3-2
Magnus Effect . . . . .	3-2
Bernoulli's Principle . . . . .	3-3
Newton's Third Law of Motion . . . . .	3-3
Drag . . . . .	3-4
Parasite Drag . . . . .	3-4
Form Drag . . . . .	3-4
Interference Drag . . . . .	3-4
Skin Friction Drag . . . . .	3-4
Induced Drag . . . . .	3-4
Total Drag . . . . .	3-5
Drag Equation . . . . .	3-6
Wing Planform . . . . .	3-6
Aspect Ratio . . . . .	3-7
Weight . . . . .	3-8
Thrust . . . . .	3-8
Three Axes of Rotation . . . . .	3-8
Stability . . . . .	3-8
Flutter . . . . .	3-10
Lateral Stability . . . . .	3-10
Directional Stability . . . . .	3-10
Turning Flight . . . . .	3-11
Rate of Turn . . . . .	3-12
Radius of Turn . . . . .	3-12
Turn Coordination . . . . .	3-12
Slips . . . . .	3-12
Forward Slip . . . . .	3-13
Side Slip . . . . .	3-13
Stalls . . . . .	3-14
Spins . . . . .	3-14
Ground Effect . . . . .	3-14

## Chapter 4—Flight Instruments

Pitot-Static Instruments . . . . .	4-1
Impact and Static Pressure Lines . . . . .	4-1
Airspeed Indicator . . . . .	4-1
Indicated Airspeed . . . . .	4-2
Calibrated Airspeed . . . . .	4-2
True Airspeed . . . . .	4-2
Airspeed Indicator Markings . . . . .	4-2
Other Airspeed Limitations . . . . .	4-3
Altimeter . . . . .	4-4
Principle of Operation . . . . .	4-4
Effect of Nonstandard Pressure And Temperature . . . . .	4-4

Setting the Altimeter . . . . .	4-5	TieDown and Securing . . . . .	6-2
Types of Altitude . . . . .	4-7	Ground Handling . . . . .	6-2
Variometer . . . . .	4-7	Launch Equipment Inspection . . . . .	6-2
Total Energy System . . . . .	4-8	Glider Preflight Inspection . . . . .	6-4
Netto . . . . .	4-9	Cockpit Management . . . . .	6-4
Electronic Flight Computers . . . . .	4-9	Personal Equipment . . . . .	6-4
Magnetic Compass . . . . .	4-11	Prelaunch Checklist . . . . .	6-4
Magnetic Variation . . . . .	4-12		
Magnetic Deviation . . . . .	4-12	Chapter 7—Launch and Recovery Procedures and	
Compass Errors . . . . .	4-12	Flight Maneuvers	
Acceleration Error . . . . .	4-13	Aerotow Launch Signals . . . . .	7-1
Turning Error . . . . .	4-13	Pre-Launch Signals for Aerotow Launches	7-1
Yaw String . . . . .	4-14	In-Flight Aerotow Visual Signals . . . . .	7-2
Inclinometer . . . . .	4-14	Takeoff Procedures and Techniques . . . . .	7-2
Gyroscopic Instruments . . . . .	4-15	Aerotow Takeoffs . . . . .	7-2
Rigidity in Space . . . . .	4-15	Normal Takeoffs . . . . .	7-3
Precession . . . . .	4-15	Crosswind Aerotow Takeoffs . . . . .	7-3
Attitude Indicator . . . . .	4-16	Common Errors . . . . .	7-4
Heading Indicator . . . . .	4-16	Takeoff Emergency Procedures . . . . .	7-4
G-Meter . . . . .	4-17	Aerotow Climbout and Release Procedures . .	7-6
Outside Air Temperature Gauge . . . . .	4-17	Common Errors . . . . .	7-8
		Aerotow Abnormal Procedures . . . . .	7-8
Chapter 5—Glider Performance		Slack Line . . . . .	7-10
Factors Affecting Performance . . . . .	5-1	Common Errors . . . . .	7-10
Density Altitude . . . . .	5-1	Boxing the Wake . . . . .	7-10
