ANSWERS TO THE ACS

INSTRUMENT

AIRPLANE

VOLUME I: GROUND PORTION

REVISION 0

ADDRESSES FAA-S-ACS-8B (CHANGE 1)

PATRICK MOJSAK

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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.

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. He 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, he upgraded to captain on the Embraer 175. In January of 2022, he entered the training department of the airline as an instructor.

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
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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.

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All	All	None - initial issue.	

BRIEFINGS

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.

BRIEFING 4

THE PRACTICAL TEST PROCESS

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.

5. Ground Portion

The ground portion of the test, long known as the ‘oral exam,’ evaluates Area of Operation I and II, which is the focus of this volume. It should be noted that oral questioning is not restricted to this portion of the test. As a result, the term ‘oral exam’ is a misnomer.

Pilot Qualifications

Weather Information

Cross-Country Flight Planning

Airplane Systems Related to IFR Operations

Airplane Flight Instruments and Navigation Equipment

Pilot Qualifications

Area of Operation I, Task A, Pilot Qualifications is evaluated by scenario-based oral questioning centered around the overall scenario provided by the examiner. Topics evaluated may include instrument rating requirements, recency of experience and recordkeeping, and when an instrument rating is required. Risk management topics may include distinguishing proficiency versus currency, personal minimums, and fitness for flight.

Weather Information

Area of Operation I, Task B, Weather Information will be evaluated by a presentation of the weather briefing obtained by the applicant before the examiner's arrival, a corresponding go/no-go decision for the flight, and the selection of an alternate airport if applicable. The examiner will also evaluate at least three of the weather phenomena listed in knowledge elements 3a through 3l and their implications on IFR flight. Risk management topics may include the limitations of various weather services and equipment and factors involved in making a go/no-go or continue/divert decision.

Cross-Country Flight Planning

Area of Operation I, Task D, Cross-Country Flight Planning will be evaluated by two presentations. The first presentation will be of the flight planning that was conducted prior to the examiner's arrival. The second presentation will be a risk analysis for the flight. Following these presentations, the examiner will propose a scenario, such as passengers bringing additional weight or changing the destination airport, which requires the applicant to recalculate fuel reserves for the flight. Risk management is normally satisfied by the applicant's risk analysis presentation. The examiner will also ask questions about various IFR publications, NOTAMs, and airframe icing.

Airplane Systems Related to IFR Operations

Area of Operation II, Task A, Airplane Systems Related to IFR Operations is an evaluation of the airplane's ice protection systems. During the ground portion of the practical test, the examiner will evaluate the applicant's knowledge of the airplane's ice protection systems and their limitations. During the flight portion of the practical test the examiner will evaluate the applicant's ability to properly operate the airplane's ice protection systems.

Airplane Flight Instruments and Navigation Equipment

Area of Operation II, Task B, Airplane Flight Instruments and Navigation Equipment is an evaluation of the airplane's flight instruments and navigation equipment. During the ground portion of the practical test, the examiner will evaluate the applicant's knowledge of individual flight instruments, systems (such as EFIS and autopilot), and navigation systems. During the flight portion of the practical test the examiner will evaluate the applicant's ability to properly operate these instruments and systems.

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

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

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

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

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

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

12 FAA. Instrument Rating - Airplane Airman Certification Standards. FAA-S-ACS-8B. (Washington, DC: Flight Standards Service, June 2018), Appendix 7.

13 FAA. Theriault - (2010) Legal Interpretation. (Washington, DC: Office of the Chief Counsel, 8 October 2010).

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

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. Instrument Rating - Airplane Airman Certification Standards. FAA-S-ACS-8B. A-13.

20 FAA. "Flight Standards Information Management System (FSIMS)." Order 8900.1, Volume 5, Chapter 2, Section 1, 5-220 (C).

AREA OF OPERATION I

TASK A

PILOT QUALIFICATIONS

PILOT QUALIFICATIONS

OVERVIEW

This is the first task to be evaluated during the practical test. Although there is only one skill element, it contains a large amount of information that is fundamental to instrument 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 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 requires significant emphasis.

Although Knowledge Element 2 states "privileges and limitations," privileges and limitations are not listed in the regulations for an instrument rating as they are for the private or commercial pilot certificate. As a result, this knowledge element evaluates when an instrument rating is required.

Knowledge Element 3 evaluates the applicant's knowledge of BasicMed since instrument-rated pilots are authorized to operate under it. Since BasicMed is

Task	***A. Pilot Qualifications***
References	14 CFR part 61; FAA-H-8083-2, FAA-H-8083-15, AC 68-1
Objective	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with the requirements to act as PIC under instrument flight rules.
Knowledge	The applicant demonstrates understanding of:
IR.I.A.K1	Certification requirements, recency of experience, and recordkeeping.
IR.I.A.K2	Privileges and limitations.
IR.I.A.K3	Part 68 BasicMed Privileges and Limitations.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.I.A.R1	Failure to distinguish proficiency versus currency.
IR.I.A.R2	Failure to set personal minimums.
IR.I.A.R3	Failure to ensure fitness for flight and physiological factors that might affect the pilot's ability to fly under instrument conditions.
IR.I.A.R4	Flying unfamiliar airplanes, or operating with unfamiliar flight display systems and avionics.
Skills	The applicant demonstrates the ability to:
IR.I.A.S1	Apply requirements to act as PIC under Instrument Flight Rules (IFR) in a scenario given by the evaluator.

still relatively new, it is a subject that many continue to struggle with.

