ANSWERS TO THE ACS

COMMERCIAL PILOT

AIRPLANE SINGLE & MULTIENGINE LAND

VOLUME I: GROUND PORTION

REVISION 1

ADDRESSES FAA-S-ACS-7A (CHANGE 1)

PATRICK MOJSAK

MOJSAK AERO LLC, ARLINGTON, TEXAS

Copyright Information

ISBN 978-1-7334211-1-9

Revision 1, December 2022

Mojsak Aero LLC
Arlington, TX

www.answerstotheacs.com

Dedication

To all those who have lost their lives in general aviation, that we may learn from their mistakes, and others, to forge a safer air transportation system.

FRONTMATTER

ABOUT THE AUTHOR

Patrick Mojsak began learning to fly from his father at the age of 12. He proceeded to then earn his private, instrument, commercial, and flight instructor certificates by the age of 18, which is when he began instructing.

Patrick graduated from the University of Texas at Arlington in 2012 with a Bachelor of Science in Electrical Engineering. He then moved to Wichita, Kansas to pursue a position with Cessna Aircraft Company as an electrical engineer. Patrick began working on Cessna's single engine piston airplanes such as the Cessna TTx (formerly the Columbia 400) by performing avionics testing, supporting production flight test regarding customer training, and drafting certification documentation.

During his time there, in early 2014, the companies of Cessna and Beechcraft merged to form what is now known as Textron Aviation. Patrick was then moved to begin working on the Citation Longitude - the company's first super mid-sized business jet. Duties included FADEC integration of the Honeywell HTF 7000 engine, wire diagram development, and assisting experimental shop with assembling a functional prototype. First flight was achieved on October 8, 2016.

During his time at Textron Aviation, Patrick continued to fly by instructing at the employee's flying club and earning additional certificates and ratings such as airline transport pilot (ATP), commercial airplane single engine sea (ASES), commercial glider, and flight instructor glider.

In late 2016, Patrick left Textron Aviation to return to his home state of Texas and pursue a career with the airlines. Patrick began working for Envoy Air Inc. (formerly known as American Eagle) in January of 2017 as a first officer on the Embraer 145 regional jet. In July of 2019, Patrick upgraded to captain on the Embraer 175.

Patrick's love for teaching is his inspiration behind this book. With new, more challenging standards being imposed by the FAA, Patrick wishes to reach a wider audience by providing detailed and tangible guidance.

FRONTMATTER
TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Individuals

Amit Alex: I would like to thank Amit Alex, flight test engineer at Gulfstream Aerospace, for his input and contributions to Briefing 3: Understanding the Risk Elements.

John and Kathy Yodice: I would like to thank the infamous John Yodice and his daughter Kathy for taking the time dig up old legal documents that are referenced in this book.

Organizations

Leidos Flight Service: I would like to thank the fine people at Leidos Flight Service for allowing me to use images of their website, a file photo, and for providing me a tour of the Fort Worth facility.

Photographic Contributions

I would like to thank the many individuals who contributed photographs to this work, each of whom are accredited below their respective photograph.

Special Thank You

Trang Nguyen: I would like to thank Trang Nguyen for her love and support throughout this project and for being a fantastic photographer responsible for numerous photographs throughout this book.

Russell and Samuel VanHoozer: I would like to thank Russell and his son Samuel for spending the day with me in their airplane helping to obtain numerous photographs for this book. I would also like to thank Russell for taking the time to review many aspects of this book and providing invaluable feedback.

Allen Herbert: I would like to thank Allen Herbert, CFII and test pilot at Textron Aviation, for his contributions of numerous professional photographs used throughout this book.

Mike Didonato: I would like to thank Mike Didonato, owner of Spinks Flight Center, for allowing me to take multiple photographs around the airplanes at his flight school that are used throughout this book.

Bill Knight: I would also like to thank Bill Knight, owner of Fly Texas Now, for allowing me to take multiple photographs around the airplanes at his flight school that are used throughout this book.

Ken Ely and Jason Newburg: I would like to thank Ken Ely and Jason Newburg of Aerobatic Aircraft of Texas for allowing to take numerous photographs around their beautiful Beechcraft Baron that are used throughout this book.

FRONTMATTER

DISCLAIMER

This book is intended to be a learning tool for applicants preparing for the practical test towards a pilot certificate and/or rating. The information presented herein is as accurate, complete, and authoritative as possible. However, there may be errors and omissions, both typographical and in content.

This book should not be used as the ultimate source of aeronautical information. It is designed to complement other aviation texts and formal flight instruction. For additional reading materials, refer to the extensive references at the end of each section.

The author and publisher shall not be liable or responsible to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the information contained in this book. This text is not a substitute for common sense, the exercise of good judgement, or formal flight instruction.

Revision	0	Date	February 11, 2020	ACS Addressed	FAA-S-ACS-7A (Change 1)
Reason(s) for Revision	NA				
Section		**Sub-Section**		**Change Description**	
All		All		None - initial issue.	

Revision	1	Date	December 31, 2022	ACS Addressed	FAA-S-ACS-7A (Change 1)
Reason(s) for Revision	Compatibility with the Answers to the ACS app.				
Section		**Sub-Section**		**Change Description**	
All		All		Multiple back end changes for compatibility with the Answers to the ACS app.	
Front Matter		Half Title Page		Updated revision and address.	
Front Matter		All		Re-formatted Front Matter section.	
Front Matter		Copyright Information		Updated copyright information.	
Front Matter		Revisions		Updated Revisions format.	
Briefings		All		Re-formatted Briefings section.	
Appendices and Addenda		All		Re-formatted Appendices and Addenda section.	

BRIEFINGS
OVERVIEW

Briefings are intended to provide necessary preliminary information prior to using this book. This includes understanding the Airman Certification Standards, an overview of the Answers to the ACS book series, understanding the risk elements, the practical test process, and a description of the overall scenario used throughout this book.

BRIEFINGS

1. THE AIRMAN CERTIFICATION STANDARDS

The Airman Certification Standards (ACS) is a Federal Aviation Administration (FAA) testing standard for both the knowledge test and practical test for a pilot certificate or rating. The ACS replaces what was previously known as the Practical Test Standards (PTS). The FAA began development of the ACS in 2011 together with industry partners by forming the ACS Working Group. Over the course of 5 years the Private Pilot Airplane and Instrument Rating Airplane ACSs were developed and released in the summer of 2016. The Commercial Pilot Airplane ACS followed 1 year later in the summer of 2017.

The ACS started out as a way to overhaul the outdated pilot knowledge testing system. This primarily included antiquated questions but also other items such as confusing Learning Statement Codes. From this the ACS grew to rectify many issues with the PTS. This included dispersing risk management and special emphasis items from introductory material to the individual tasks themselves. The FAA also took advantage of the PTS-to-ACS transition to make changes to the oral exam as well as certain flight maneuvers.

Airman Certification

The FAA certifies all aspects of the National Airspace System (NAS) including products (aircraft, engines, and propellers), airports, and airmen. Airmen consist of those individuals required to operate the NAS including pilots, flight instructors, mechanics, dispatchers, and air traffic controllers among others.[1] Each type of airman has their own certification process. This briefing will discuss the certification process for pilots.

FAA Pilot Certification System

FAA Pilot Certification Process

Pilot, flight instructor, and ground instructor certificates.

FAA Pilot Certification System

Pilot certification in the United States under the FAA consists of certificates and ratings. Certificates represent a pilot's level of skill and consist of a physical certificate. The FAA currently provides six levels of pilot certificates, from the lowest to the highest skill level, as follows:

1. **Student Pilot:** The lowest pilot certificate, the student pilot certificate, allows pilots to operate an aircraft solo with no occupants onboard except if accompanied by a flight instructor or examiner. This allows pilots to obtain the required solo aeronautical experience for a certificate or rating.

2. **Sport Pilot:** The sport pilot certificate was created in 2004 in an effort to lower the cost of flight training. This is done by reducing the requirements for the certificate relative to the recreational and private pilot certificates but limiting the types of aircraft that the pilot can operate. The sport pilot certificate requires fewer hours of training (20 hours) and no medical certificate to act as pilot in command, but pilots are limited to operating only light-sport aircraft, which are aircraft weighing 1,320 pounds or less (1,430 pounds or less for seaplanes).

3. **Recreational Pilot:** The recreational pilot certificate was created long before the sport pilot certificate but for similar reasons – to lower the cost of flight training by reducing requirements relative to the private pilot certificate but limiting the types of aircraft that the pilot can operate. The recreational pilot certificate still requires a medical certificate to act as pilot in command but fewer hours of training (30 hours) than the private pilot certificate. Pilots are limited to operating aircraft with four seats or less, only one engine that must be 180 horsepower or less, and may carry no more than one passenger among other limitations.

4. **Private Pilot:** The private pilot certificate is the original pilot certificate intended for private (as opposed to commercial) use. Private pilots may not receive compensation, save for few exceptions, and are allowed to fly any aircraft for which they are rated.

5. **Commercial Pilot:** The commercial pilot certificate is required to act as pilot in command of an aircraft in a commercial operation and to receive compensation. Examples of commercial operations include charter flights, aerial photography, and crop dusting among others and are smaller than what are considered airline operations.

6. **Airline Transport Pilot (ATP):** The ATP certificate is required to operate an aircraft in an airline operation. Airline operations are largely governed by 14 CFR Part 121 and are generally required for aircraft with a passenger-seating configuration of greater than 30 seats.

1. THE AIRMAN CERTIFICATION STANDARDS

Ratings are applied to a certificate and grant a pilot privileges to either operate certain aircraft or operate aircraft under instrument flight rules (IFR). The four types of ratings are as follows:

- **Category Rating:** A category rating grants a pilot the privilege to operate a certain category of aircraft. The FAA currently recognizes seven categories of aircraft: airplane, rotorcraft, glider, lighter-than-air, powered-lift, powered parachute, and weight-shift-control.
- **Class Rating:** A class rating grants a pilot the privilege to operate a certain class of aircraft within a given category. Table B-1-1 summarizes the different classes of aircraft. Note that there are no classes within the glider and powered-lift categories.

Category	Classes
Airplane	• Airplane Single Engine Land (ASEL) • Airplane Multiengine Land (AMEL) • Airplane Single Engine Sea (ASES) • Airplane Multiengine Sea (AMES)
Rotorcraft	• Helicopter • Gyroplane
Glider	• None
Lighter-Than-Air	• Balloon • Airship
Powered-Lift	• None
Powered Parachute	• Powered Parachute Land (PPL) • Powered Parachute Sea (PPS)
Weight-Shift-Control	• Weight-Shift-Control Land (WSCL) • Weight-Shift-Control Sea (WSCS)

Table B-1-1: Aircraft Categories and Classes

1. THE AIRMAN CERTIFICATION STANDARDS

It should be noted that class ratings may only apply to certain pilot certificates. For example, although the ASEL class rating can be applied to all six pilot certificates, the AMEL class rating does not exist for the sport and recreational pilot certificates. Table B-1-2 shows the applicability of various class ratings to pilot certificates.

	Student	Sport	Recreational	Private	Commercial	ATP
ASEL	X	X	X	X	X	X
AMEL	X			X	X	X
ASES	X	X	X	X	X	X
AMES	X			X	X	X
Helicopter	X		X	X	X	X
Gyroplane	X	X	X	X	X	
Glider	X	X		X	X	
Balloon	X	X		X	X	
Airship	X	X		X	X	
Powered-Lift	X			X	X	X
PPL	X	X		X		
PPS	X	X		X		
WSCL	X	X		X		
WSCS	X	X		X		

Table B-1-2: Aircraft Class Rating Applicability

- **Type Rating:** A type rating grants a pilot the privilege to operate a certain type of aircraft, if required. It should be noted that although an appropriate category and class rating is required to operate all aircraft, only select aircraft require a type rating. These generally include turbojet-powered airplanes and large aircraft (those weighing over 12,500 lbs).

- **Instrument Rating:** An instrument rating grants a pilot the privilege to operate an aircraft under IFR. There are only three instrument ratings as follows:

  - » **Instrument-Airplane Rating:** The instrument-airplane rating grants a pilot the privilege to operate any airplane for all class ratings that pilot holds under IFR.

  - » **Instrument-Helicopter Rating:** The instrument-helicopter rating grants a pilot the privilege to operate helicopters under IFR.

  - » **Instrument-Powered-Lift Rating:** The instrument-powered-lift rating grants a pilot the privilege to operate powered-lift aircraft under IFR.

