



Gregory N. Brown
Mark J. Holt

THE TURBINE PILOT'S FLIGHT MANUAL

FOURTH EDITION

Includes required
Airline Transport Pilot
Certification Training
Program (ATP-CTP) topics



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Preface

THIS MANUAL GREW from the need to summarize in one place the information a pilot is expected to know when moving up to high-performance turbine aircraft. Flying professionally in today's competitive environment demands good basic knowledge of aircraft systems and procedures. This knowledge pays off at job interviews, at ground school, and of course, in flight operations.

Most initial pilot training programs cover only those areas of "aeronautical knowledge" required to pass FAA knowledge and practical tests up through commercial and CFI certificates. By nature, such training emphasizes low-altitude piston airplane systems and operations. This book is designed to be a ready, readable source for pilots to learn and prepare for that first step up into turbine equipment and operations and for the subsequent transition into more advanced types. Such preparation is important for several reasons.

Interviewers for turbine flight positions expect a certain basic level of knowledge among applicants. This book is designed to capsule that knowledge in one place for purposes of interview preparation.

Initial training ground schools for turbine operators are relatively similar. They anticipate basic knowledge from participants and dive right into the detailed specifics of their own aircraft. We wanted to provide the basics in a form that would allow new-hire pilots to prepare for first-time turbine ground schools.

Review for recurrent training is equally important. When annual checkride rolls around the first few times in a pilot's career and at upgrade time to the captain's seat, many of the basics have been forgotten.

This is the place to refresh understanding of the basic principles of aircraft systems.

Each step of a pilot's flying career takes him or her into more advanced aircraft—from piston aircraft to turboprops, then to corporate and regional jets, and for many pilots, on to transport category aircraft. This book is designed to make every one of those transitions easier.

Finally, this manual is also for pilots and other aviation enthusiasts who simply enjoy the opportunity to learn about more-advanced aircraft, even if they don't anticipate flying them anytime soon.

New and returning readers alike will appreciate the many enhancements made in this fourth edition of *The Turbine Pilot's Flight Manual*. Along with dozens of additional illustrations and updates to technology and terminology throughout the book, we have incorporated the newly required academic subject matter for completion of an Airline Transport Pilot Certification Training Program (ATP-CTP).

The ATP-CTP is required under 14 CFR §61.156 for applicants for an ATP certificate with airplane category multiengine class rating or type rating and is designed to bridge the "knowledge gap" for pilots moving up from flying piston-powered aircraft under commercial pilot certificates to operating turbine-powered aircraft. This requires training in essential subject areas listed in Advisory Circular 61-138, *Airline Transport Pilot Certification Training Program*, covering the baseline knowledge and experience to prepare them for the duties, responsibilities, and challenges of corporate-aviation and air carrier environments.

Newly added or expanded ATP-CTP aeronautical knowledge areas include:

- Aerodynamics
- Automation
- Adverse weather conditions
- Air carrier operations
- Transport airplane performance
- Professionalism and leadership development

Our ongoing goal with *The Turbine Pilot's Flight Manual* has been to ease and accelerate pilot transition into each level of turbine aircraft, from small turbo-props and very light jets to the largest commercial

jetliners. Over the more than two decades since this book was first published, it has become a popular university and professional flight school text and required reading for many regional airline new-hire pilots in preparation for ground school.

With the addition of the recently required ATP-CTP subject matter, we hope to even better prepare pilots advancing to turbine-powered aircraft. We have pulled out all the stops in this latest edition to make the next step in your flying career smoother and more exciting than ever.

Acknowledgments

AMONG THE GREAT DIFFICULTIES of assembling a complex, comprehensive book such as *The Turbine Pilot's Flight Manual* is gathering and checking all of the information. Aircraft systems vary by manufacturer, type, and model. Procedures for flying any one aircraft type also vary tremendously from one operator to the next. Our objective is to cover turbine flying in a general way, but with enough detail to provide all of the basics. No one person can be knowledgeable in all these things.

Many individuals and companies have helped us greatly over all editions to date by sharing their expertise. We'd like to thank, first and foremost, the individuals who spent their valuable time reviewing our manuscript and sharing suggestions and information.

Keith Lamb, Boeing 787 Dreamliner Captain for a major airline, helped us immensely on this new fourth edition both by contributing expertise and by applying fresh eyes to double-check correlation of existing with new material. Captain Brian Rouse of a Canadian international carrier offered valuable suggestions for new content.