Risk Elements 1 through 4 evaluate various risks that can affect instrument-rated pilots. Two of these elements that may receive added emphasis include Risk Elements 2 and 3. Risk Element 2 may involve a presentation of the applicant's personal minimums system, while Risk Element 3 may involve a fitness for flight evaluation.

PILOT QUALIFICATIONS
PRIVILEGES AND LIMITATIONS

Knowledge	The applicant demonstrates understanding of:
IR.I.A.K2	Privileges and limitations.

Privileges and limitations are not listed for an instrument rating since they only apply to pilot certificates. As a result, it is more appropriate to understand when an instrument rating required. An instrument rating is required under three circumstances: while operating under instrument flight rules (IFR) or instrument meteorological conditions (IMC), in Class A airspace, or under special VFR at night.

IFR or IMC

Class A Airspace

Special VFR at Night

IFR or IMC

14 CFR §61.3(e) requires a pilot to hold the appropriate instrument rating while operating under IFR or IMC:

§61.3 Requirement for certificates, ratings, and authorizations.

(e) Instrument rating. No person may act as pilot in command of a civil aircraft under IFR or in weather conditions less than the minimums prescribed for VFR flight unless that person holds:

(1) The appropriate aircraft category, class, type (if required), and instrument rating on that person's pilot certificate for any airplane, helicopter, or powered-lift being flown;
…

This can occur in one of two ways. The first and most common way is operating under an IFR flight plan in controlled airspace whether conditions are VMC or IMC. The second way is operating in IMC in *uncontrolled* airspace with no IFR flight plan. In both of these instances an instrument rating is required.

Class A Airspace

14 CFR §91.135 requires that flights in Class A airspace be conducted under IFR. This therefore requires the pilot to hold an instrument rating in conjunction with 61.3(e) discussed previously:

§91.135 Operations in Class A airspace.

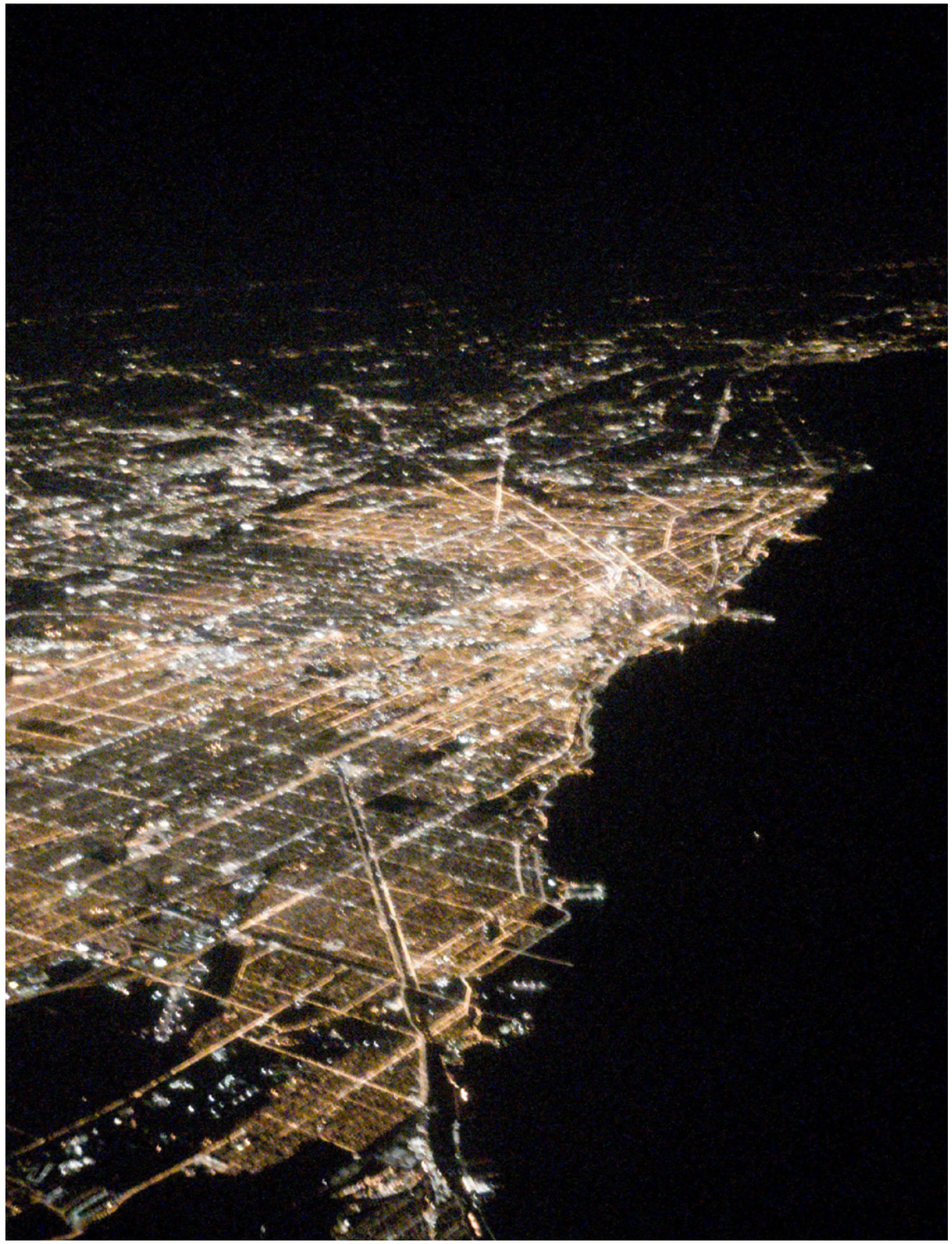
Except as provided in paragraph (d) of this section, each person operating an aircraft in Class A airspace must conduct that operation under instrument flight rules (IFR)…