It should be noted that just because there are only instrument ratings for the airplane category, helicopter class, and powered-lift category does not mean all other aircraft are prohibited from being operated under IFR. For example, a pilot with an airplane instrument rating may operate a glider under IFR, and a pilot with a commercial pilot's license with an airship class rating may operate an airship under IFR.[2]

FAA Pilot Certification Process

Certification requirements for a pilot certificate or rating are summarized as follows:

1. **Eligibility:** The applicant seeking the pilot certificate or rating in question must first be eligible. Eligibility generally includes a minimum age requirement (18 for commercial), proficiency in the English language, and a prerequisite pilot certificate (private pilot for commercial).
2. **Aeronautical Knowledge:** Applicants seeking a pilot certificate or rating must receive and log ground training from an instructor, or complete a home study course, over a variety of knowledge areas applicable to the certificate or rating sought. This prepares the applicant for both the knowledge test and the practical test. Knowledge areas may include aerodynamics, aircraft systems, and aeronautical decision making.
3. **Pass the Knowledge Test:** The applicant must pass the knowledge test for the pilot certificate or rating in question. For a commercial pilot certificate with an airplane single or multiengine land rating, the required knowledge test is the Commercial Pilot – Airplane (CAX) knowledge test which is a 100-question multiple choice test with a 3-hour time limit. Knowledge tests are taken on a computer at approved testing centers.
4. **Aeronautical Experience:** Aeronautical experience consists of required flight times, flights, and takeoffs and landings that must be performed in the aircraft itself. Aeronautical experience is recorded using a pilot logbook.
5. **Pass the Practical Test:** Lastly, the applicant must pass the practical test. The practical test is a two-part test administered by an evaluator. The first part of the test is the ground portion, also known as the oral exam, in which the evaluator assesses the applicant's knowledge over various subject areas via oral questioning. The second part of the test is the flight portion in which the evaluator assesses the applicant's skills by demonstrating various flight maneuvers. If the applicant passes the practical test, they are awarded the pilot certificate or rating sought. The practical test is discussed in greater detail in ***Briefing 4***.

ACS Structure

Like the PTS before it, the ACS is divided into areas of operation, tasks, and elements (Figure B-1-1):[3]

Areas of Operation

Tasks

Elements

Area of Operation I. Preflight Preparation

Task

Task	*B. Airworthiness Requirements*
References	14 CFR parts 39, 43, 91; FAA-H-8083-2, FAA-H-8083-25
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with airworthiness requirements, including airplane certificates.

Knowledge Elements

Knowledge	The applicant demonstrates understanding of:
CA.I.B.K1	General airworthiness requirements and compliance for airplanes, including:
CA.I.B.K1a	a. Certificate location and expiration dates
CA.I.B.K1b	b. Required inspections and airplane logbook documentation
CA.I.B.K1c	c. Airworthiness Directives and Special Airworthiness Information Bulletins
CA.I.B.K1d	d. Purpose and procedure for obtaining a special flight permit
CA.I.B.K2	Pilot-performed preventive maintenance.
CA.I.B.K3	Equipment requirements for day and night VFR flight, to include:
CA.I.B.K3a	a. Flying with inoperative equipment
CA.I.B.K3b	b. Using an approved Minimum Equipment List (MEL)
CA.I.B.K3c	c. Kinds of Operation Equipment List (KOEL)
CA.I.B.K3d	d. Required discrepancy records or placards

Risk Elements

Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
CA.I.B.R1	Inoperative equipment discovered prior to flight.

Skill Elements

Skills	The applicant demonstrates the ability to:
CA.I.B.S1	Locate and describe airplane airworthiness and registration information.
CA.I.B.S2	Determine the airplane is airworthy in a scenario given by the evaluator.
CA.I.B.S3	Apply appropriate procedures for operating with inoperative equipment in a scenario given by the evaluator.

Figure B-1-1: ACS Structure

Areas of Operation

Areas of operation are broad subjects relating to a particular phase of flight or operational area that are defined by regulation and specific to the class rating sought. There are four class ratings for airplanes: airplane single engine land (ASEL), airplane multiengine land (AMEL), airplane single engine sea (ASES), and airplane multiengine sea (AMES). For the commercial pilot ASEL and AMEL ratings, areas of operation are defined in 14 CFR §61.127(b)(1) and (2) and include 11 subjects. Areas of operation are numbered with Roman numerals and organized in a logical sequence for a flight beginning with preflight preparation and ending with postflight procedures.

Tasks

Tasks are subdivisions of areas of operation and narrow down the subject at hand further, such as to a particular maneuver. As an example, Area of Operation IV relates to takeoffs, landings, and go-arounds. The tasks within Area of Operation IV are for specific types of takeoffs and landings, such as normal, short-field, and soft-field. Tasks within an area of operation are assigned letters beginning with ‘A’ and listed in alphabetical order.

As an example, Area of Operation IV relates to takeoffs, landings, and go-arounds, while Task C evaluates the soft-field takeoff and climb.

Elements

Elements are categorized as either knowledge, risk, or skill elements.

Knowledge Elements

Risk Elements

Skill Elements

Knowledge Elements

Knowledge elements are specific items associated with the task at hand that the applicant must *know*. Evaluation of knowledge elements during the practical test is accomplished by either direct or scenario-based oral questioning. Systems questions, for example, are typically evaluated by direct oral questioning, whereas airworthiness questions are often evaluated by scenario-based oral questioning.

Knowledge elements are provided a number preceded by the letter 'K.' In addition to this, individual knowledge elements are provided a unique coding that contains the applicable ACS, area of operation, and task. For example, CA.I.A.K1 indicates the following:

CA: Commercial Pilot Airplane ACS

I: Area of Operation I

A: Task A

K1: Knowledge Element 1

Risk Elements

Risk elements are historically common causes of accidents associated with the task at hand that the applicant must *consider*. Since risk elements are among the biggest changes with the ACS, this is discussed in detail in ***Briefing 3***. Risk elements may be evaluated by either scenario-based oral questioning or observing the applicant's actions during the flight test. As an example, CA.I.A.R2 which reads, 'flying unfamiliar airplanes, or operating with unfamiliar flight display systems, and avionics' may be evaluated during the oral exam by a hypothetical scenario in which only an unfamiliar airplane is available for the flight. CA.II.C.R1 however, which reads, 'propeller safety' may be evaluated by the examiner simply observing the applicant take precautions such as ensuring the magnetos are off prior to towing, avoiding the arc of the propeller when able, and yelling 'clear' prior to engine start.

Similar to knowledge elements, risk elements are provided a number preceded by the letter 'R.' These are coded in the same manner as knowledge elements. For example, Risk Element 1 within Task A of Area of Operation I in the Commercial Pilot Airplane ACS would be coded as CA.I.A.R1.

Skill Elements

Skill elements are actions associated with the task at hand that the applicant must demonstrate or *do*. Skill elements for tasks contained in Area of Operation I, which are evaluated during the oral exam, consist of either scenario-based oral evaluation, presentations by the applicant to the examiner, or evaluation of at least three knowledge elements. Skill elements for Area of Operation II and on involve actions to accomplish during a maneuver such as clearing turns, checklist usage, and airspeed/altitude/heading tolerances.

Similar to knowledge and risk elements, skill elements are provided a number preceded by the letter 'S.' These are coded in the same manner as knowledge and risk elements. For example, Skill Element 1 within Task A of Area of Operation I in the Commercial Pilot Airplane ACS would be coded as CA.I.A.S1.

Using the ACS

When it comes to using the ACS for a practical test, the examiner must evaluate applicable areas of operation, applicable tasks within these areas of operation, and at least one knowledge element, one risk element, and all skill elements within an applicable task.[4]

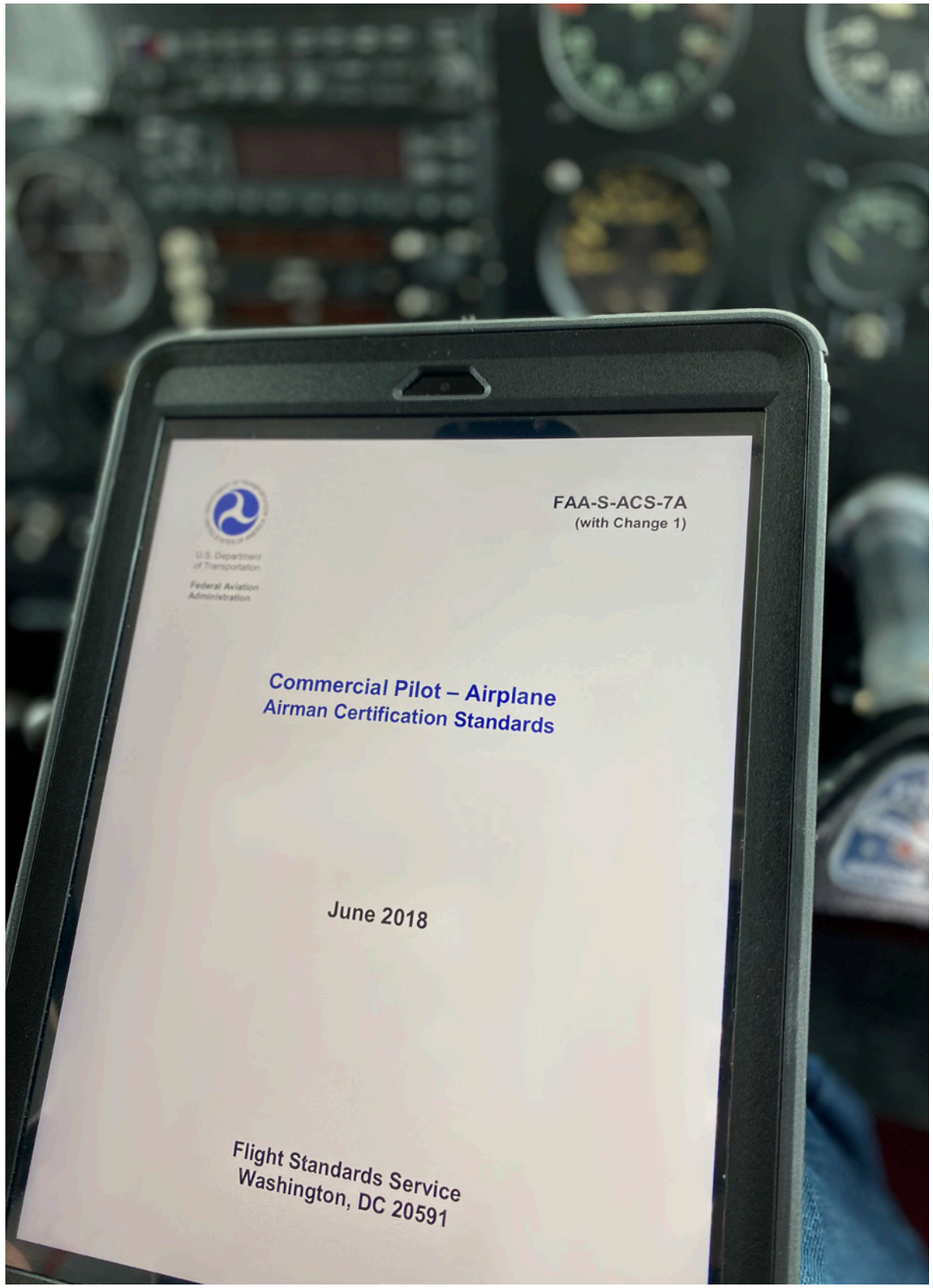
Applicable Areas of Operation

Applicable Tasks

One Knowledge Element

One Risk Element

All Skill Elements



Applicable Areas of Operation

The examiner must evaluate all areas of operation applicable to the aircraft being used for the practical test. Non-applicable areas of operation are not indicated directly but are obvious in most cases. An example of a non-applicable area of operation is Area of Operation X, Multiengine Operations if taking the practical test in a single engine airplane.

Applicable Tasks

Within a given area of operation, all tasks applicable to the aircraft being used for the practical test need to be evaluated. An applicable task is identified by looking for an aircraft category and class in parentheses after the task's title. If there are no parentheses after the task's title, then the task is applicable to all categories and classes of aircraft covered by that ACS and as a result must be evaluated. If specific categories and classes of aircraft *are* listed in parentheses after the task title, then the task only needs to be evaluated if the practical test is being taken in those aircraft and may be omitted otherwise. For example, Area of Operation IV, Task L, Rough Water Approach and Landing (ASES, AMES) must only be evaluated in single and multiengine seaplanes. If the practical test is being taken in a single or multiengine land airplane, the task will be omitted.

XI. Postflight Procedures

Task	***A. After Landing, Parking and Securing (ASEL, AMEL)***
References	FAA-H-8083-2, FAA-H-8083-3; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with after landing, parking, and securing procedures.
Knowledge	The applicant demonstrates understanding of:
CA.XI.A.K1	Airplane shutdown, securing, and postflight inspection.
CA.XI.A.K2	Documenting in-flight/postflight discrepancies.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
CA.XI.A.R1	Inappropriate activities and distractions.
CA.XI.A.R2	Confirmation or expectation bias as related to taxi instructions.
CA.XI.A.R3	Airport specific security procedures.
CA.XI.A.R4	Disembarking passengers.
Skills	The applicant demonstrates the ability to:
CA.XI.A.S1	Utilize runway incursion avoidance procedures.
CA.XI.A.S2	Park in an appropriate area, considering the safety of nearby persons and property.
CA.XI.A.S3	Complete the appropriate checklist.
CA.XI.A.S4	Conduct a postflight inspection and document discrepancies and servicing requirements, if any.
CA.XI.A.S5	Secure the airplane.