Among major-airline pilots who have generously shared their expertise via past editions are Pat O'Donnell, Don Cronk, Dick Ionata, Ray Holt, Bill Niederer, Dan Moshiri, John Trimbach, and Shane LoSasso. Engines consultant Vick Viquesney, aeronautical engineers Bruce Haeffele, Richard W. Thomas, and Paul S. Sellers, and Professor Tom Carney of the Purdue University Aviation Technology Department also contributed valuable expertise. We are grateful to them all.

We also wish to thank the many fine companies and their people who answered our technical questions and provided supporting information. While it is impossible to name them all here, among them are Allied-Signal Garrett Engine and AiResearch Los Angeles Divisions, United Technologies Pratt & Whitney, Honeywell Business and Commuter Aviation Systems, and Aerospace Systems and Technologies.

Our appreciation goes out to Joe Statt, Nick Apostolopoulos, and Michelle Statt for their multimedia contributions to *The Turbine Pilot's Flight Manual* online reader resource materials, and to Mike Fizer and the Aircraft Owners and Pilots Association for generously providing cover photos. Finally, thanks to Jean Brown for Greg's author photo on the back cover.

About the Authors



GREG BROWN's love for flying is obvious to anyone who knows his column, "Flying Carpet," in AOPA Flight Training magazine or who has read his other books, *The Savvy Flight Instructor*, *Flying Carpet: The Soul of an Airplane*, *Job Hunting for Pilots*, and *You Can*

Fly! A flight instructor since 1979, Greg was 2000 Industry/FAA Flight Instructor of the Year, winner of the 1999 NATA Excellence in Pilot Training Award, and recipient of the 2013 AOPA Let's Go Flying Award. In addition, he has served as a professional pilot in both scheduled and corporate aviation. Mr. Brown holds an ATP certificate with Boeing 737 type ratings and Flight Instructor certificate with all fixed-wing aircraft ratings including glider. An active pilot since 1971, Mr. Brown was also designated the first-ever Master Flight Instructor. He is also a noted aerial photographer. Visit Greg Brown's website at www.gregbrownflyingcarpet.com.



MARK J. HOLT, a pilot for a major airline, soloed at age sixteen and has logged over 20,000 hours in his more than 35 years of flying. He holds an ATP pilot certificate with Boeing 757/767, Airbus 319/320/321, and BAE Jetstream 41 type ratings and a Flight

Engineer (Turbojet) certificate. His professional aviation career includes extensive flight and ground instructing experience and service as a check airman for a large Part 121 regional airline. Mark also served nine years as an electronics/radar technician for the U.S. Air Force Air National Guard. Mark Holt is also co-author of *Air Carrier Operations*.

Chapter 1

Introduction

HOW TO USE THIS MANUAL

This manual is designed for both comprehensive reading and quick reference. We recognize that some readers will want to familiarize themselves with turbine operations and will read it from beginning to end. At the same time, we feel that the manual should be in a form that allows easy access to information in order to answer a question or review a system.

Pilots will immediately notice the familiar sections of an aircraft *Pilot's Operating Handbook* or *Pilot's Information Manual*, so they should find it easy to access reference information. While most sections of the book correspond to those found in aircraft manuals, we have rearranged the order of the sections in order to make logical reading for straight-through readers.

Concurrently, check out *The Turbine Pilot's Flight Manual—Aircraft Systems* online resource site. While reading this manual and examining relevant figures, you can simultaneously reference narrated color animations to enhance your understanding of complex devices and systems. Access the “Aircraft Systems” online resource site at www.asa2fly.com/reader/tpfm.

We have tried our best to minimize specific references to federal aviation regulations (FARs) due to their constant state of change. (Holding speeds changed at least twice during the writing of this manual.)

In general, procedures discussed in this book are based on commercial operations conducted under 14 CFR Parts 135 and 121. This is because the largest

percentage of turbine aircraft and pilots operate commercially. Many corporate flight departments also elect to operate under more conservative commercial rules, and in any case most of our readers are already familiar with less-stringent Part 91 operations.

One of the most exciting aspects of a flying career is the continuing personal growth that comes from mastering new knowledge. We've tried our best to convey turbine aircraft information in a manner that's as enjoyable and interesting for you as it is for us. We hope you'll agree.