Special VFR at Night

14 CFR §91.157(b)(4)(i) requires that the pilot hold an instrument rating in order to operate under special VFR at night:

§91.157 Special VFR weather minimums.
...
(b) Special VFR operations may only be conducted—
...
(4) Except for helicopters, between sunrise and sunset (or in Alaska, when the sun is 6 degrees or more below the horizon) unless—

(i) The person being granted the ATC clearance meets the applicable requirements for instrument flight under part 61 of this chapter...



Courtesy Allen Herbert.

1 FAA. *Instrument rating requirements*. 14 CFR §61.65(a)(1) Amdt. 61-136. (Washington, DC: U.S. Government Publishing Office, 1 January 2020).
2 FAA. "Pilot in Command Proficiency Check and Other Changes to the Pilot and Pilot School Certification Rules." 76 FR 54099. (Washington, DC: U.S. Government Publishing Office, 31 August 2011).
3 FAA. *Instrument Rating – Airplane Airman Certification Standards*. FAA-S-ACS-8B (with Change 1). (Washington, DC: Flight Standards Service, 6 June 2019), 2.
4 FAA. *Instrument rating requirements*. 14 CFR §61.65(a)(2) Amdt. 61-136.
5 FAA. "Certification: Pilots and Flight and Ground Instructors." AC 61-65H. (Washington, DC: U.S. Government Publishing Office, 27 August 2018).
6 FAA. *Instrument rating requirements*. 14 CFR §61.65(a)(3) Amdt. 61-136.
7 FAA. *Instrument rating requirements*. 14 CFR §61.65(a)(7) Amdt. 61-136.
8 FAA. *Requirement for certificates, ratings, and authorizations*. 61.3(e) Amdt. 61-140.
9 FAA. *Prerequisites for practical tests*. 14 CFR §61.39(a)(6)(ii) Amdt. 61-142.
10 FAA. Instrument rating requirements. 14 CFR §61.65(a)(6) Amdt. 61-136.
11 FAA. *Prerequisites for practical tests*. 14 CFR §61.39(a)(6)(i) Amdt. 61-142.
12 FAA. *Prerequisites for practical tests*. 14 CFR §61.39(a)(6)(iii) Amdt. 61-142.
13 FAA. *Instrument rating requirements*. 14 CFR §61.65(a)(8)(ii) Amdt. 61.136.
14 FAA. *Gebhart – (2009) Legal Interpretation*. (Washington, DC: Office of the Chief Counsel, 22 June 2009).
15 FAA. *Haralson – (2009) Legal Interpretation*. 17 October 2009.
16 FAA. *Gordon – (2006) Legal Interpretation*. Date accessed: 4 October 2020.
17 FAA. *Pilot logbooks*. 14 CFR §61.51(g)(1) Amdt. 61-142.
18 FAA. *Practical tests: Required aircraft and equipment*. 14 CFR §61.45(d)(2) Amdt. 61-124.
19 FAA. *Flight instruction; Simulated instrument flight and certain flight tests*. 14 CFR §91.109(c) Amdt. 91.324.
20 FAA. *Aeronautical Information Manual*. (Washington, DC: U.S. Government Publishing Office, 16 July 2020), PCG V-3.
21 FAA. *Legal Interpretation # 84-29*. 7 November 1984.
22 FAA. *Rohlfing – (2016) Legal Interpretation*. 24 February 2016.
23 FAA. *Glaser – (2008) Legal Interpretation*. 18 March 2008.
24 FAA. *Pratte – (2012) Legal Interpretation*. 25 September 2012.
25 FAA. *Reconsideration of Legal Interpretations (Glaser-2008 and Pratte-2012)*. 28 February 2022.
26 Moore, Jim. "FAA Takes More Practical Approach to Instrument Rating Requirements." 9 March 2022. https://www.aopa.org/news-and-media/all-news/2022/march/09/faa-takes-more-practical-approach-to-instrument-rating-requirements.
27 FAA. *Instrument Rating Course*. 14 CFR §141 Appendix C.
28 FAA. *Regulatory Relief: Aviation Training Devices; Pilot Certification, Training, and Pilot Schools; and Other Provisions*. 83

AREA OF OPERATION I

TASK B

WEATHER INFORMATION

WEATHER INFORMATION

OVERVIEW

The primary objective of this task is to obtain a weather briefing and present the results to the examiner per Skill Elements 1, 3, and 4. This includes selecting an alternate airport (if required) and a go/no-go decision for the flight. Knowledge Elements 1 and 2 are evaluated concurrently with this presentation. The weather briefing is normally obtained before the examiner arrives to conduct the test. As a result, ensure adequate time is scheduled to obtain and analyze the weather briefing.

The examiner will also evaluate your knowledge regarding various weather phenomena and their implications on flight as discussed in Skill Element 2. The examiner will select a minimum of three weather phenomena and may evaluate one or more risk elements concurrently. Generalized questions and answers are provided in Knowledge Elements K3a through K3k that can be adapted to actual weather obtained from the weather briefing or weather based on a scenario provided by the examiner.