Area of Operation XII, Task A, After Landing, Parking, and Securing is only applicable to single and multiengine land airplanes.

One Knowledge Element

Within each applicable task, at least one knowledge element must be evaluated. Although the examiner has the ability to select any knowledge element at random, certain knowledge elements are required to be covered, each of which can satisfy the requirement to evaluate one knowledge element. This includes learning statement codes listed on the applicant's airman knowledge test report and knowledge elements required by skill elements.

It should also be noted that knowledge sub-elements in effect count as one knowledge element.[5] Knowledge sub-elements are indicated by letters within a knowledge element. As a result, if the examiner evaluates a single sub-element, this counts towards the one knowledge element required for the applicable task. This is contrary to the belief that all sub-elements must be evaluated to satisfy the overarching knowledge element.

Airman Knowledge Test Learning Statement Codes

The examiner is required to evaluate any knowledge elements indicated by learning statement codes listed on the applicant's knowledge test report. Learning statement codes are subject areas related to questions that the applicant missed on the knowledge test. This is discussed in detail in ***Briefing 4***.

Knowledge Elements Required by Skill Elements

Certain knowledge elements are required by skill elements. As discussed previously, all skill elements must be evaluated. As a result, knowledge elements required by skill elements are guaranteed to be evaluated. The three skill elements requiring this are:

- **CA.I.C.S2:** Requires the evaluation of at least three different weather phenomena listed in CA.I.C.K3.
- **CA.I.G.S1:** Requires the evaluation of at least three different airplane systems listed in CA.I.G.K1.
- **CA.I.H.S1:** Requires the evaluation of at least three different aeromedical/physiological issues listed in CA.I.H.K1.

One Risk Element

At least one risk element within an applicable task must be evaluated. It should be noted that, similar to knowledge elements, risk sub-elements in effect count as one risk element. As a result, evaluation of a single sub-element counts toward the one risk element required for the task.

All Skill Elements

All skill elements within an applicable task must be evaluated.

Revisions to the ACS

Each ACS is generally revised once a year in the month of June. This is done to allow universities with flight training programs to have sufficient time to modify their courses in response to any ACS changes for the fall semester. The significance of each revision varies and is reflected in the ACS's document number:

FAA-S-ACS-7A (Change 1)

FAA: FAA document.

S: Standards document.

ACS: ACS document.

7: The number assigned to the particular ACS document. Currently Private Pilot Airplane is 6, Instrument Airplane is 8, and Commercial Pilot Airplane is 7.

A: Revision A. Revision letters reflect a major revision that either affects public safety or is due to a regulatory change.

Change 1: For minor revisions that only affect things such as wording, a change number is issued.

Since its initial issue in 2016, the ACS has effectively stabilized and revisions as of late have been relatively minor. The FAA's goal is for revisions to take place on a biannual basis.

Changes From the PTS

Re-Structuring of Elements

Previously with the PTS, tasks contained only a numbered list of elements that were not categorized. As discussed previously, with the ACS, elements are now categorized as either knowledge, risk, or skill elements and uniquely coded. The original numbered elements from the PTS largely make up the skill elements in the ACS. Knowledge elements have been added to provide a standard for the knowledge test but to also further evaluate the applicant's knowledge of a given task during the practical test. Risk elements are based on historical accident data and evaluate the applicant's risk management ability. Risk elements are discussed in detail in ***Briefing 3***.

Changes to the Oral Exam

An overview of the oral exam is presented in ***Briefing 4***. Although the overall structure of the oral exam remains the same, there are several key changes with the ACS. One of the biggest changes is the requirement for scenario-based evaluation. In addition to this, examiners must now evaluate various weather phenomena in Area of Operation I, Task C, observe a cross-country risk analysis presentation in Area of Operation I, Task D, and observe a self-assessment presentation in Area of Operation I, Task H.

Scenario-Based Evaluation

Evaluation of Various Weather Phenomena

Cross-Country Risk Analysis Presentation

Self-Assessment Presentation

Scenario-Based Evaluation

Although scenario-based evaluation was encouraged in the PTS, it is now required with the ACS. This is made evident by numerous skill elements in Area of Operation I that explicitly call for scenario-based evaluation. These include:

- **CA.I.A.S1:** *Apply requirements to act as PIC under Visual Flight Rules (VFR) in a scenario given by the evaluator.*
- **CA.I.B.S2:** *Determine the airplane is airworthy in a scenario given by the evaluator.*
- **CA.I.B.S3:** *Apply appropriate procedures for operating with inoperative equipment in a scenario given by the evaluator.*
- **CA.I.C.S2:** *Analyze the implications of at least three of the conditions listed in K3a through K3l above, using actual weather or weather conditions in a scenario provided by the evaluator.*
- **CA.I.D.S4:** *Recalculate fuel reserves based on a scenario provided by the evaluator.*
- **CA.I.H.S2:** *Perform self-assessment, including fitness for flight and personal minimums, for actual flight or a scenario given by the evaluator.*

It should be noted that other skill elements may also necessitate scenario-based evaluation. Examples include ***CA.I.D.S1***, determination and presentation of cross-country flight planning and ***CA.I.F.S1***, determination and presentation of weight and balance, each of which are based on an overall scenario provided by the examiner.

Evaluation of Various Weather Phenomena

In the PTS, examiners were required to evaluate the applicant's knowledge on various weather *products* such as weather reports, charts, and forecasts. This element was subdivided into numerous sub-elements that listed specific weather products. In the ACS however, this has been consolidated into a single knowledge element with no sub-elements. This was done due to the fact that weather products are very dynamic and have changed significantly especially in recent years.

In place of an itemized list of weather products is a list of various weather phenomena such as clouds, thunderstorms, and icing. This was done in an effort to synchronize the knowledge and practical tests and to encourage application of knowledge of various weather phenomena for actual flight.

Cross-Country Risk Analysis Presentation

In the PTS, applicants only had to present their cross-country flight planning for Area of Operation I, Task D. With the ACS however, applicants must now also present a risk analysis related to the cross-country using real-time weather. The most widely used method of compliance is the acronym PAVE (Pilot, Aircraft, enVironment, and External pressures) and is discussed in detail in ***CA.I.D.S1***.

Self-Assessment Presentation

In the ACS, Area of Operation I, Task H now requires a self-assessment presentation to include fitness for flight and personal minimums. The most widely used method of compliance for determination of fitness for flight is the acronym IMSAFE (Illness, Medication, Stress, Alcohol, Fatigue, and Eating). Regarding determination of personal minimums, the FAA has provided a handful of recommendations in various sources. Each of these are discussed in detail in ***CA.I.H.S2***.

Changes to Flight Maneuvers

The two flight maneuvers that have changed the most in the PTS-to-ACS transition are slow flight and stalls.

Slow Flight

Slow flight has been changed to now require the applicant to fly just prior to, but without, activation of the stall warning. This differs from the previously required procedure in the PTS to fly just prior to the actual stall, which required activation of the stall warning. This change is due to the FAA's belief that pilots will be trained to disregard the stall warning if intentionally flying with it activated.[6] This is discussed in detail in Area of Operation VII, Task A in Volume II.

Stalls

Stalls have been changed to require the applicant to verbally acknowledge the cues of an impending stall and full stall.[7] Widely used methods of compliance include verbally stating "there's the buffet," "there's the stall warning," and "there's the break." This is discussed in Area of Operation VII, Tasks B and C in Volume II.

BRIEFINGS

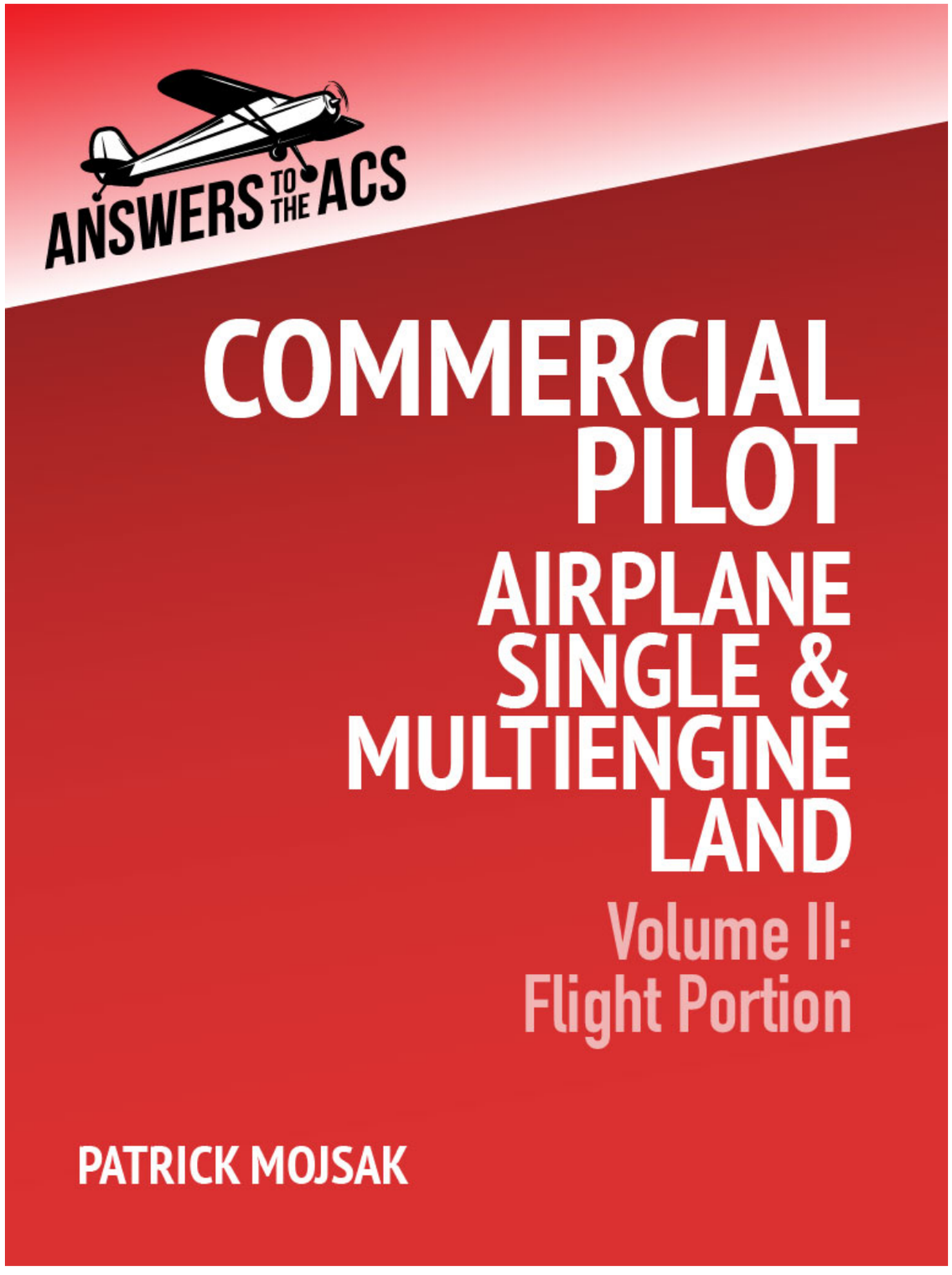
2. ABOUT ANSWERS TO THE ACS

Answers to the ACS is a book series that seeks to fully address the FAA's Airman Certification Standards (ACS) for the practical test. This briefing discusses the philosophy utilized by this book, its structure, and how to use this book.

Obsolescence of the Building Block Concept of Learning

Answers to the ACS Structure

How to Use This Book



Obsolescence of the Building Block Concept of Learning

Conventional textbooks are designed to follow the building block concept of learning, in that fundamental concepts are discussed first and then built upon to form more advanced concepts later on. This works well for a relatively small volume of information, but quickly breaks down when the volume of information becomes too large. In recent decades, the typical textbook has grown to several hundred pages. Regardless of the field of study, the average student simply does not read such a large textbook from cover to cover.

Aviation is no different than many other areas of study in that its required breadth and depth of knowledge has grown tremendously in recent years due to the litigious nature of society. Each new accident brings new requirements that the FAA "must" impose. Although this is not the most effective way to conduct pilot training, it is the card that we are dealt and as a result must be contended with. It is because of this that the PTS, a mere pamphlet, has grown to what the ACS is today.