TRANSITIONING PISTON PILOTS

You've earned your commercial pilot certificate, perhaps your CFI, and even an ATP. You're over the hump and off to a good start on your professional aviation career.

Now is a good time to reflect upon the knowledge and experience you've gained to date. You're an expert on piston aircraft operations and systems, sectional charts, basic aerodynamics, pilot certification requirements, low-altitude weather, and the basics of instrument flying. But there's a lot more to learn as you transition to ever more sophisticated aircraft. The hours you've invested in learning the system probably have been spent flying at slow airspeeds at altitudes below 12,000 feet. Chances are that you'll soon be operating faster equipment at higher altitudes. Looking up the career ladder you probably won't be flying

those piston aircraft you've mastered for long. Turbine engines power the airplanes at the next levels. Their mechanical and electrical systems vary considerably from the aircraft you've trained in. You'll be dealing with big-time hydraulic systems, additional flight controls, and computerized flight management systems. Some interesting new aerodynamic issues also arise with the move into turbine aircraft—when did you last worry about the sound barrier? The terminology is also different. There is no V_{NE} in turbine-powered aircraft. Maximum operating speeds are instead defined in terms of V_{MO} and M_{MO} . Approaches are conducted relative to V_{REF} .

Even your psyche as a pilot must change. As part of a two- or three-pilot crew, you'll have to master careful and precise team coordination.

Why should you care? Employers will expect at least rudimentary knowledge of turbine systems and operations at your interviews. Your first turbine ground schools will be a heck of a challenge, and plenty of pilots are waiting to fill the shoes of any washouts. You'll want to prepare as much as possible ahead of time. Finally, knowledge will help get you hired. How can you network with a friendly corporate or airline captain if you don't know what kind of jet he or she is flying?

Where does a pilot learn about these things? Most entry-level turbine jobs require a commercial pilot's certificate with multiengine and instrument ratings. The FAA doesn't require any turbine aircraft knowledge or experience to earn any of those ratings. And many private flight schools don't even address turbine topics since graduates are still 1,000 hours away from their ATPs. Graduates of university flight programs are sometimes introduced to turbine operations and systems, but years may pass before the knowledge is applied.

"I want a turbine job, but I don't know anything about it. Somewhere there must be a straightforward book that explains this stuff in general terms!" This book is designed to do just that: introduce you to the basic concepts and terminology of multiengine turbine aircraft.

We recommend that you read the book from front to back, with an eye toward picking up the principles and the terminology. If you have a ground school scheduled, follow up by seriously reviewing topics that directly relate to your upcoming job. Then go back to the training section in Chapter 2. You'll be able to prepare a specific study program for yourself by following the suggestions there.

Obviously, we can't cover every aspect of every turbine aircraft in one book. Our goal, rather, is to familiarize the upgrading pilot with turbine aircraft in a broad introductory manner. You won't be ready to fly a turboprop or jet after reading this book, but you will know what they're talking about in ground school.

TRANSITIONING MILITARY AVIATORS

Among our target readers are current or ex-military pilots interested in pursuing civilian flying careers. Military fliers have always been rated among the best candidates for civilian jobs. However, some aspects of civilian flying are markedly different from what military pilots may be used to. Military pilots, while having received excellent training, often lack exposure to certain topics that civilian employers expect them to know. Throughout the book, we have made a thorough effort to point out issues of special interest to you, the military pilot. Based on the comments of military pilots who've already transitioned to civilian aviation, we especially encourage you to concentrate on certain topics as you proceed through this book. Even minimal understanding of the following areas should pay off at interview time, in ground school, and on the flight line.

Crew Resource Management

If there is a single, most important topic impacting your success in today's civilian aviation market, it is "CRM": "crew resource management" (also known as "cockpit resource management"). This term refers to the latest procedures for interaction and coordination of multiengine crews. At interviews, on your simulator checkride, during flight training, and on line you can expect constant evaluation of your performance in this context.

Crew resource management skills become virtually a state of mind among multiengine crews. Your career may be heavily impacted based on whether employers perceive you as part of the CRM process or as a lone-wolf pilot. (See "Crew Resource Management" in Chapter 8.)

If you've been flying single-engine operations, pay particular attention to CRM issues in your reading. It would also be well worth your time to take one of the excellent CRM workshops offered around the country.

A related topic is checklist procedures. These vary significantly between civilian and some military operations, especially if you've been flying single-pilot aircraft. We recommend covering that section (Chapter 8, also) in some depth and perhaps practicing checklist procedures with friends who've already made the civilian transition.