Task	***C. Weather Information***
References	14 CFR part 91; FAA-H-8083-25; AC 00-6, AC 00-45, AC 00-54; AIM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with weather information for a flight under IFR.
Knowledge	The applicant demonstrates understanding of:
IR.I.B.K1	Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes.
IR.I.B.K2	Acceptable weather products and resources required for preflight planning, current and forecast weather for departure, en route, and arrival phases of flight.
IR.I.B.K3	Meteorology applicable to the departure, en route, alternate, and destination under Instrument Flight Rules (IFR) to include expected climate and hazardous conditions such as:
IR.I.B.K3a	a. Atmospheric composition and stability
IR.I.B.K3b	b. Wind (e.g., crosswind, tailwind, windshear, mountain wave, etc.)
IR.I.B.K3c	c. Temperature
IR.I.B.K3d	d. Moisture/precipitation
IR.I.B.K3e	e. Weather system formation, including air masses and fronts
IR.I.B.K3f	f. Clouds
IR.I.B.K3g	g. Turbulence
IR.I.B.K3h	h. Thunderstorms and microbursts
IR.I.B.K3i	i. Icing and freezing level information
IR.I.B.K3j	j. Fog/mist
IR.I.B.K3k	k. Frost
IR.I.B.K3l	l. Obstructions to visibility (e.g., smoke, haze, volcanic ash, etc.)
IR.I.B.K4	Flight deck displays of digital weather and aeronautical information.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.I.B.R1	Factors involved in making the go/no-go and continue/divert decisions, to include:
IR.I.B.R1a	a. Circumstances that would make diversion prudent
IR.I.B.R1b	b. Personal weather minimums (see ***IR.I.A.R2***)
IR.I.B.R1c	c. Hazardous weather conditions to include known or forecast icing or turbulence aloft
IR.I.B.R2	Limitations of:
IR.I.B.R2a	a. Onboard weather equipment
IR.I.B.R2b	b. Aviation weather reports and forecasts
IR.I.B.R2c	c. Inflight weather resources
Skills	The applicant demonstrates the ability to:
IR.I.B.S1	Use available aviation weather resources to obtain an adequate weather briefing.
IR.I.B.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. (see Knowledge Elements K3a through K3k)
IR.I.B.S3	Correlate weather information to make a competent go/no-go decision.
IR.I.B.S4	Determine whether an alternate airport is required, and, if required, whether the selected alternate airport meets regulatory requirements.

Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.I.B.R1	Factors involved in making the go/no-go and continue/divert decisions, to include:
IR.I.B.R1a	a. Circumstances that would make diversion prudent

Identifying Risks

Risks
Fuel exhaustion due to flying an excessive number of instrument approaches and going missed due to low ceiling and visibility, and not diverting in a timely manner.

Although there are many circumstances that would make diversion prudent, this risk element is restricted to weather. For pilots flying under IFR, this is most commonly low ceilings and visibility at the destination airport. Pilots often fly an excessive number of instrument approaches which burns too much fuel, not leaving enough to divert. However, icing and thunderstorms can also necessitate a diversion.

In 2017 an instructor and student on a training flight in a Piper PA-34-220T Turbo Seneca III nearly ran out of fuel after flying multiple approaches and diverting three times.[39] The crew was unable to land at the destination due to high crosswinds, but flew the approach three times. They then diverted to their filed alternate and flew an approach there, but had to go missed due to the ceiling and visibility being too low. They diverted again to a nearby airport. Here they flew two approaches and went missed twice due to low ceilings and visibility as well as being unable to activate the airport lights. They then diverted to yet another airport and flew two approaches. The first they went missed due to low ceilings and visibility again, but on the second attempt they saw the runway right at minimums and landed. The airplane was nearly out of fuel.

WEATHER INFORMATION

CIRCUMSTANCES THAT WOULD MAKE DIVERSION PRUDENT

R

Assessing Risks

◇ **Severity (Catastrophic):** Although the example incident did not result in a catastrophic accident, this is possible and has occurred many times in the past.

◇ **Likelihood:** Likelihood of a diversion being necessary is largely dependent on weather conditions that result in low ceilings and visibility as well as the pilot's proactiveness in obtaining a weather briefing.

◇ **Example:** For the proposed flight, the likelihood of a diversion is remote since the weather at the destination is low enough to require an alternate. Using the ***risk assessment matrix***, this makes circumstances that would make diversion prudent a ***serious***-risk item.

Mitigating Risks

The following are risk mitigation measures regarding circumstances that would make diversion prudent:

- First and foremost, obtain a weather briefing before any flight. Although this does not eliminate the likelihood of encountering unexpected weather as discussed in ***Risk Element 2b***, it greatly reduces it.
- If having to go missed off of an instrument approach due to weather and not seeing the runway at minimums, do not attempt another approach. Divert to an alternate.
- Carry extra fuel, even beyond the required 45-minute reserve.

1 FAA. *Aviation Weather Services*. AC 00-45H. (Washington, DC: U.S. Government Publishing Office, 14 November 2016), 3-1 through 3-26.