As a result, students in aviation and other fields have found that the only realistic way to study such vast material is to determine the requirements for a given test, and then quickly locate the information and absorb it. It is for this reason that Answers to the ACS is not designed like a conventional textbook. Instead, it is organized like the ACS itself which facilitates the ability for applicants to quickly locate the element they wish to study. As a result, Answers to the ACS is not intended to be read from cover to cover since information is compartmentalized in an easy to locate manner. It is in this sense that the building block concept of learning has become largely obsolete for most fields of study.

Answers to the ACS Structure

As discussed in ***Briefing 4***, a given practical test applies to a particular pilot certificate and aircraft rating. As a result, each Answers to the ACS book addresses a particular pilot certificate and aircraft rating with the following three books in work:

Private Pilot Airplane Single Engine Land

Instrument Airplane

Commercial Pilot Airplane Single and Multiengine Land

Due to the large volume of information required by the ACS, each Answers to the ACS book is divided into two volumes. The first volume addresses the ground portion (also known as the "oral exam") of the practical test which encompasses Area of Operation I. The second volume addresses the flight portion of the practical test which encompasses Area of Operation II and on.

Elements

Although most elements are individually addressed, some are combined, and others are addressed more than once. For example, CA.I.D.K3a, b, and c are combined since these relate to interconnected concepts dealing with cross-country flight planning. CA.I.H.R1 on the other hand, *aeromedical and physiological issues*, is evaluated for each of the 12 conditions listed in CA.I.H.K1, even though it is a single risk element.

Knowledge elements are addressed in a straightforward manner by presenting the applicable information with a textual description along with visual elements such as figures and photographs as necessary. Sample oral questions and answers are provided where they are likely to be encountered during the practical test. Step-by-step instructions are also provided where necessary, such as for cross-country flight planning.

Risk elements are addressed by subdividing the element into risk identification, assessment, and mitigation. Example accidents are most often used as a starting point, but accident studies are used as well. This is discussed in further detail in ***Briefing 3***.

The addressing of skill elements differs between volumes I and II. In Volume I, skill elements largely relate to oral presentations provided to the examiner or the answering of scenario-based questions. In Volume II, pictorial profiles for flight maneuvers are provided along with a breakdown of all skill elements in sequential order with a corresponding explanation.

References

Answers to the ACS is unique in that as much information as possible is referenced to reputable sources such as the FAA including current and historical regulations, legal interpretations, and safety information. This book should serve as a starting point if more information is desired. Additionally, if you, your instructor, or your examiner questions the information from this book, locate the appropriate reference for further reading.

Revisions

Answers to the ACS is dynamic in that it stays revised to keep up with changing regulations, new information, and the ACS itself. See the Revisions section at the front of the book to check its revision status and which ACS document it addresses.

How to Use This Book

As discussed in the disclaimer at the beginning of this book, this book is not a substitute for flight or ground training from an authorized instructor. Instead, this book should serve to augment such training and allow for more targeted study.

Due to the tremendous amount of information presented herein, it is recommended that applicants obtain this book early in training, or even beforehand. Each element should be studied gradually as they are encountered in training. For example, when beginning to learn cross-country flight planning, ***Task D*** of this book should be referenced.

Once preparation for the practical test begins in earnest, which may be 1 to 2 months out, begin by studying the elements in which you feel you are weakest. Once these are solidified, and time permitting, study elements in which you are confident to reinforce them. Check each of these off by using a printout of the ACS or something similar.

To locate the desired element you wish to study, simply begin at the table of contents at the front of the book or use the dropdown navigational table of contents. Select the desired task, which will bring you to its corresponding overview page. On this page, a task table identical to that of the ACS will be presented with elements hyperlinked. Tap on the hyperlink of the desired element to view it.

About 1 week prior to the practical test, begin filling out the Practical Test Preparation Worksheets and ensure they are completed prior to the practical test. This is discussed in detail in ***Briefing 4*** and each respective task.

All pages are organized to provide maximum situational awareness. See the following page for a breakdown of the layout of each page.

Sub-Section title: The sub-section title often correlates to a particular element in Volume I. Sub-section titles can also be found in the dropdown navigational table of contents.

Section title: The section title is presented at the very top of the page and correlates to the task's title in Volume I.

Element identifier: The element identifier identifies the element type as either a knowledge (K), risk (R), or skill (S) element.

Standard Text

Standard text is shown against a white background and discusses the topic at hand. References to figures and tables are shown as necessary. Hyperlinks to other areas within the book are shown in ***red text***. Hyperlinks to websites are shown in soft blue. Photographs are used widely throughout the book.

Example Text

Example text is italicized with a pale yellow background and discusses examples pertaining to the overall scenario used in this book described in ***Briefing 5****. Examples include a number of topics ranging from decision making to calculations.*

Area of operation number

Area of Operation I

Page number: Page number format is area of operation number - task letter - page number.

I-B-22

Task letter

Task B

BRIEFINGS

4. THE PRACTICAL TEST PROCESS

The practical test, also known as the ‘checkride,’ follows a predictable procedure which is outlined in this briefing.

1. Schedule Appointment

2. Practical Test Preparation

3. Pre-Test Briefing

4. Eligibility Determination

5. Ground Portion

6. Flight Portion

7. Post-Flight Briefing

Although seemingly nebulous and intimidating, each checkride follows a standardized procedure.

1. Schedule Appointment

Once you and your instructor deem that you are ready for the practical test, schedule an appointment with an evaluator. The term 'evaluator' is a broad term used in the ACS which refers to any one of several different types of individuals that may administer a practical test. Historically, the two types of evaluators that could administer a practical test for a commercial pilot applicant were a designated pilot examiner (DPE) or an FAA aviation safety inspector (ASI). However, due to recent changes within the FAA, DPEs are currently the only individuals that administer practical tests for pilot applicants. A DPE is a private individual designated by the FAA that is permitted to administer practical tests on their behalf. This is necessary since the FAA does not have the resources to keep up with the demand for practical tests on their own.

Locating a DPE

Arranging the Practical Test

Eligible Aircraft

Locating a DPE

DPEs can be located one of two ways. The first is on the FAA's website at http://av-info.faa.gov/DesigneeSearch.asp. Here, the desired flight standards district office (FSDO) can be selected, and all DPEs under that FSDO will be shown. Up until recently, DPEs were restricted to administering practical tests within their FSDO's jurisdiction. DPEs no longer have these geographic limitations, however. Applicants should first attempt to locate a DPE that is nearby and within their FSDO's jurisdiction. If a DPE cannot be located within one's FSDO, or if delays are excessive, applicants should then attempt to look in neighboring FSDOs. ***Figure B-4-1*** shows a map of FSDOs and their respective jurisdictions around the US.

The second way is simply by word of mouth. Local flight instructors and flight schools will often have a preferential DPE that they use, which will take care of this decision.

BRIEFINGS

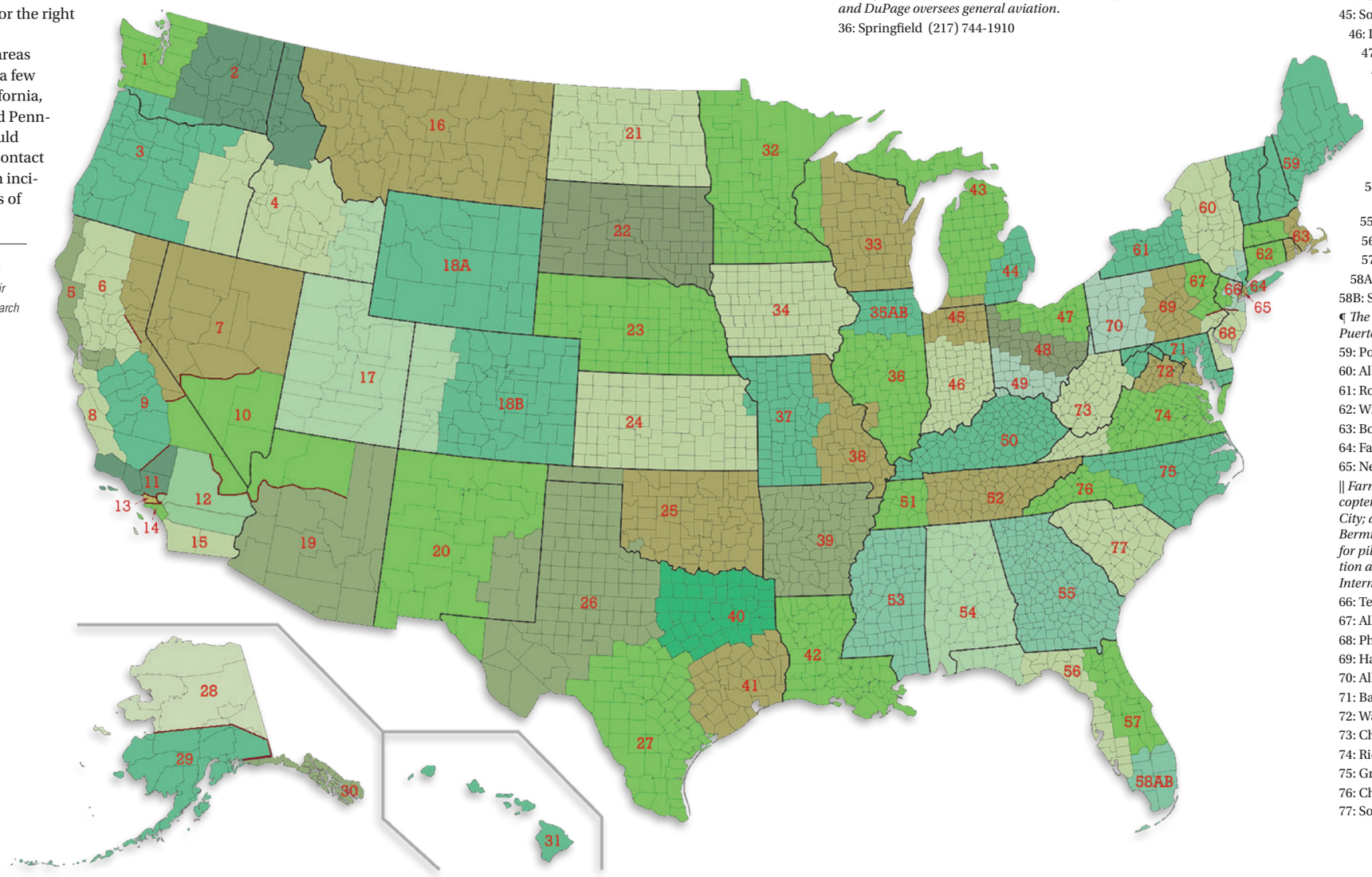
4. THE PRACTICAL TEST PROCESS

When it comes to reporting accidents or low-flying aircraft, getting permits and certifications, enforcing airman and aircraft regulations, participating in safety seminars, or asking questions about aircraft modifications or maintenance issues, your local Flight Standards District Office (FSDO) is the place to start. There are 80 FSDOs covering 77 geographical areas of responsibility in the United States to choose from, which can be confusing when searching for the right field office.

The flight standards coverage areas are organized by county lines with a few exceptions in Alaska, Arizona, California, Maryland, Nevada, New Jersey, and Pennsylvania. The map shown here should help you figure out what FSDO to contact based on your location or where an incident occurred. This is up-to-date as of the publish date of this magazine.