Pressure Altitude . . . . .	5-1	Common Errors . . . . .	7-11
Atmospheric Pressure . . . . .	5-1	Ground Launch Takeoff . . . . .	7-11
Altitude . . . . .	5-1	Ground Launch Signals . . . . .	7-12
Temperature . . . . .	5-2	Pre-launch Signals for Ground Launches	7-
Moisture . . . . .	5-2	12	
High and Low Density Altitude Condition . .	5-2	In-flight Signals for Ground Launches .	7-12
Winds . . . . .	5-3	Tow Speeds . . . . .	7-12
Weight . . . . .	5-4	Automobile Launch . . . . .	7-14
Rate of Climb . . . . .	5-5	Normal Into-the-Wind Ground Launch . . . . .	7-14
Flight Manuals and Placards . . . . .	5-5	Crosswind Takeoff and Climb—Ground Launch	7-
Areas of the Manual . . . . .	5-5	15	
Placards . . . . .	5-6	Ground Tow Launch—Climbout and Release	
Performance Information . . . . .	5-6	Procedures . . . . .	7-16
Glider Polars . . . . .	5-6	Common Errors . . . . .	7-16
Weight and Balance Information . . . . .	5-8	Abnormal Procedures, Ground Launch . . . . .	7-16
Limitations . . . . .	5-8	Emergency Procedures, Ground Launch . . .	7-16
Terms and Definitions . . . . .	5-10	Self-Launch Takeoff Procedures . . . . .	7-18
Center of Gravity . . . . .	5-11	Preparation and Engine Start . . . . .	7-18
Problems Associated with CG Forward of		Common Errors . . . . .	7-18
Forward Limit . . . . .	5-11	Taxiing the Self-Launching Glider . . . . .	7-18
Problems Associated with CG Aft of		Common Errors . . . . .	7-18
the Aft Limit . . . . .	5-11	Before Takeoff Check—Self-Launching Glider	7-18
Sample Weight and Balance Problems . . . . .	5-12	Common Errors . . . . .	7-18
Determining CG Without Loading Charts .	5-12	Normal Takeoff—Self-Launching Glider . . . . .	7-18
Ballast Weight . . . . .	5-13	Crosswind Takeoff—Self-Launching Glider . .	7-19
Effects of Water Ballast . . . . .	5-13	Common Errors . . . . .	7-19
		Self-Launch—Climb-Out and ShutDown	
Chapter 6—Preflight and Ground Operations		Procedures . . . . .	7-20
Assembly Techniques . . . . .	6-1	Common Errors . . . . .	7-21
Trailing . . . . .	6-1	Landings . . . . .	7-21

Common Errors . . . . .	7-21	Pitch Influence of the Glider Towhook Position	8-5
Emergency Procedures, Self-Launching Glider	7-22	Self-Launch Glider Oscillations During	
		Powered Flight . . . . .	8-6
Performance Maneuvers, Straight Glides . . .	7-22	Nosewheel Glider Oscillations During	
Common Errors . . . . .	7-22	Launches and Landings . . . . .	8-6
Turns . . . . .	7-22	Tailwheel/Tailskid Equipped Glider Oscillations	
Common Errors . . . . .	7-24	During Launches and Landings . . . . .	8-7
Steep Turns . . . . .	7-25	Off-Field Landing Procedures . . . . .	8-7
Common Errors . . . . .	7-25	After Landing Off-Field . . . . .	8-9
Spiral Dive . . . . .	7-25	Off-Field Landing Without Injury . . . . .	8-9
Common Errors . . . . .	7-26	Off-Field Landing With Injury . . . . .	8-10
Maneuvering at Minimum Control Airspeed,		Systems and Equipment Malfunctions . . . . .	8-10
Stalls, and Spins . . . . .	7-26	Flight Instrument Malfunctions . . . . .	8-10