Training by Civilian Employers

Once hired by a civilian employer, you'll probably enjoy your training. While often challenging and intensive, civilian ground and flight training is generally based on the concept of "train to proficiency." The intent is to train all hired pilots until they're sharp, rather than wash people out. Standard training procedures and preparation suggestions are covered in Chapter 2.

If there's anything to be careful of in civilian training, it's to avoid coasting, due to the relaxed and supportive nature of classes. Pilots do flunk out of training. Participants need to be self-motivated because there are plenty of other applicants waiting if anyone drops out. (It's not uncommon for outside pilots to show up uninvited at smaller operations on the first day of ground school, with hopes of filling any unexpected slots.)

Civilian Aircraft and Civilian Aviation Terminology

As a military pilot, you probably haven't spent much time around regional or corporate aircraft or the latest airline equipment. You may be familiar with the Boeing 747s and the Airbus A-320s operated by the majors. But can you tell the difference between an Airbus A-330 and a Boeing 767? How about the forty or so most common commuter and corporate aircraft?

You may lump civilian aircraft identification skills into the "nice to know but not really important" file. However, it takes only one detailed taxi clearance at a major airport to prove that civilian aircraft identification skills are a necessity (for example, "American 71, wait for the A-330, then taxi via the inner, hold short of K, wait for the Embraer RJ145, then transition to the outer behind, and follow the Falcon Jet to 25R").

Review the Airline, Regional, and Corporate Aircraft Spotter's Guide (see Appendix 2) to improve your civilian aircraft identification skills. Spend some time at the airport checking out these aircraft. The knowledge will pay off for you on the line. Aircraft

familiarity is also important when deciding where to apply for a flight position. Your life on the job will vary tremendously depending on whether or not the aircraft you fly are pressurized, carry flight attendants and refreshments, and are equipped with lavatories or autopilots.

A civilian airline and corporate terminology section has also been included in this book, with you in mind. (See the Glossary.) Like the military, civilian aviation has its own lingo. The more familiar you are with the system, the more comfortable your transition to civilian aviation will be.

Once you've gotten through the book, we strongly encourage you to subscribe immediately to some of the excellent civilian aviation magazines currently available. Join online aviation forums (Google "aviation forums"), read active posts, and ask questions. You'll learn more about the airplanes, lingo, and issues facing the industry. Go hang around the airport, too. Pilots everywhere love to show off their airplanes. Besides, some may turn into job contacts.

Aircraft Systems

Depending upon what types of aircraft you've been flying, there are probably significant differences in aircraft systems that you'll need to learn. We recommend skimming all of the systems chapters (Chapters 3–6) for minor differences and then returning in more depth to those systems unfamiliar to you.

One system, in particular, is brand new and challenging for many transitioning military pilots: propellers. We have included a special supplement on propeller basics for those who may not be going straight into jets. (Review "Propeller Supplement for Transitioning Military Jet Pilots" and then "Turboprop Propeller Systems" in Chapter 3.)

Contemporary Issues in the Aviation Industry

While brief, "Contemporary Issues in the Aviation Industry" in Chapter 2 is very important to you. Social and union issues have become extremely sensitive in today's civilian aviation industry. It's important to maintain the proper mind-set if you want to get hired and to keep and enjoy your job.

About Your Civilian Counterparts

Finally, a few words are in order regarding your civilian counterparts. Many military pilots wonder about the credentials of the civilian pilots they'll be flying with. Most civilian pilots earn their ratings through university flight programs, at private flight schools, or with private flight instructors. Civilian flight training varies tremendously in quality. While some pilots graduate from top-notch programs comparable in quality with military training, others collect their training from many different sources, a la carte. (The predictable nature of military training is one of your competitive points as a job candidate.)

To gain flight hours and professional experience, the typical newly graduated civilian pilot works first as a flight instructor (CFI) for a year or so, then moves on to cargo, air-tour, or air-taxi operations. ("Air-taxi" refers to commercial, on-demand charter

operators.) From there, he or she moves to a regional (commuter) airline or corporate flight department. (The luckier ones may skip a level or two on their way up the ladder.) To be sure, by the time civilian pilots make it to the higher professional levels, they're pretty sharp. In particular, many have excellent all-weather flying experience in commercial operations. Like your military peers, most civilian pilots aspire to corporate or airline jet captains' positions.