2 FAA. *Aviation Weather Services*. AC 00-45H. 3-26 through 3-37.

3 FAA. *Aviation Weather Services*. AC 00-45H. 3-37 through 3-46.

4 FAA. *Aviation Weather Services*. AC 00-45H. 3-57 through 3-62.

5 NOAA. "NOAA's Geostationary and Polar-Orbiting Weather Satellites." Last modified 17 August 2018. https://noaasis.noaa.gov/NOAASIS/ml/genlsatl.html.

6 FAA. *Aviation Weather Services*. AC 00-45H. 3-74 through 3-76.

7 FAA. *Aviation Weather Services*. AC 00-45H. 4-1 through 4-13.

8 FAA. *Aviation Weather Services*. AC 00-45H. 4-13 through 4-19.

9 FAA. *Aviation Weather Services*. AC 00-45H. 5-35 through 5-38.

10 FAA. *Aviation Weather Services*. AC 00-45H. 5-75 through 5-94.

11 NWS. "TAF Format Changes and 30 Hour TAF's." http://www.prh.noaa.gov/hnl/pages/taf30.php.

12 FAA. *Aviation Weather Services*. AC 00-45H. 5-96 through 5-100.

13 FAA. *Aviation Weather Services*. AC 00-45H. 5-16 through 5-30.

14 FAA. *Aviation Weather Services*. AC 00-45H. 5-1 through 5-7.

15 FAA. *Aviation Weather Services*. AC 00-45H. 5-7 through 5-11.

16 FAA. *Aviation Weather Services*. AC 00-45H. 5-30 through 5-33.

17 FAA. *Aviation Weather Services*. AC 00-45H. 5-33 through 5-34.

18 FAA. *Aviation Weather*. AC 00-6B. (Washington, DC: U.S. Government Publishing Office, 23 August 2016), 1-1 through 1-5.

19 FAA. *Aviation Weather*. AC 00-6B. 12-1 through 12-11.

20 FAA. *Aviation Weather*. AC 00-6B. 7-1 through 7-6.

21 FAA. *Aviation Weather*. AC 00-6B. 15-1 through 15-2.

22 FAA. *Aviation Weather*. AC 00-6B. 17-5 through 17-6.

23 FAA. *Aviation Weather*. AC 00-6B. 17-3 through 17-5.

24 FAA. *Aviation Weather*. AC 00-6B. 2-1 through 2-3.

25 FAA. *Aviation Weather*. AC 00-6B. 1-1.

AREA OF OPERATION II

TASK A

AIRPLANE SYSTEMS RELATED TO IFR OPERATIONS

AIRPLANE SYSTEMS RELATED TO IFR OPERATIONS

OVERVIEW

Although the title of this task is quite vague, it refers to ice protection systems. This is because flight in IMC (visible moisture) is a prerequisite for airframe icing. During the ground portion of the practical test, examiner will evaluate the applicant's knowledge of all ice protection systems installed on the airplane as well as at least one of the two risk elements. During the flight portion of the test, the examiner will evaluate the applicant's operation of these systems.

Task	***A. Airplane Systems Related to IFR Operations***
References	14 CFR parts 61, 91; FAA-H-8083-2, FAA-H-8083-15; AFM; AC 91-74
Objective	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with anti-icing and de-icing systems.
Knowledge	The applicant demonstrates understanding of:
IR.II.A.K1	The general operational characteristics and limitations of applicable anti-icing and deicing systems, including airframe, propeller, intake, fuel, and pitot-static systems.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.II.A.R1	Pilots with little or no experience with flight in icing conditions.
IR.II.A.R2	Limitations of anti-icing and deicing systems.
Skills	The applicant demonstrates the ability to:
IR.II.A.S1	Demonstrate familiarity with anti- or de-icing procedures or information published by the manufacturer that is specific to the airplane used on the practical test.

Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.II.A.R1	Pilots with little or no experience with flight in icing conditions.

Gaining true experience in icing conditions safely is something that not many pilots are afforded. This is because it requires a FIKI-certified airplane and a pilot or flight instructor with sufficient experience in these conditions, both of which may be hard to find and cost-prohibitive. Even Part 121 pilots with only jet time lack true icing experience since jets climb and descend through these conditions quickly and have ice protection systems that can handle significant ice. For the most part, the only pilots with true icing experience are Part 135 charter and cargo pilots which make up a small subset of the total pilot population. As a result, the vast majority of pilots have little or no experience in icing conditions.

Identifying Risks

Risks
Loss of control due to excessive ice accumulation.

Table II-A-1 summarizes select icing accidents in small airplanes in 2018 and 2019 including pilot experience.

Date	Accident No.	Injuries	Pilot Experience	Occupational Pilot?
01/11/18	WPR18FA073	1 fatal	Commercial pilot, 643 hours	Yes
04/16/18	CEN18FA143	2 fatal	Commercial pilot, 2,300 hours	No
04/19/18	CEN18FA144	2 fatal	Private pilot, 496 hours	No
04/24/18	CEN18LA146	3 minor	Commercial pilot, 4,602 hours	Yes
11/17/18	CEN19FA029	2 fatal	Private pilot, 10,623 hours	No
12/11/18	GAA19CA096	None	Commercial pilot, 2,158 hours	Yes
02/15/19	WPR19FA084	2 fatal	Private pilot, 1,619 hours	No
03/06/19	ANC19FA038	1 fatal	Private pilot, 950 hours	No
05/24/19	WPR19FA154	2 fatal	Private pilot, 930 hours	No
11/06/19	GAA20CA075	None	Commercial pilot, 430 hours	No

Table II-A-1: Summary of Small Airplane Icing Accidents in 2018 and 2019

AIRPLANE SYSTEMS RELATED TO IFR OPERATIONS

PILOT ICING EXPERIENCE

Pilot experience varies widely with icing accidents. As a result, it can be surmised that general pilot experience, without any icing experience, is not very beneficial. The takeaway is that pilots without any icing experience should avoid icing conditions.