Maneuvering at Minimum Controllable Airspeed	7-26	Airspeed Indicator Malfunctions . . . . .	8-10
Common Errors . . . . .	7-26	Altimeter Malfunctions . . . . .	8-10
Stall Recognition and Recovery . . . . .	7-26	Variometer Malfunctions . . . . .	8-11
Advanced Stalls . . . . .	7-28	Compass Malfunctions . . . . .	8-11
Secondary Stall . . . . .	7-28	Glider Canopy Malfunctions . . . . .	8-11
Accelerated Stalls . . . . .	7-29	Glider Canopy Open Unexpectedly . . .	8-11
Crossed-Control Stall . . . . .	7-30	Broken Glider Canopy . . . . .	8-11
Common Errors . . . . .	7-31	Frosted Glider Canopy . . . . .	8-11
Spins . . . . .	7-31	Water Ballast Malfunctions . . . . .	8-11
Entry Phase . . . . .	7-32	Retractable Landing Gear Malfunction . . .	8-11
Incipient Phase . . . . .	7-32	Primary Flight Controls . . . . .	8-12
Developed Phase . . . . .	7-32	Elevator Malfunctions . . . . .	8-12
Recovery Phase . . . . .	7-32	Aileron Malfunctions . . . . .	8-12
Common Errors . . . . .	7-33	Rudder Malfunctions . . . . .	8-13
Minimum Sink Airspeed . . . . .	7-33	Secondary Flight Control Systems . . . . .	8-14
Common Errors . . . . .	7-34	Elevator Trim Malfunctions . . . . .	8-14
Best Glide Airspeed . . . . .	7-34	Spoiler/Dive Break Malfunctions . . . . .	8-14
Common Errors . . . . .	7-34	Miscellaneous Flight System Malfunctions	8-14
Speed-To-Fly . . . . .	7-34	Towhook Malfunctions . . . . .	8-14
Common Errors . . . . .	7-34	Oxygen System Malfunctions . . . . .	8-15
Traffic Patterns . . . . .	7-34	Drogue Chute Malfunctions . . . . .	8-15
Crosswind Landings . . . . .	7-36	Self-Launch Gliders . . . . .	8-15
Common Errors . . . . .	7-36	Self-Launch Glider Engine Failure During	
Slips . . . . .	7-36	Takeoff or Climb . . . . .	8-15
Common Errors . . . . .	7-38	Inability to Re-start a Self-Launch Glider	
Downwind Landings . . . . .	7-38	Engine While Airborne . . . . .	8-16
Common Errors . . . . .	7-38	Self-Launch Glider Propeller Malfunctions	8-16
After-Landing and Securing . . . . .	7-38	Self-Launch Glider Electrical System	
		Malfunctions . . . . .	8-17
Chapter 8—Abnormal and Emergency Procedures		In-Flight Fire . . . . .	8-17
Porpoising . . . . .	8-1	Emergency Equipment and Survival Gear . .	8-17
Pilot-Induced Oscillations . . . . .	8-1	Survival Gear Item Checklists . . . . .	8-17
Pilot-Induced Pitch Oscillations During Launch	8-1	Food and Water . . . . .	8-18
Factors Influencing PIOS . . . . .	8-1	Clothing . . . . .	8-18
Improper Elevator Trim Setting . . . . .	8-2	Communication . . . . .	8-18
Improper Wing Flaps Setting . . . . .	8-2	Navigation Equipment . . . . .	8-18
Pilot-Induced Roll Oscillations During Launch	8-3	Medical Equipment . . . . .	8-18
Pilot-Induced Yaw Oscillations During Launch	8-3	Stowage . . . . .	8-18
Gust-Induced Oscillations . . . . .	8-4	Oxygen System . . . . .	8-18
Vertical Gusts During High-Speed Cruise .	8-5	Parachute . . . . .	8-18
Pilot-Induced Pitch Oscillations During Landing	8-5		