In the course of flying you'll probably hear about some interesting "time-building" jobs held by your civilian counterparts during their careers. Bush flying, island cargo hopping, emergency medical flying, water bombing, mercenary and missionary flying make some of their stories almost as good as yours! Most pilots would agree that a combination of military and civilian backgrounds makes for a great flight department.

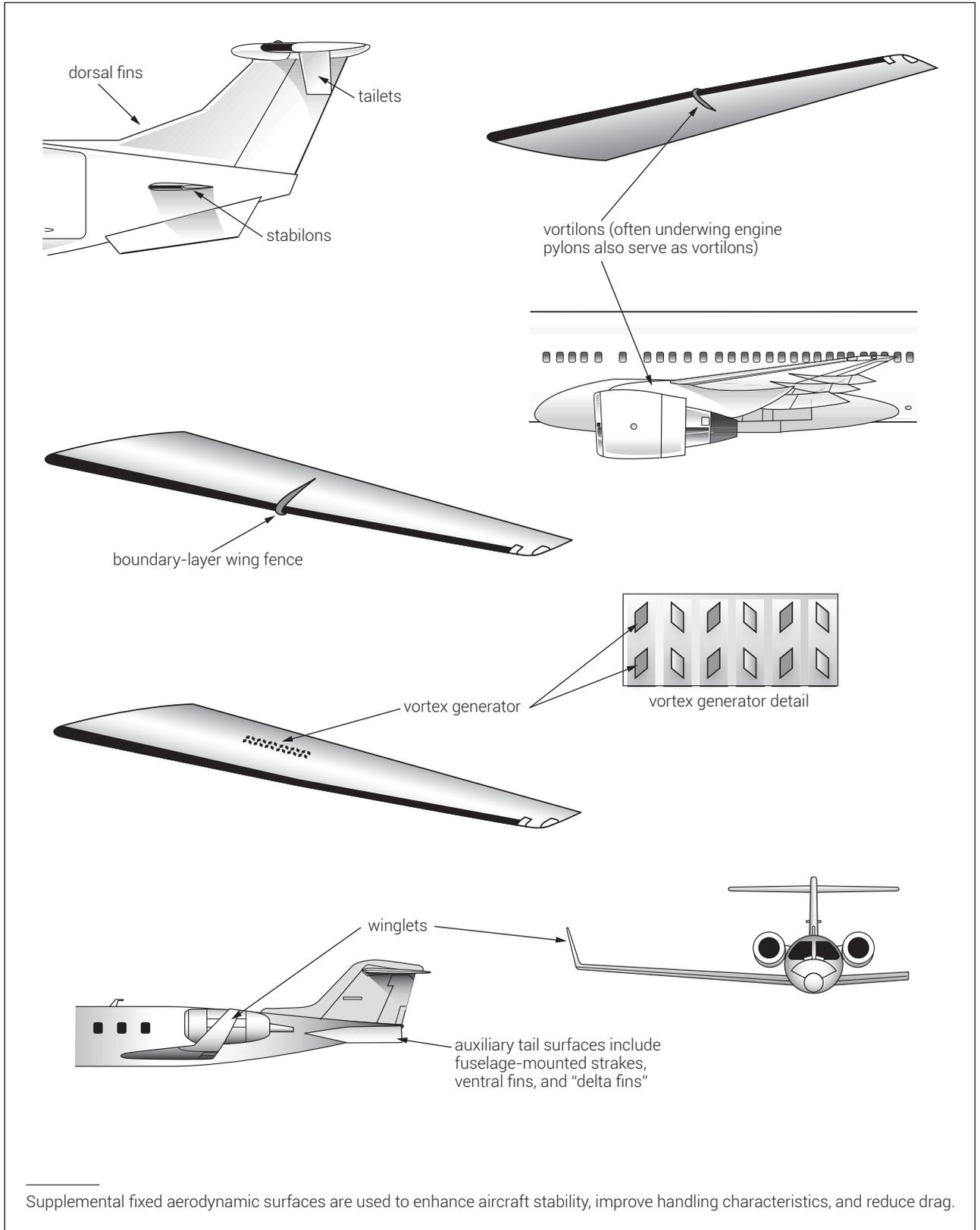


FIGURE 15.13 | Taillets, vortex generators, boundary-layer wing fences, vortilons, stabilons, and ventral fins.