Paul Cianciolo is an assistant editor and the social media lead for FAA Safety Briefing. *He is a U.S. Air Force veteran, and a rated aircrew member and search and rescue team leader with the Civil Air Patrol.*

1: Seattle (425) 227-2813
2: Spokane (509) 532-2340
3: Portland (Oregon) (503) 615-3200
4: Boise (208) 387-4000
5: Oakland (510) 748-0122
6: Sacramento (916) 422-0272
7: Reno (775) 858-7700
8: San Jose (408) 291-7681
9: Fresno (559) 454-0286
10: Las Vegas (702) 617-8500
11: Van Nuys (818) 904-6291
12: Riverside (951) 276-6701
13: Los Angeles (310) 725-6600
14: Long Beach (562) 420-1755
15: San Diego (858) 502-9882
16: Helena (406) 449-5270
17: Salt Lake City (801) 257-5020
18A: Casper * (800) 325-5785
18B: Denver * (800) 847-3808
** Casper FSDO shares and works within the Denver FSDO boundaries.*
19: Scottsdale (480) 419-0111
20: Albuquerque (505) 764-1200
21: Fargo (701) 492-5800
22: Rapid City (605) 737-3050
23: Lincoln (402) 475-1738
24: Wichita (316) 941-1200
25: Oklahoma City (405) 951-4200
26: Lubbock (806) 740-3800
27: San Antonio (210) 308-3300
28: Fairbanks (907) 474-0276
29: Anchorage (907) 271-2000
30: Juneau (907) 586-7532
31: Honolulu † (808) 837-8300
† Service area includes American Samoa, Guam, and Northern Mariana Islands.
32: Minneapolis (612) 253-4400
33: Milwaukee (414) 486-2920
34: Des Moines (515) 289-3840
35A: Chicago O'Hare ‡ (847) 294-7900
35B: DuPage ‡ (630) 443-3100
‡ The FSDOs share same geographic area; however, Chicago O'Hare oversees Part 121 operations only and DuPage oversees general aviation.
36: Springfield (217) 744-1910



37: Kansas City (816) 329-4000
38: St. Louis (314) 890-4800
39: Little Rock (501) 918-4400
40: North Texas § (214) 277-8500
§ The Fort Worth Alliance and Dallas FSDOs were combined into North Texas as of Oct. 1, 2013.
41: Houston (281) 929-7000
42: Baton Rouge (225) 932-5900
43: Grand Rapids (616) 954-6657
44: East Michigan (734) 487-7222
45: South Bend (574) 245-4600
46: Indianapolis (317) 837-4400
47: Cleveland (440) 686-2001
48: Columbus (614) 255-3120
49: Cincinnati (513) 842-9600
50: Louisville (502) 753-4200
51: Memphis (901) 322-8600
52: Nashville (615) 324-1300
53: Jackson (601) 664-9800
54: Alabama & Northwest Florida (205) 876-1300
55: Atlanta (404) 474-5100
56: Tampa (813) 287-4900
57: Orlando (407) 812-7700
58A: South Florida ¶ (954) 641-6000
58B: San Juan ¶ (787) 764-2538
¶ The South Florida FSDO service area includes Puerto Rico and U.S. Virgin Islands.
59: Portland (Maine) (207) 780-3263
60: Albany (518) 785-5660
61: Rochester (585) 436-3880
62: Windsor Locks (860) 6a54-1000
63: Boston (781) 238-7500
64: Farmingdale || (631) 755-1300
65: New York City || (516) 228-8029
|| Farmingdale FSDO is responsible for all helicopter activity within the 5 boroughs of New York City; and New York City FSDO is responsible for Bermuda and Greenland, but it's not responsible for pilot examiners, airworthy examiners, inspection authorizations, FAASTeam, nor Flight Safety International at LaGuardia.
66: Teterboro (201) 556-6600
67: Allentown (610) 264-2888
68: Philadelphia (610) 595-1500
69: Harrisburg (717) 774-8271
70: Allegheny (412) 886-2580
71: Baltimore (410) 787-0040
72: Washington (703) 230-7664
73: Charleston (304) 347-5199
74: Richmond (804) 222-7494
75: Greensboro (336) 369-3900
76: Charlotte (704) 319-7020
77: South Carolina (803) 765-5931

Figure B-4-2: FSDO Map (Courtesy FAA Safety Briefing)

Arranging the Practical Test

Once the DPE has been selected, contact them via telephone. This is normally accomplished by your flight instructor or flight school. The following information should be determined when arranging the practical test, and can be documented using Form CA-B-1:

- **Date and Time:** First, agree on a date and time for the practical test with the examiner. Depending on demand and their availability, a wait time of anywhere from a week to over a month can be expected. Ensure enough time is available between scheduling and taking the practical test to allow for review. However, if wait times are long, the practical test may need to be scheduled some time during training and not necessarily when the applicant is ready.

- **Location:** Next, agree on a location to meet the examiner and conduct the practical test. Many examiners will agree to travel to the applicant's home airport. Other examiners will require the applicant to travel to their airport. In some cases, the examiner may agree to meet at an intermediate location. If the examiner agrees to meet at the applicant's home airport or an intermediate location, ensure that there are adequate facilities available to conduct the ground portion/oral exam (i.e. a private, climate-controlled room with a table and chairs, restrooms, etc.).

EXAMINER INFORMATION

NAME	PHONE NUMBER	FEE	
STEVE JONES	999-999-9999	$400.00	☑ CASH ONLY

PRACTICAL TEST INFORMATION

DATE	TIME	LOCATION	AIRPLANE MAKE & MODEL
8/1/19	8:00 AM	KFWS	PA-44-180

TYPE TEST

- ☐ PRIVATE ASEL
- ☐ INSTRUMENT AIRPLANE
- ☐ COMMERCIAL ASEL
- ☑ COMMERCIAL AMEL

OVERALL SCENARIO: TAKING FRIEND WHO IS BUSINESS OWNER IN THEIR AIRPLANE ALONG WITH TWO EMPLOYEES TO TYLER TEXAS FOR A BUSINESS MEETING. FRIEND IS PAYING FOR MY PILOT SERVICES.

CROSS-COUNTRY ASSIGNMENT

DEPARTURE: KFWS

DESTINATION: KTYR

REMARKS: DIRECT

WEIGHT AND BALANCE INFORMATION

LOAD	DESCRIPTION	WEIGHT
PASSENGER 1	FRIEND	160 LBS
PASSENGER 2	EMPLOYEE 1	250 LBS
PASSENGER 3	EMPLOYEE 2	250 LBS
PASSENGER 4		
PASSENGER 5		
BAGGAGE	12 40-LB BOXES	480 LBS

IACRA INFORMATION

USERNAME	PASSWORD	FTN
FLYBOI89@HOTMAIL.COM	@VI@TORJOHN1989	A1234567

KNOWLEDGE TEST SUBJECTS (INCORRECT ANSWERS)

ACS Code	DESCRIPTION
CA.I.C.K2	WEATHER PRODUCTS FOR PREFLIGHT PLANNING
CA.I.C.K3J	FOG/MIST
CA.I.C.K3K	FROST
CA.I.D.K3	CROSS-COUNTRY FLIGHT PLANNING CALCULATIONS
CA.I.F.K2A	ATMOSPHERIC CONDITIONS EFFECTS ON PERFORMANCE
CA.I.H.K2	REGULATIONS REGARDING USE OF ALCOHOL + DRUGS

Figure B-4-3: Form CA-B-1 Completed

- **Overall Scenario:** Obtain the overall scenario for the practical test from the examiner. This will include a hypothetical reason to take the flight, such as a family event or business meeting. In addition to this information, the following should be provided:
  - » **Cross-Country Assignment:** The examiner should provide the destination airport to plan a cross-country to. The departure airport will be the airport where the practical test is conducted.
  - » **Weight and Balance Information:** The examiner should provide the number of passengers, their weights, and the amount of baggage for the weight and balance determination.
- **Knowledge Test Report:** Some examiners may request a copy of the applicant's knowledge test report to view the learning statement codes corresponding to the questions the applicant missed. This is used to determine which knowledge and risk elements must be evaluated ahead of time, since the examiner is required to evaluate these items.
- **Fee:** Determine what the examiner's fee is for a first attempt and a retake. The FAA recommends examiners to accept fees only in cash since checks can be cancelled by disgruntled applicants that fail their practical test. Determine if the examiner requires the fee in cash or allows for checks.

The overall scenario is a realistic scenario that the applicant may perform after they obtain their license.

Eligible Aircraft

For a commercial pilot ASEL rating, the only requirements regarding the aircraft used for the practical test are contained in 14 CFR §61.45.[13] In general, the aircraft must have two pilot stations with dual controls and the aircraft must be capable of performing all applicable tasks in the ACS for the practical test. Until April of 2018, at least a portion of the practical test had to be taken in a complex airplane (an airplane with retractable landing gear and a constant speed propeller). However, the FAA removed this requirement thus allowing any aircraft to be used similar to a private pilot ASEL practical test.[14]

For a commercial pilot AMEL rating, however, a complex airplane must still be used for the practical test. Although it may seem like all multiengine airplanes have constant speed propellers and rectractable landing gear, there are some that don't. Examples include the Partenavia P68, Champion 402 Lancer, and Brittian Norman Islander, none of which would be eligible for use during the commercial pilot AMEL practical test.

A complex multiengine airplane is required for a commercial pilot AMEL practical test.

1 49 USC §40102(a)(8) (2018).

2 FAA. *Requirements for certificates, ratings, and authorizations*. 14 CFR §61.3(e)(3) & (4) Amdt. 60-6. (Washington, DC: U.S. Government Publishing Office, 27 June 2018).

3 FAA. "Airman Certification Standards: What's New and What's Next?" 2017. 17. https://www.faa.gov/training_testing/testing/acs/media/acs_briefing.pdf.

4 FAA. "Airman Certification Standards: What's New and What's Next?" 2017. 19.

5 FAA. "Airman Certification Standards: What's New and What's Next?" 2017. 20.

6 FAA. "Airman Certification Standards (ACS): Slow Flight and Stalls." SAFO 17009. (Washington, DC: Flight Standards Service, 30 May 2017). 2.

7 FAA. "Airman Certification Standards: What's New and What's Next?" 2017. 13.

8 NTSB. "Aircraft Accident Report: Crash During Experimental Test Flight, Gulfstream Aerospace Corporation GVI (G650), N652GD." (Washington, DC: Records Management Division, 10 October 2012).

9 NTSB. "Aviation Accident Final Report." Accident Number DCA16FA199. 16 January 2018.

10 FAA. "Safety Risk Management Policy." Order 8040.4B. (Washington, DC: Office of Accident Investigation and Prevention (AVP-1), 2 May 2017), 12 through 17.

11 FAA. *Risk Management Handbook*. FAA-H-8083-2. (Washington, DC: U.S. Government Publishing Office, 2009), 4-2.

12 NTSB. "Pilot/Operator Aircraft Accident/Incident Report." Form 6120.1. 2013. 1 through 2.

13 FAA. *Practical tests: Required aircraft and equipment*. 14 CFR §61.45 Amdt. 61-124. (Washington, DC: U.S. Government Publishing Office, 21 August 2009).

14 FAA. *Use of a Complex Airplane During a Commercial Pilot or Flight Instructor Practical Test*. N 8900.463. 24 April 2018. https://www.faa.gov/documentlibrary/media/notice/n_8900.463.pdf.

15 FAA. *Prerequisites for practical tests*. 14 CFR §61.39(a)(6) Amdt. 61-142. 27 June 2018.

16 FAA. "Flight Standards Information Management System (FSIMS)." Order 8900.1, Volume 5, Chapter 2, Section 1, 5-220 (A). 26 August 2015. http://fsims.faa.gov/PICDetail.aspx?docId=8900.1,Vol.5,Ch2,Sec1.

17 FAA. "Flight Standards Information Management System (FSIMS)." Order 8900.1, Volume 5, Chapter 2, Section 1, 5-220 (B). 26 August 2015. http://fsims.faa.gov/PICDetail.aspx?docId=8900.1,Vol.5,Ch2,Sec1.

18 FAA. *Murphy – (2009) Legal Interpretation*. (Washington, DC: Office of the Chief Counsel, 30 June 2009). 2.

19 FAA. *Commercial Pilot – Airplane Airman Certification Standards*. FAA-S-ACS-7A. (Washington, DC: Flight Standards

PILOT QUALIFICATIONS

OVERVIEW

This is the first task to be evaluated during the practical test. Although there is only one skill element in this task, it contains a large amount of information that is fundamental to commercial pilot operations. As a result, although the examiner is only required to cover one knowledge element and one risk element, most examiners will cover significantly more than this.

The examiner will begin by verifying eligibility and certification requirements which are covered in ***Knowledge Element 1***. This includes verification of a number of pertinent documents and a thorough logbook audit to ensure that all aeronautical experience, flight training, ground training, and endorsements have been performed and documented correctly. Although this mostly consists of paperwork, it is a source of common errors on part of applicants and flight instructors and, as a result, requires significant emphasis.

Knowledge Element 2 discusses commercial pilot privileges and limitations which is a common subject of confusion due to complex and sometimes unclear regulations governing it. Due to the importance of understanding this subject in real-world flight operations, it is a near guarantee that the examiner will evaluate this.

Task	***A. Pilot Qualifications***
References	14 CFR parts 61, 68, 91; AC 68-1; FAA-H-8083-2, FAA-H-8083-25
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating as pilot-in-command (PIC) as a commercial pilot.
Knowledge	The applicant demonstrates understanding of:
CA.I.A.K1	Certification requirements, recent flight experience, and recordkeeping.
CA.I.A.K2	Privileges and limitations.
CA.I.A.K3	Medical certificates: class, expiration, privileges, temporary disqualifications.
CA.I.A.K4	Documents required to exercise commercial pilot privileges.
CA.I.A.K5	Part 68 BasicMed privileges and limitations.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
CA.I.A.R1	Failure to distinguish proficiency versus currency.
CA.I.A.R2	Flying unfamiliar airplanes, or operating with unfamiliar flight display systems, and avionics.
Skills	The applicant demonstrates the ability to:
CA.I.A.S1	Apply requirements to act as PIC under Visual Flight Rules (VFR) in a scenario given by the evaluator.

PILOT QUALIFICATIONS
OVERVIEW

Knowledge Elements 3 and ***4*** cover required pilot documents needed to exercise commercial pilot privileges including medical certificates. Due to the importance and everyday use of this knowledge by pilots, this subject is also nearly guaranteed to be evaluated. ***Knowledge Element 5*****,** however, is not as likely to be evaluated since commercial pilots are unable to take advantage of the benefits offered by BasicMed.