5			
Glider Induced Oscillations . . . . .	8-5		

Chapter 9—Soaring Weather	
The Atmosphere . . . . .	9-1
Composition . . . . .	9-1
Properties . . . . .	9-2
Temperature . . . . .	9-2
Density . . . . .	9-2
Pressure . . . . .	9-2
Standard Atmosphere . . . . .	9-3
Layers of the Atmosphere . . . . .	9-3
Scale of Weather Events . . . . .	9-4
Thermal Soaring Weather . . . . .	9-4
Thermal Shape and Structure . . . . .	9-5
Atmospheric Stability . . . . .	9-6
Understanding Soundings . . . . .	9-8
Air Masses Conducive to Thermal Soaring	9-11
Cloud Streets . . . . .	9-11
Thermal Waves . . . . .	9-12
Thunderstorms . . . . .	9-13
Weather for Slope Soaring . . . . .	9-18
Wave Soaring Weather . . . . .	9-20
Mechanism for Wave Formation . . . . .	9-20
Lift Due to Convergence . . . . .	9-23
Obtaining Weather Information . . . . .	9-25
Automated Flight Service Stations . . . . .	9-25
Preflight Weather Briefing . . . . .	9-25
Direct User Access Terminal System . . . . .	9-26
On the Internet . . . . .	9-26
Interpreting Weather Charts, Reports, And	
Forecasts . . . . .	9-27
Graphic Weather Charts . . . . .	9-27
Surface Analysis Chart . . . . .	9-27
Weather Depiction Chart . . . . .	9-27
Radar Summary Chart . . . . .	9-28
US Low-Level Significant Weather	
Prognostic Chart . . . . .	9-28
Winds and Temperatures Aloft . . . . .	9-30
Composite Moisture Stability Chart . . . . .	9-30
Printed Reports and Forecasts . . . . .	9-33
Printed Weather Reports . . . . .	9-33
Aviation Routine Weather Report . . . . .	9-33
Pilot Reports . . . . .	9-34
Radar Weather Reports . . . . .	9-34
Printed Forecasts . . . . .	9-34
Terminal Aerodrome Forecast . . . . .	9-34
Aviation Area Forecast . . . . .	9-36
Communications and Product Headers	9-36
Precautionary Statements . . . . .	9-37
Synopsis . . . . .	9-37
VFR Clouds and Weather . . . . .	9-37
Convective Outlook Chart . . . . .	9-37
Winds and Temperatures Aloft Forecast . . . . .	9-38
Transcribed Weather Broadcasts . . . . .	9-39
Chapter 10—Soaring Techniques	
Thermal Soaring . . . . .	10-1
Ridge and Slope Soaring . . . . .	10-9
Wave Soaring . . . . .	10-12
Preflight Preparation . . . . .	10-12
Getting into the Wave . . . . .	10-13
Flying in the Wave . . . . .	10-15
Soaring Convergence Zones . . . . .	10-18
Combined Sources of Updrafts . . . . .	10-18
Chapter 11—Cross-Country Soaring	
Flight Preparation and Planning . . . . .	11-1
Personal and Special Equipment . . . . .	11-2
Navigation . . . . .	11-4
Using the Plotter . . . . .	11-4
A Sample Cross-Country Flight . . . . .	11-6
Navigation Using GPS . . . . .	11-8
Cross-Country Techniques . . . . .	11-8
Soaring Faster and Farther . . . . .	11-10
Special Situations . . . . .	11-13
Course Deviations . . . . .	11-13
Lost Procedures . . . . .	11-14
Cross-Country Using a Self-Launching Glider	11-14
High-Performance Glider Operations and	
Considerations . . . . .	11-15
Cross-Country Using Other Lift Sources . . . . .	11-16