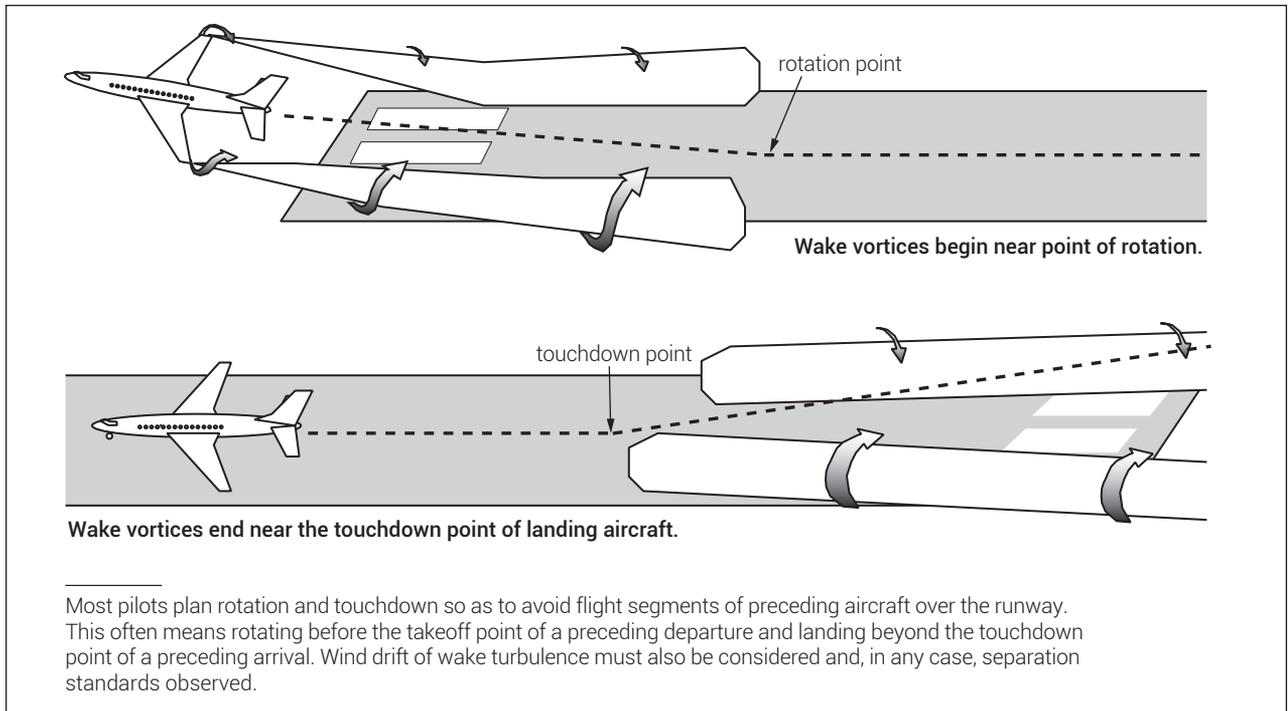


FIGURE 15.17 | Wing tip vortices on takeoff and landing.