However, even those with significant icing experience can succumb to its effects. In 2003, the pilot and sole occupant of a Cessna 208B Caravan lost control and crashed due to airframe icing while conducting an instrument approach into Yellowstone Regional Airport (KCOD).[5] The pilot was an experienced Part 135 cargo pilot with almost 10,000 hours total time and over 4,000 hours in the Cessna 208B alone. In the remarks section of his logbooks, he even noted his icing experience, ranging from trace to over an inch of accumulation.

Assessing Risks

- **Severity (Catastrophic):** Encountering icing conditions in flight has the potential to lead to a catastrophic accident regardless of pilot experience.
- **Likelihood:** Likelihood is largely dependent on the probability of encountering icing conditions, which can be determined from the appropriate weather products.
- **Example:** For the proposed flight, the likelihood of encountering icing conditions is **remote** since moderate icing is forecasted, although at altitudes above the planned cruising altitude (see ***IR.I.B.S1***). Additionally, the applicant has no icing experience. Using the ***risk assessment matrix***, this is a **serious**-risk item.

Mitigating Risks

The following are risk mitigation measures for pilots with little or no experience with flight in icing conditions:

- Know how to verify if an aircraft is FIKI-certified. Understand that non-FIKI airplanes are prohibited from flying in known icing conditions. FIKI-certified airplanes may fly in known icing conditions, but the airplane's limitations must be abided by, such as prohibition of flight in severe icing conditions or SLD.
- If you own or operate a FIKI-certified airplane, seek training from a flight instructor or pilot with icing experience before flying the airplane in known icing conditions. If this is not possible, perform a thorough study of the airplane's ice protection systems and limitations, fully understand all icing-related weather products (AIRMETs, SIGMETs, PIREPs, freezing level charts, forecast icing product), and research icing flying strategies (route adjustments for weather phenomena such as fronts, escape plans, etc.). Use added caution, for instance, do not attempt to fly in greater than light icing conditions.

AIRPLANE SYSTEMS RELATED TO IFR OPERATIONS

REFERENCES

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2 AOPA. "FAA Letter Offers New 'Known Icing' Definition. 28 January 2009. https://www.aopa.org/news-and-media/all-news/2009/january/28/faa-letter-offers-new-known-icing-definition.

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5 NTSB. "Aviation Accident Final Report." Accident No DEN04MA015. 29 September 2004.

6 NTSB. "Aviation Accident Final Report." Accident No CEN13FA130. 6 May 2015.

7 NTSB. "Aviation Accident Final Report." Accident No CEN15FA040. 11 May 2017.

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

AREA OF OPERATION II

TASK B

AIRPLANE FLIGHT INSTRUMENTS AND NAVIGATION EQUIPMENT

FLIGHT AND NAVIGATION INSTRUMENTS

OVERVIEW

For this task, the examiner will evaluate the applicant's knowledge regarding the flight instruments and navigation equipment installed on the airplane used for the practical test. This is analogous to the Operation of Systems task for the private pilot certificate except that it is focused on flight instruments and navigation equipment used for instrument flight. Knowledge Elements 1 and 2 discuss how these systems work and Skill Element 1 discusses their operation by the pilot in flight. Risk Elements 1 through 5 relate to various risks associated with these systems, including common failure modes and auxiliary devices such as handheld GPS receivers and electronic flight bags.

Task	***B. Airplane Flight Instruments and Navigation Equipment***
References	14 CFR parts 61, 91; FAA-H-8083-15; AIM
Objective	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with managing instruments appropriate for an IFR flight.
Knowledge	The applicant demonstrates understanding of:
IR.II.B.K1	Operation of their airplane's applicable flight instrument system(s) including:
IR.II.B.K1a	a. Pitot-static instrument system: altimeter, airspeed indicator, vertical speed indicator
IR.II.B.K1b	b. Gyroscopic/electric/vacuum instrument system: attitude indicator, heading indicator, turn-and-slip indicator/turn coordinator
IR.II.B.K1c	c. Electrical systems, electronic flight instrument displays (PFD, MFD), transponder, and ADS-B
IR.II.B.K1d	d. Magnetic compass
IR.II.B.K2	Operation of their airplane's applicable navigation system(s) including:
IR.II.B.K2a	a. VOR, DME, ILS, marker beacon receiver/indicators
IR.II.B.K2b	b. RNAV, GPS, Wide Area Augmentation System (WAAS), FMS, autopilot
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.II.B.R1	Failure to monitor and manage automated systems
IR.II.B.R2	The difference between approved and non-approved navigation devices
IR.II.B.R3	Common failure modes of flight and navigation instruments.
IR.II.B.R4	The limitations of electronic flight bags.
IR.II.B.R5	Failure to ensure currency of navigation databases.
Skills	The applicant demonstrates the ability to:
IR.II.B.S1	Operate and manage installed instruments and navigation equipment.