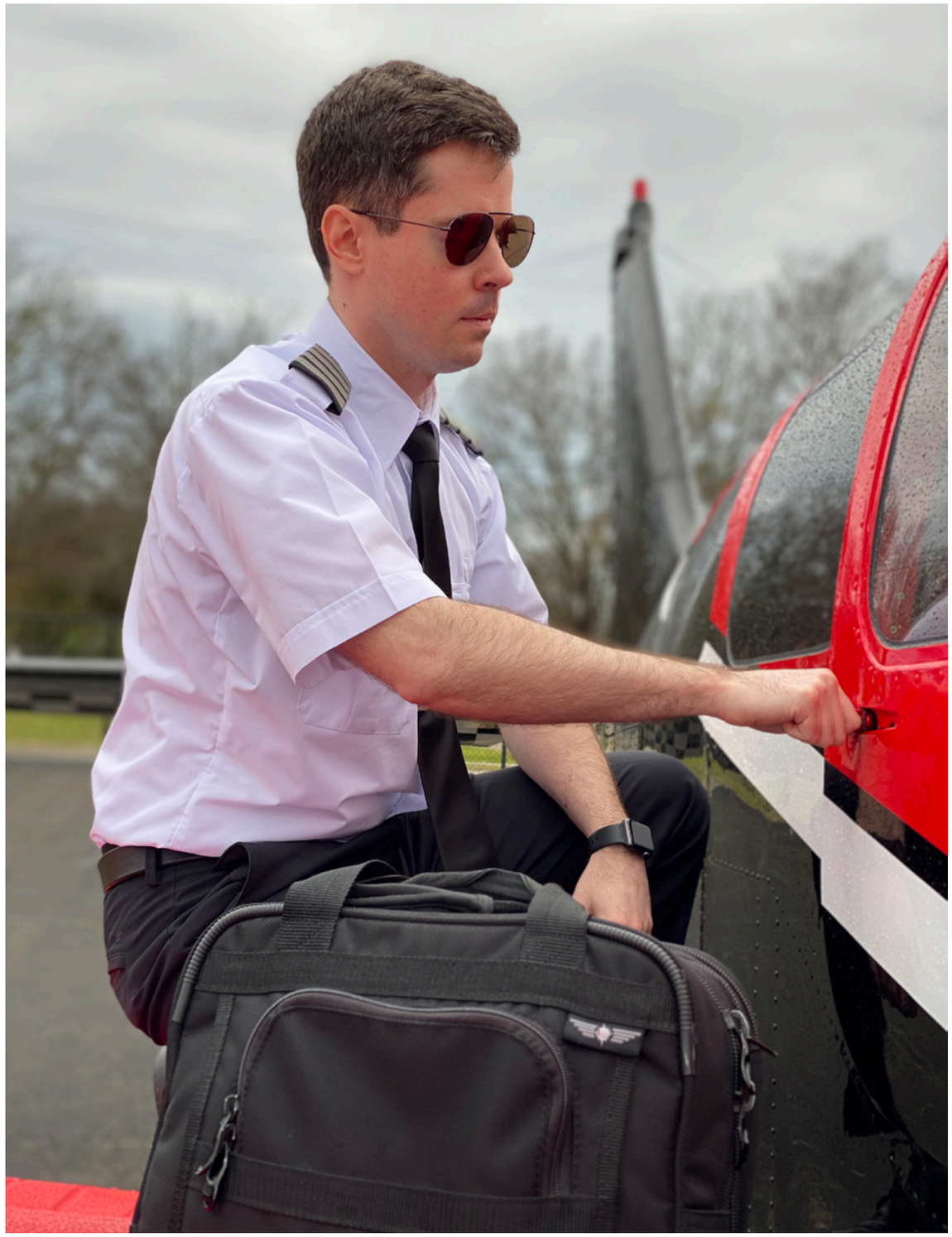
Risk Elements 1 and/or ***2*** will be evaluated by scenario-based evaluation. Both of these risk elements emphasize differentiating what is legal and what is safe. Although commercial pilots are legally allowed to fly a large number of different airplane makes and models, attempting to fly unfamiliar and significantly different airplanes requires an appropriate risk analysis. This also applies to familiar airplanes, in which a pilot must differentiate between currency and proficiency for a given operation.

Knowledge	The applicant demonstrates understanding of:
CA.I.A.K2	Privileges and limitations.
	Return to Overview

This knowledge element discusses the privileges and limitations of a commercial pilot certificate.

Privileges

Limitations



Commercial pilots can be paid to fly, such as working for a Part 135 charter.

Privileges

As a Pilot for a Part 125, 135, or 137 Operation

As a Pilot Conducting the Operations Listed in §119.1(e)

As a Pilot Transporting an Individual in an Aircraft They Own

§61.133 Commercial pilot privileges and limitations. *(a) Privileges—(1) General. A person who holds a commercial pilot certificate may act as pilot in command of an aircraft—*

(i) Carrying persons or property for compensation or hire, provided the person is qualified in accordance with this part and with the applicable parts of this chapter that apply to the operation; and

(ii) For compensation or hire, provided the person is qualified in accordance with this part and with the applicable parts of this chapter that apply to the operation.[43]

In short, a commercial pilot can be paid for their services acting as a pilot. However, there are caveats as subtly indicated by the qualifying statement, *"…provided the person is qualified in accordance with…the applicable parts of this chapter that apply to the operation…"* The chapter being referenced is Chapter I of Title 14, which contains Parts 1 through 199. A review of Chapter I shows that there are three ways a commercial pilot may fly for hire: as a pilot for a Part 125, 135, or 137 operation, as a pilot conducting the operations listed in §119.1(e), or as a pilot transporting an individual in an aircraft they own.

As a Pilot for a Part 125, 135, or 137 Operation

Each of these operations require a commercial pilot certificate to act as pilot in command (PIC) or second in command (SIC). A commercial pilot certificate grants you the privilege of being hired by a company that holds one of these operating certificates and to receive compensation. Operating certificates are intended to pose stricter regulations on certain types of operations, namely public air transportation, such as those governed by Part 135 (smaller charter operations). It should be noted that Part 121 operations (large airlines) now require that both the PIC and SIC hold an Airline Transport Pilot Certificate.

As a Pilot Conducting the Operations Listed in §119.1(e)

14 CFR §119.1(e) lists 16 operations that do not require an operating certificate. The following are 10 of these operations that apply to airplanes. These are essentially entry-level jobs for low-time commercial pilots. For each of these operations, you may act as the pilot *and operator* by providing the airplane, charging for services including the airplane and your piloting, and advertising to the general public, all under Part 91. The key thing to remember with each of these operations is that they cannot involve the transportation of persons or property – so if people or cargo are carried onboard the airplane, it must return to the departure airport. If no people or cargo are carried onboard, the airplane may land at a different airport. The only exception includes the carriage of election candidates.

- **Ferry flights:** This consists of repositioning an airplane from one airport to another for various purposes such as maintenance or delivery. Ferry flying may be as simple as flying an airplane to a nearby airport where maintenance can be performed. In more extreme cases, light piston singles and twins are modified by removing all seats except the pilot seat and placing an additional fuel tank in the cabin to allow for transoceanic flights such as from the US to Europe for delivery.

- **Flight instruction:** This consists of flight instruction, in which a flight instructor certificate is required in addition to a commercial pilot certificate. These operations may range from a freelance flight instructor training students in an airplane they own, to a large flight school operating multiple aircraft and employing multiple flight instructors.

- **Nonstop commercial air tours:** These are essentially sightseeing flights. To operate under Part 91, the following limitations apply:

  - » Limited to a 25-statute mile radius of the departure airport.

  - » Flights must be non-stop (must not land anywhere except the departure airport).

  - » The airplane must:

    - * Have a standard airworthiness certificate.

    - * Have a passenger-seat configuration of 30 seats or fewer.

    - * Have a maximum payload capacity of 7,500 lbs or less.

- **Skydiving:** This consists of climbing up to altitude (normally 10,000 feet) above the airport and letting skydivers jump out. The most common 'jump plane' in use currently is the Cessna 182 Skylane which will normally have all seats except the pilot seat removed and a modified door that opens upward.

  It is important to note that skydiving operations are limited to a 25-statute mile radius of the airport and that flights must be non-stop (must not land anywhere except the departure airport).

- **Powerline or pipeline patrol:** Pipeline patrol consists of low altitude flying (about 200 feet AGL) over above-ground pipelines to inspect them per DOT requirements by looking for issues such as leaks or damage. Pilot duties include recording any discrepancies with the pipeline and taking photos. Some operations will provide an observer to perform these duties. Powerline patrol is similar to pipeline patrol except that powerlines are inspected instead.

- **Aerial photography or survey:** Aerial photography may be as simple as having a photographer onboard with camera in hand taking pictures out of an open window, or as complex as flying an airplane modified with a camera dome installed on the belly. Aerial photography purposes can range from personal hobby to contract work for corporations.

  Aerial survey, also known as aerial mapping, consists of using airplanes to acquire survey and mapping information. This is often accomplished by flying preplanned tracks and utilizing multiple sensors including GPS, cameras, and most importantly lidar sensors. The data acquired is then fused together to produce mapping information.

- **Crop dusting:** This includes various agricultural operations such as crop dusting/spraying, seeding, and bird chasing. Crop dusting, or spraying, is the aerial deployment of pesticides on crops, while seeding is the aerial deployment of seeds. Popular airplanes used for these purposes are the Cessna 188 Ag Wagon and the Piper PA25 Pawnee. These airplanes are going away, however, in favor of turboprops such as the Air Tractor 802.

  Bird chasing consists of flying an airplane at low altitude over crops in an attempt to scare birds away. This is no longer common due to the high cost and risk involved.

- **Election candidates:** Carriage of election candidates is the one exception to transporting persons for hire and providing an airplane for such a service without an operating certificate. Many pilots offer their services to politicians running for election. It should be noted, however, that as of January 6, 2010, U.S. House of Representatives Candidates are prohibited from using non-commercial aircraft for such travel.[44]

- **Banner towing:** Banner towing, as the name implies, involves towing a large banner at low altitude for the purpose of advertisement. Banner towing is normally accomplished in small single engine airplanes, often tailwheel airplanes, such as the Piper Cub. Banner towing requires knowledge and skill relating to the airplane's hook and release system, banner pickup, airplane handling with a banner in tow, and dropping the banner.

- **Fire fighting:** Small airplanes are typically not used for the actual deployment of fire retardant due to their limited useful load. Instead, they are usually used for 'fire spotting' which involves low altitude flying similar to powerline/pipeline patrol or aerial photography/ survey described above. Fire spotter operations are more of a preventive measure in which the spotter looks for small fires with potential to become larger, or conditions conducive to fire formation such as downed power lines. Many different light piston singles or twins are used for fire spotting, but a popular choice is the Cessna 337 Skymaster. Fire spotting is seasonal with most operations taking place in the summer.

Crop dusting is among the exceptions listed in §119.1(e) (courtesy Benjamin Wiebe).

As a Pilot Transporting an Individual in an Aircraft They Own

Understanding this privilege requires an understanding of the concept of operational control. The FAA defines operational control as the exercise of authority over initiating, conducting, or terminating a flight.[45] It is essentially the person or entity that controls exactly how the aircraft is used, such as whether it can depart and where it will go. It is important to understand that this authority is separate from PIC authority, although it is possible for the same person to exercise both operational control and PIC authority concurrently. Table I-A-3 lists 3 common scenarios regarding operational control and lists the operator and the PIC for the flight.

An individual who owns an airplane and hires a pilot to fly them in that airplane for transportation is considered the operator of the flight, since they determine how the airplane will be used, not the pilot. This interpretation is the basis for how most private jets are operated under Part 91; relatively wealthy individuals who own these airplanes and are not trained pilots themselves hire pilots to fly them in it. Understand, however, that it is illegal for an individual to be compensated as both the pilot and operator of a flight without an operating certificate.

Scenario	Operator	PIC
Patrick is a private pilot and rents a Cessna 182. He flies his two friends, Aaron and Scott, from Fort Worth Spinks Airport (FWS) to Stephenville Regional Airport (SEP) in the Cessna 182 for lunch.	Patrick	Patrick
Tony is a commercial pilot employed by Aero Services LLC which is a Part 135 charter company. Tony flies 3 revenue passengers on an assigned flight from Tulsa International Airport (TUL) to Stillwater Regional Airport (SWO) in a Piper PA-34 Seneca that the company owns and operates.	Aero Services LLC	Tony
John is not a rated pilot and owns a Mooney M20C. He hires Terry, who is a commercial pilot, to fly him in his airplane from Abilene Regional Airport (ABI) to Midland International Airport (MAF) and pays Terry $40 per hour for his services.	John	Terry

Table I-A-3: Operational Control Scenarios

Limitations

§61.133 Commercial pilot privileges and limitations *(b) Limitations. (1) A person who applies for a commercial pilot certificate with an airplane category or powered-lift category rating and does not hold an instrument rating in the same category and class will be issued a commercial pilot certificate that contains the limitation, "The carriage of passengers for hire in (airplanes)... on cross-country flights in excess of 50 nautical miles or at night is prohibited." The limitation may be removed when the person satisfactorily accomplishes the requirements listed in §61.65 of this part for an instrument rating in the same category and class of aircraft listed on the persons commercial pilot certificate.*[46]

There is only one limitation for the commercial pilot airplane certificate: commercial pilots who do not hold an instrument rating are prohibited from carrying passengers for hire on cross-country flights in excess of 50 nautical miles or at night.