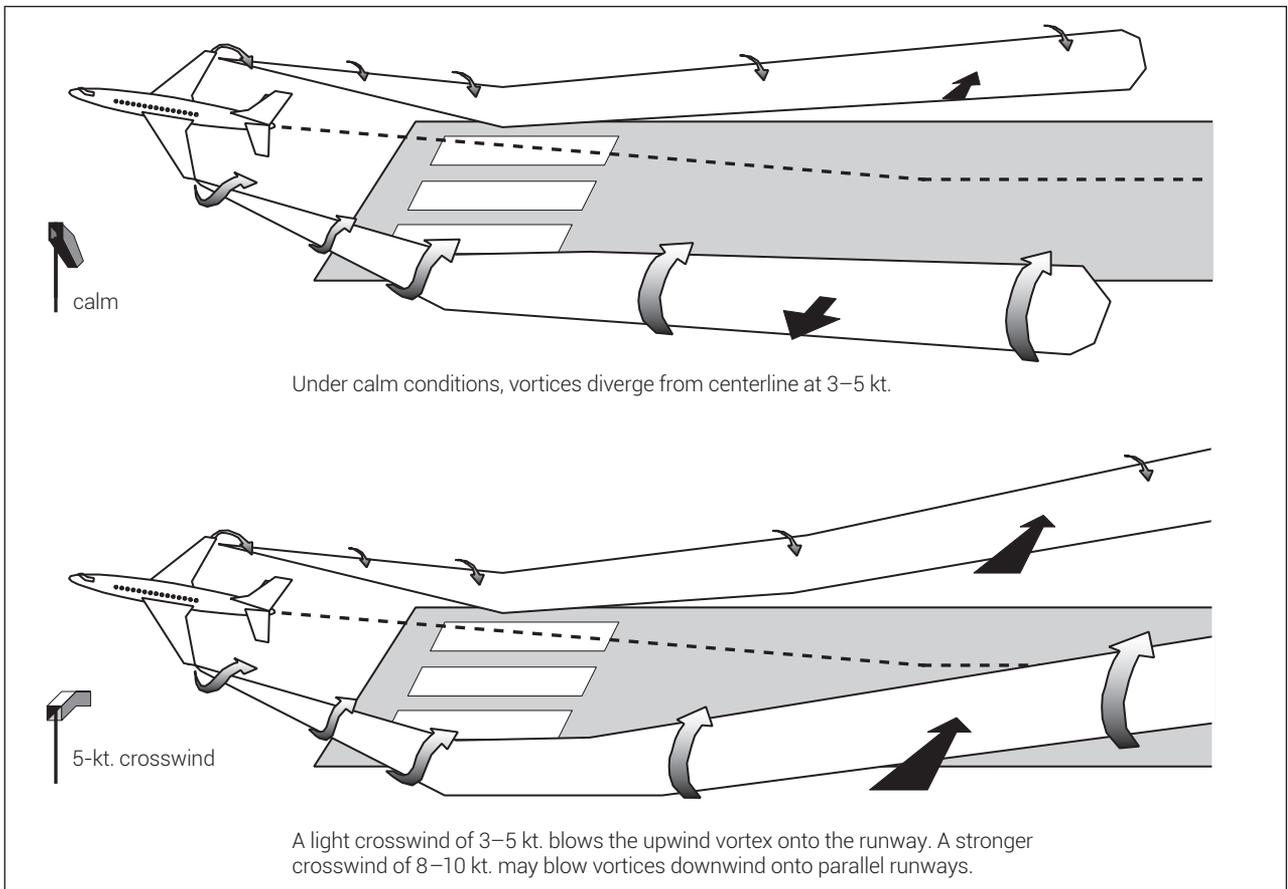


FIGURE 15.18 | Effect of crosswind on wing tip vortices.

THE TURBINE PILOT'S FLIGHT MANUAL

FOURTH EDITION

Gregory N. Brown
Mark J. Holt



Aviation Supplies & Academics, Inc.
7005 132nd Place SE
Newcastle, Washington 98059
asa2fly.com | 425.235.1500

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Everything a pilot is expected to know when transitioning to turbine-powered aircraft.

Whether you're preparing for a turbine aircraft ground school, studying for your Airline Transport Pilot (ATP) certificate, priming for a corporate or airline interview, or upgrading into a personal jet or turboprop—*The Turbine Pilot's Flight Manual* is for you. With precision and humor, authors Greg Brown and Mark Holt cover all the basics for turbine pilot operations, clearly explaining the differences between turbine aircraft and their piston engine counterparts.

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The Turbine Pilot's Flight Manual introduces all the principles and lingo required to "talk turbine." Many airlines and corporate flight departments recommend reading it before interviewing and prior to attending ground school.



Greg Brown's love of flying is obvious to anyone who knows his column, "Flying Carpet" in AOPA's *Flight Training* magazine, or who has read his other books, *You Can Fly!*, *The*

Savvy Flight Instructor, *Job Hunting for Pilots*, and *Flying Carpet: The Soul of an Airplane*. Greg was the 2000 National Flight Instructor of the Year, the first Master CFI, and was awarded the 2013 AOPA Let's Go Flying Award. Greg holds an ATP certificate with Boeing 737 type rating, and flight instructor certificate with all fixed-wing aircraft ratings.



Mark J. Holt, a pilot for a major airline who has logged over 20,000 hours in his 35 years of flying, holds an ATP certificate with Boeing 757/767, Airbus

319/320/321, BAE Jetstream 41 type ratings, and Flight Engineer (Turbojet) as well as flight/ground instructor certificates. His professional aviation career includes extensive flight and ground instructing experience and service as a check airman for a large regional airline. Mark is also co-author of *Air Carrier Operations*.