FLIGHT AND NAVIGATION INSTRUMENTS

GYROSCOPIC INSTRUMENTS

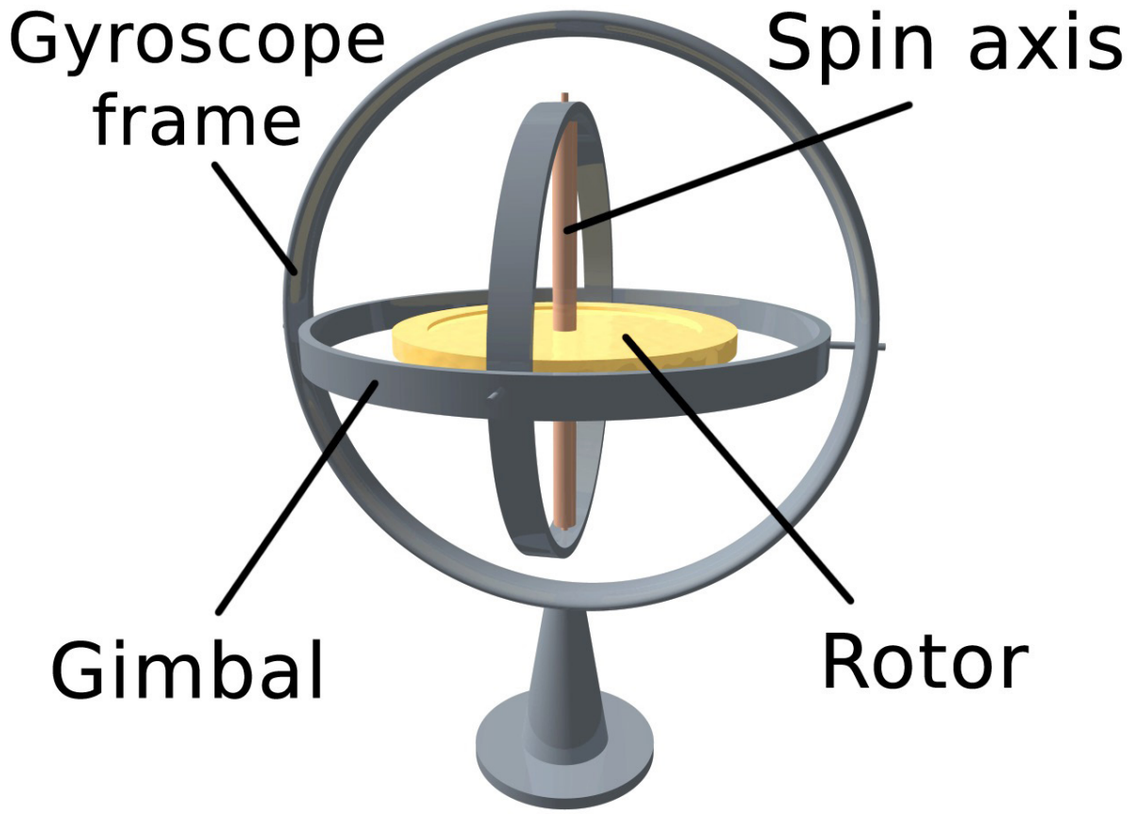
Knowledge	The applicant demonstrates understanding of:
IR.II.B.K1	Operation of their airplane's applicable flight instrument system(s) including:
IR.II.B.K1b	b. Gyroscopic/electric/vacuum instrument system: attitude indicator, heading indicator, turn-and-slip indicator/turn coordinator

Pneumatic Systems

Attitude Indicator

Heading Indicator

Turn Indicator



Elements of a gyroscope (courtesy Lucas Vieira).

Heading Indicator[18,19]

Principle of Operation

Errors and Limitations

Examiner: *"Explain the heading indicator."*

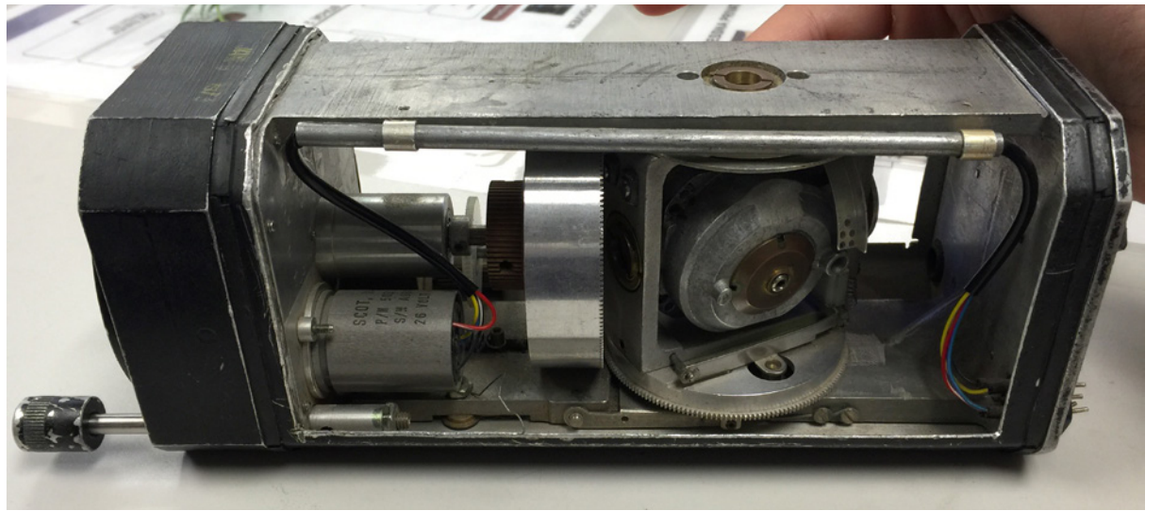
You: *"The heading indicator displays the airplane's magnetic heading as set to the compass. It contains a gyro with a horizontal spin axis and utilizes the principle of rigidity in space. The gyro is spun by airflow from the vacuum system. It is subject to precession, which causes the heading indicator to drift, resulting in a need to periodically reset it."*