PERFORMANCE AND LIMITATIONS

OVERVIEW

The objective of this task is to determine the airplane's weight and balance, and performance, and present the results to the examiner. Recall in ***Task D*** that climb, cruise, and descent performance were already determined and presented. This leaves takeoff, accelerate-stop, accelerate-go (if applicable), all-engine climb (if applicable), single engine climb, and landing performance remaining. As a result, with respect to performance, these are the only phases emphasized. Similar to the weather briefing and cross-country flight planning, weight and balance, and performance must have been determined prior to the examiner arriving. After you provide these presentations, the examiner may ask follow-up questions regarding risk management.

Task	***F. Performance and Limitations***
References	FAA-H-8083-1, FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with operating an airplane safely within the parameters of its performance capabilities and limitations.
Knowledge	The applicant demonstrates understanding of:
CA.I.F.K1	Elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance.
CA.I.F.K2	Factors affecting performance, to include:
CA.I.F.K2a	a. Atmospheric conditions
CA.I.F.K2b	b. Pilot technique
CA.I.F.K2c	c. Airplane configuration
CA.I.F.K2d	d. Airport environment
CA.I.F.K2e	e. Loading (e.g., center of gravity)
CA.I.F.K2f	f. Weight and balance
CA.I.F.K3	Aerodynamics.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
CA.I.F.R1	Inaccurate use of manufacturer's performance charts, tables, and data.
CA.I.F.R2	Exceeding airplane limitations.
CA.I.F.R3	Possible differences between calculated performance and actual performance.
Skills	The applicant demonstrates the ability to:
CA.I.F.S1	Compute the weight and balance, correct out-of-center of gravity (CG) loading errors and determine if the weight and balance remains within limits during all phases of flight.
CA.I.F.S2	Utilize the appropriate airplane manufacturer's approved performance charts, tables, and data.

PERFORMANCE AND LIMITATIONS

PERFORMANCE DATA

Knowledge	The applicant demonstrates understanding of:
CA.I.F.K1	Elements related to performance and limitations by explaining the use of charts, tables, and data to determine performance.

Return to Overview

Takeoff Performance

Accelerate-Stop Performance

Accelerate-Go Performance

Climb Performance

Cruise Performance

Descent Performance

Landing Performance

Weight and Balance

This knowledge element discusses airplane performance data furnished by manufacturers and how to utilize them. Performance data is provided for each phase of flight including takeoff, climb, cruise, descent, and landing. It's contained in section 5 of a modern pilot's operating handbook (POH). This data may be presented as either a graph or table of values depending on the manufacturer's preference.

Performance data will provide certain outputs, such as takeoff distance, require certain inputs, such as gross weight and wind, and contain conditions and possibly notes as well. Conditions are requirements that the pilot must fulfill to allow the performance data to be valid. For example, a common condition for takeoff performance data is to hold the brakes, set full power, then release the brakes. If the pilot performs a rolling takeoff instead of the aforementioned procedure, they will nullify the takeoff performance data as this technique uses up more runway. Notes allow the performance data to be adapted for certain criteria. For example, some takeoff performance data will contain notes to increase or decrease takeoff distance by a certain percentage based on runway gradient or surface.

Lastly, although weight and balance is technically not considered an aspect of performance proper, being located separately in section 6 of a modern POH, it is closely related to performance and will be discussed here.

Accelerate-Stop Performance

Accelerate-stop performance data consists of determining accelerate-stop distance. Accelerate-stop distance is the runway length required for a multiengine airplane to accelerate to a specified speed from brake release during takeoff, experience an engine failure, then bring the airplane to a full stop (Figure I-F-9). The specified speed is normally termed the 'decision speed' by most manufacturers and typically coincides with the rotation speed.

The inputs, conditions, and calculation of accelerate-stop distance are practically identical to that of takeoff distance. The only exception is that after the decision speed, conditions include immediately bringing both throttles to idle and applying maximum braking.

Although accelerate-stop performance data can be presented as either a table or graph like takeoff performance, most manufacturers only present this as a graph (***Figure I-F-10***). As a result, only the graph method will be discussed.

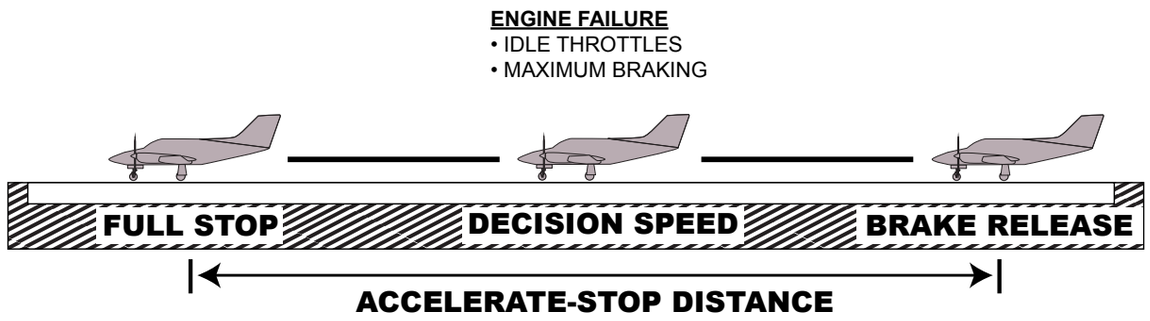


Figure I-F-9: Accelerate-Stop Distance Definition

ACCELERATE - STOP DISTANCE

CONDITIONS

POWER: FULL THROTTLE & 2600 RPM BEFORE BRAKE RELEASE
THROTTLES IDLE AT DECISION SPEED
MIXTURES: BEST POWER
COWL FLAPS: OPEN
BRAKES: RELEASE AFTER FULL POWER ESTABLISHED
MAXIMUM BRAKING AT DECISION SPEED
FLAPS: UP
RUNWAY: PAVED, LEVEL, & DRY SURFACE

GROSS WEIGHT	DECISION SPEED (KIAS)
3,700 LBS	70 KTS
3,500 LBS	68 KTS
3,300 LBS	66 KTS
3,100 LBS	64 KTS

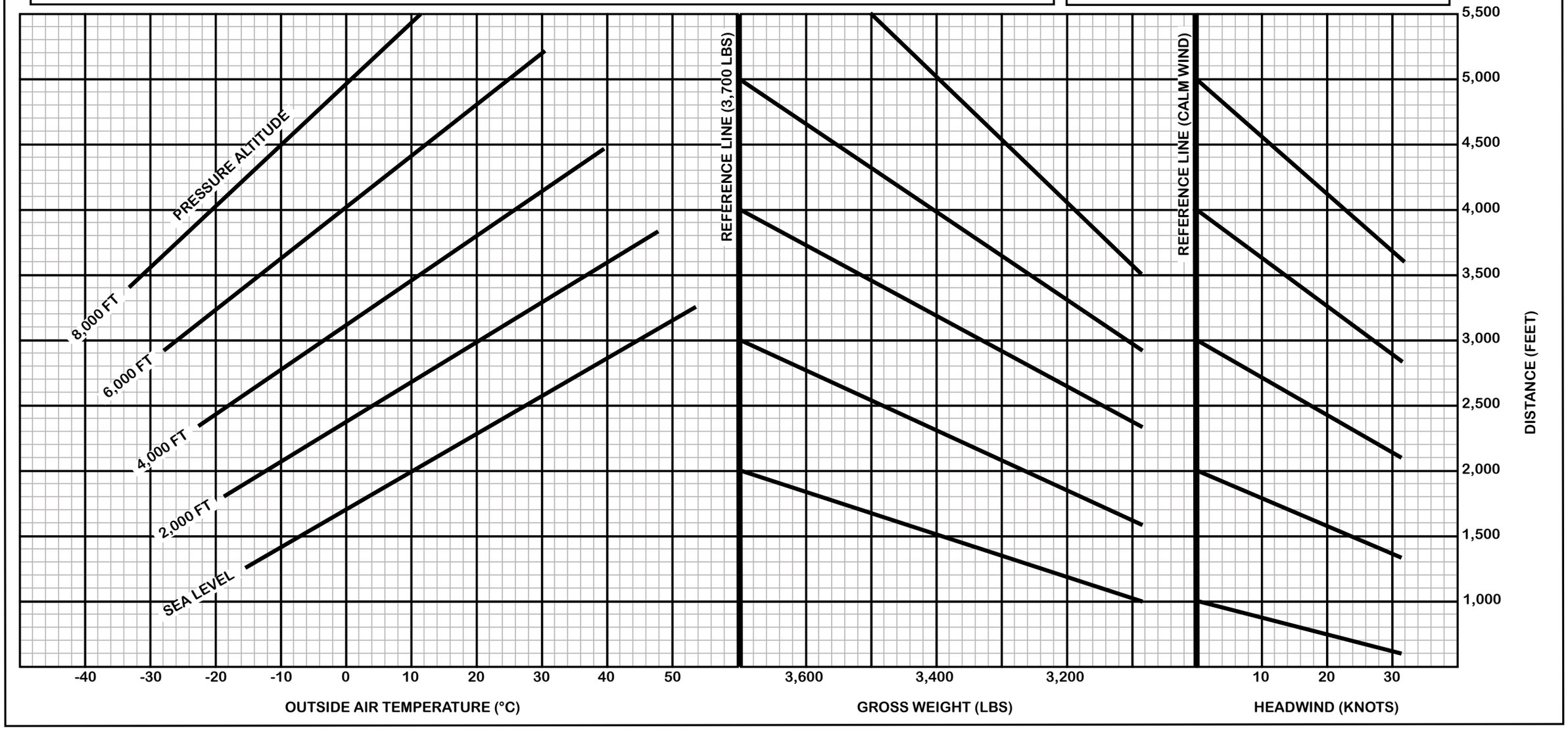


Figure I-F-10: Accelerate-Stop Performance Graph

Example

Accelerate-stop distance will be determined for the takeoff runway under the same conditions as discussed in the ***takeoff performance example****. Recall that the temperature was found to be 2 degrees Celsius and the pressure altitude 133 feet. As a result, a vertical line is drawn from a temperature of 2 degrees Celsius up to a pressure altitude of 133 feet within the pressure altitude reference lines. A horizontal line is then drawn from this point, continuing through the gross weight section since the airplane will be near its maximum gross weight, and through the wind correction section since no performance credit will be taken due to light winds. An accelerate-stop distance of 1,800 feet is then found. No notes are provided with the graph (****Figure I-F-11****).*

ACCELERATE - STOP DISTANCE

CONDITIONS

POWER: FULL THROTTLE & 2600 RPM BEFORE BRAKE RELEASE
THROTTLES IDLE AT DECISION SPEED
MIXTURES: BEST POWER
COWL FLAPS: OPEN
BRAKES: RELEASE AFTER FULL POWER ESTABLISHED
MAXIMUM BRAKING AT DECISION SPEED
FLAPS: UP
RUNWAY: PAVED, LEVEL, & DRY SURFACE

GROSS WEIGHT	DECISION SPEED (KIAS)
3,700 LBS	70 KTS
3,500 LBS	68 KTS
3,300 LBS	66 KTS
3,100 LBS	64 KTS

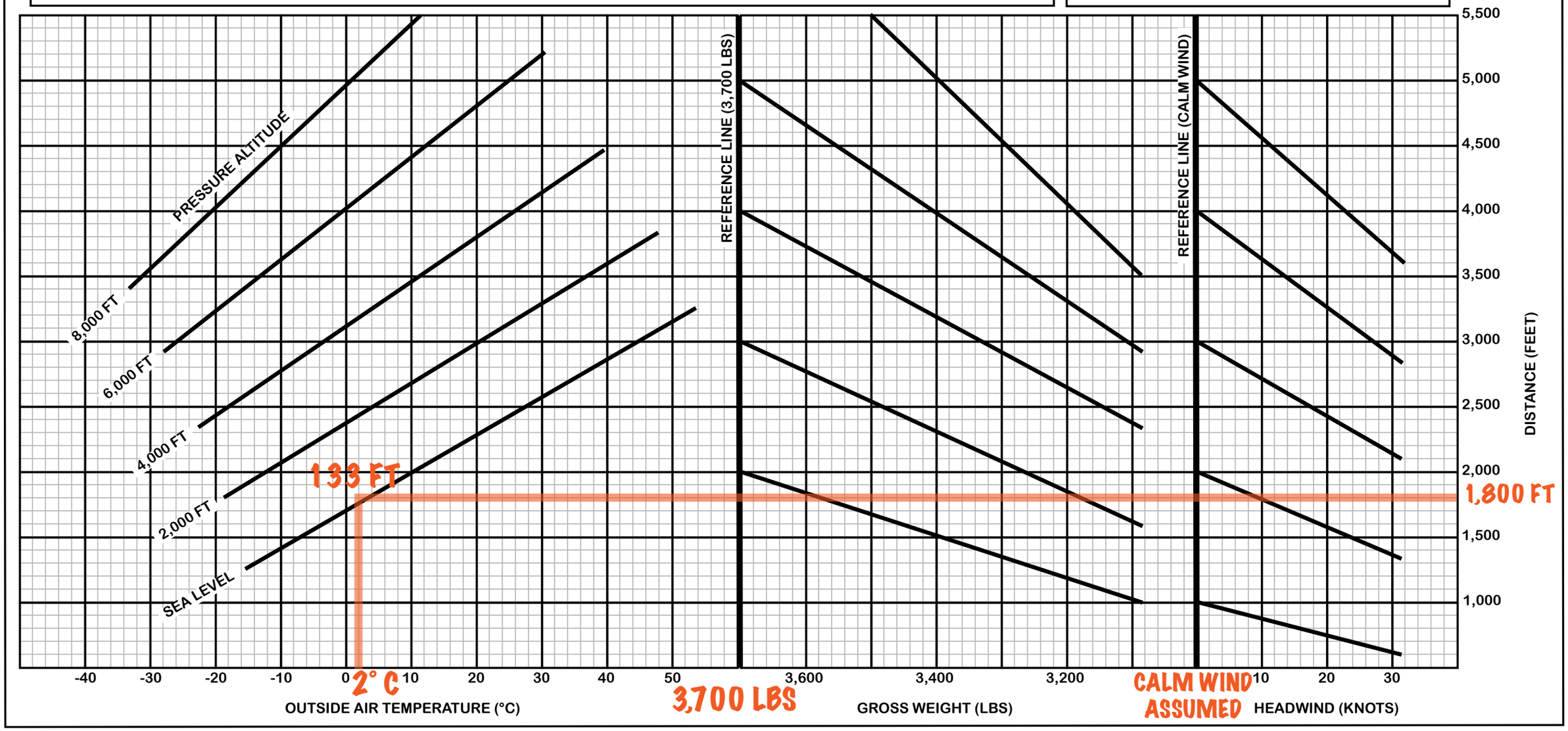


Figure I-F-11: Accelerate-Stop Performance Graph (Annotated)

1 CAA. *Empty weight*. CAR §3.73. (Washington, DC: U.S. Government Publishing Office, 1 November 1949).

2 FAA. *Empty weight and corresponding center of gravity*. 14 CFR §23.29(a) Amdt. 23-21. 1 March 1978.

3 GAMA. *Specification for Pilot's Operating* Handbook. GAMA Specification No. 1. (Washington, DC: General Aviation Manufacturers Association, 18 October 1996), 1-6.

4 GAMA. *Specification for Pilot's Operating* Handbook. GAMA Specification No. 1. 1-6.

5 GAMA. *Specification for Pilot's Operating* Handbook. GAMA Specification No. 1. 1-6.

6 GAMA. *Specification for Pilot's Operating* Handbook. GAMA Specification No. 1. 1-6.

7 Kamm, Richard W. "Mixed Up About Fuel Mixtures." 1 February 2002. https://www.aviationpros.com/home/article/10387634/mixed-up-about-fuel-mixtures.

8 CAA. *Take-off*. CAR §3.84(c). 1 November 1949.

9 CAA. *Landing*. CAR 3.86(a)(2). 1 November 1949.

10 Giancoli, Douglas C. *Physics for Scientists and Engineers with Modern Physics*. Vol. 1. (Upper Saddle River, NJ: Pearson Education Inc., 2008), 201.

11 NTSB. "Aviation Accident Final Report." Accident Number GAA17CA239. 20 July 2017.

12 NTSB. "Aviation Accident Final Report." Accident Number ERA16FA257. 11 December 2017.

13 NTSB. "Aviation Accident Final Report." Accident Number CEN17LA341. 19 March 2018.

14 NTSB. "Aviation Accident Final Report." Accident Number GAA18CA021. 21 February 2018.

APPENDICES
OVERVIEW

The following appendices discuss pertinent information referenced throughout this book.

6. COMPLEX AND MULTIENGINE AIRPLANE SYSTEMS

This appendix discusses systems unique to complex and multiengine airplanes as applied to ***Task G***.

Secondary Flight Controls

Powerplant and Propeller

Landing Gear

Fuel, Oil, and Hydraulic

Electrical

Environmental

Deicing and Anti-Icing

Courtesy Aerobatic Aircraft of Texas

Secondary Flight Controls

Knowledge	The applicant demonstrates understanding of:
CA.I.G.K1	Airplane systems, to include:
CA.I.G.K1b	b. Secondary flight controls
	Return to Overview

In addition to pitch trim, yaw trim, and flaps, complex and multiengine airplanes may be equipped with roll trim and/or speed brakes.

Roll Trim

Speed Brakes

Yaw trim is one of the most critical secondary flight controls for multiengine airplanes (courtesy Aerobatic Aircraft of Texas).

Roll Trim

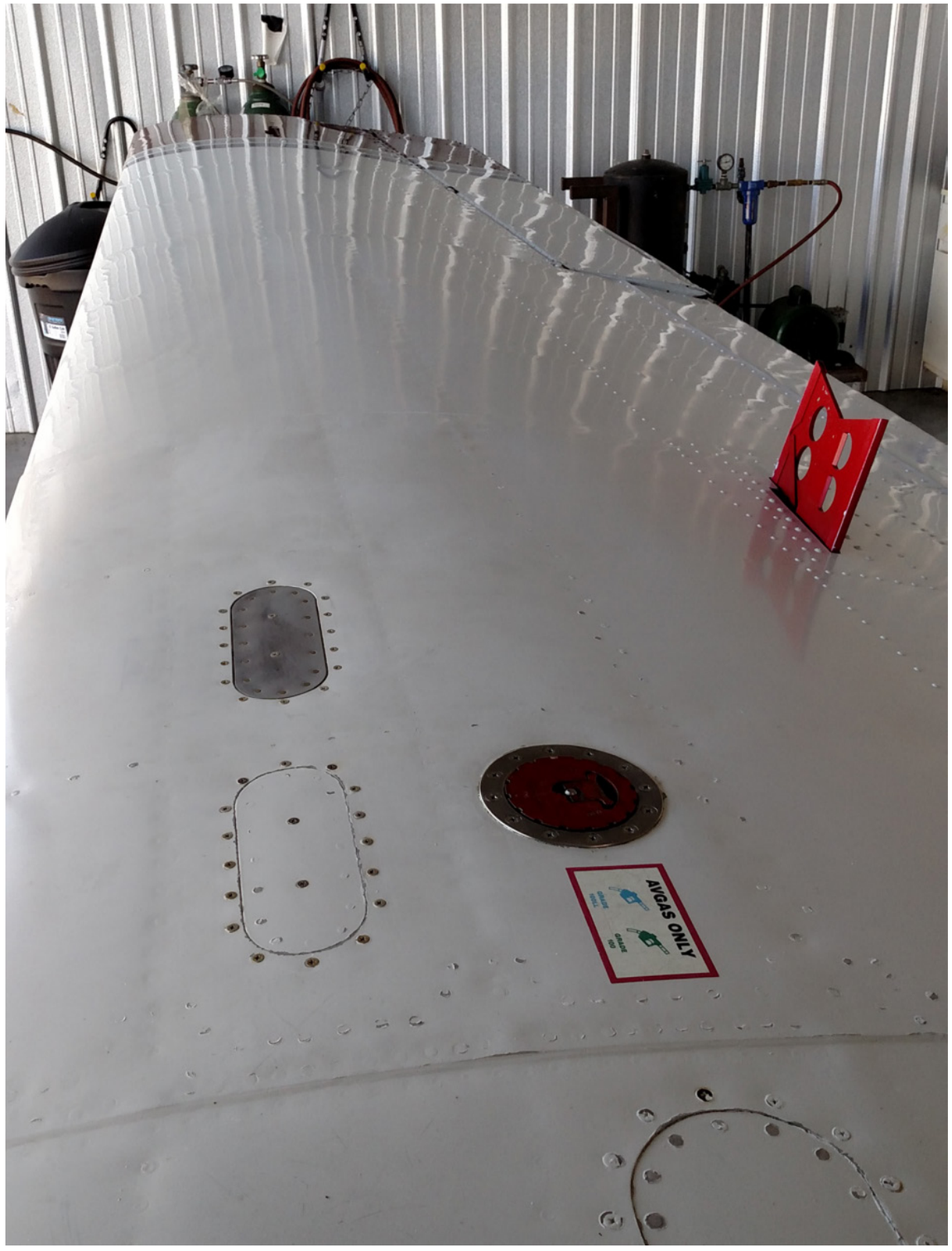
Controllable roll trim is normally only found on multiengine airplanes for the purpose of extended single engine operations. The cockpit control is normally a knob that applies a force along the airplane's longitudinal axis in the same direction that it is rotated. Similar to yaw trim, roll trim may be provided as a ground adjustable tab, trim tab, or bungee system. However, roll trim may also be provided as a servo trim tab.

A servo trim tab, also known as a balance tab, is attached to the trailing edge of one of the ailerons (typically the left one) and incorporates two functions: a servo function and a trim function. The servo function causes the tab to deflect in the *opposite* direction of the aileron, which *reduces* control forces for the pilot. It can be thought of as a simple form of power steering. The trim function biases the neutral position of the servo function. In other words, trimming the airplane to roll right will cause a servo trim tab to deflect up more for all aileron angles than if it were trimmed neutrally (wings level).

Speed Brakes

Speed brakes are installed on some high-performance airplanes as either original equipment or as an aftermarket modification. Speed brakes increase parasite drag and reduce lift to allow for increased descent rates without increasing airspeed or reducing engine power significantly, which helps reduce shock cooling. Shock cooling is the rapid cooling of an airplane engine as a result of significantly reducing power and increasing airspeed in a descent, which can lead to engine fatigue, damage, and shortened engine life.

Like flaps, speed brakes have a control and actuating mechanism. The vast majority of speed brakes are electrically controlled and electrically actuated. However, some older systems are purely manual, consisting of a small handle that actuates the speed brakes via push/pull rods. Partial deployment is also possible with this type of system. Electrically controlled and electrically actuated speed brakes consist of an electric motor used to extend each speed brake. The speed brakes are spring-loaded to the down position in case of an electrical failure which would allow them to self-retract in case they were extended.



Speed brakes deployed (courtesy Robert Melville).

1 AOPA. "FAA Revises System for Issuing Student Pilot Certificates." 4 November 2016. https://www.aopa.org/news-and-media/all-news/2016/november/04/faa-revises-system-for-issuing-student-pilot-certificates.

2 FAA. *Civil aircraft flight manual, marking, and placard requirements*. 14 CFR §91.9(b). (Washington, DC: U.S. Government Publishing Office, 30 September 1963).

3 FAA. *Airplane or Rotorcraft Flight Manual*. 14 CFR §21.5 Amdt. 21-92. 16 October 2009.

4 CAA. *Empty Weight*. CAR 3.73. 1 November 1949.

5 FAA. *Loading information*. 14 CFR §23.1589(a) Amdt. 23-50. 11 March 1996.

6 Knuteson, Randy. "Boosting Your Knowledge of Turbocharging." *Aircraft Maintenance Technology*. July 1999.

7 Deakin, John. "Pelican's Perch #31: Those Fire-Breathing Turbos." 18 July 2000. https://www.avweb.com/features_old/pelicans-perch-31those-fire-breathing-turbos-part-1/.

8 Deakin, John. "Those Fire-Breathing Turbos (Part 6 - and FINAL!)." 12 November 2000. https://www.avweb.com/features_old/pelicans-perch-36those-fire-breathing-turbos-part-6-and-final/.

9 Busch, Mike. "Savvy Maintenance, Opinion: Turbo Trouble." 1 September 2018. https://www.aopa.org/news-and-media/all-news/2018/september/pilot/savvy-maintenance-turbo-trouble.

10 NTSB. "Aviation Accident Final Report." Accident Number ERA14CA157. 7 June 2015.

11 NTSB. "Aviation Accident Final Report." Accident Number DEN00LA033. 13 August 2001.

12 NTSB. "Safety Alert: Activate Leading-Edge Deice Boots as Soon as Airplane Enters Icing Conditions." SA-014. December 2008, Revised December 2015.