Principle of Operation

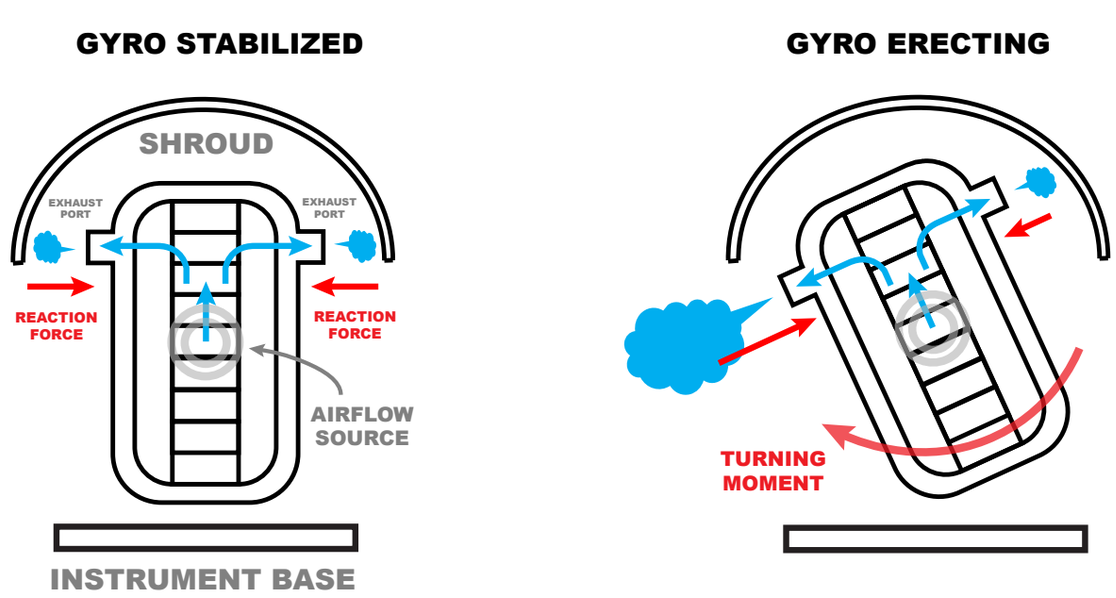
The heading indicator displays the airplane's heading stabilized by a gyro. This provides an improvement over magnetic compasses which are subject to numerous errors and difficult to use during turns. The disadvantage, however, is that the pilot must set the heading indicator with reference to the compass upon startup, and due to multiple errors, must periodically do so in flight. Similar to the attitude indicator, the heading indicator is pneumatically powered.

The heading indicator utilizes a gyro with a horizontal spin axis and employs the gyroscopic principle of rigidity in space. The airplane in essence yaws around the gyro while it maintains a constant position. This motion is translated via gears to the heading card on the face of the instrument.

Similar to the attitude indicator, an erection mechanism is necessary. A common one employed is the shroud-type erection mechanism. In this system, a semi-circular shroud that is attached to the inner gimbal covers or exposes the exhaust ports of the gyro's housing of which there are two, one on each side. It should be noted, however, that unlike the attitude indicator, this erection mechanism is not sensitive to gravity. As a result, it is only most effective when the airplane is straight and level.



Heading indicator with cover removed.



Heading indicator erection mechanism.

The heading card provides heading indications in 5-degree increments, with cardinal directions shown for north (N), south (S), east (E), and west (W), and two-digit headings shown for every other 30-degree increment. A knob is provided to allow the pilot to set the heading indicator to the magnetic compass. The knob must first be pushed to cage the assembly (heading card and gyro), and then rotated to set the desired heading. Some heading indicators may also provide a heading bug for use with autopilot or as a reference.

Errors and Limitations

The two errors of the heading indicator are gimbal error and precession. It is because of these errors that the heading indicator must be frequently reset in flight. Heading indicators are also subject to attitude limitations.

- **Gimbal Error:** Gimbal error is a phenomenon in which the heading indicator is unable to detect heading changes as effectively while the airplane is in a bank (or climb/descent) as opposed to straight and level. This is due to the gyro being tilted relative to the instrument itself. When the gyro's spin axis is parallel to the bottom of the instrument, such as while taxiing on the ground or in straight and level flight, heading changes are translated most effectively. As the angle increases the effectiveness is reduced.
- **Precession:** Precession in heading indicators is primarily caused by imperfections of the gyro. This may include friction or imbalance of the rotor which cause the gyro to tilt, resulting in a small change in heading over time.
- **Limitations:** Due to gimbal error discussed previously, heading indicators are limited by 55 degrees of pitch and bank, outside of which erroneous indications may be displayed.

REFERENCES

1 FAA. *Aviation Maintenance Technician Handbook – Airframe, Volume 2*. FAA-H-8083-31A. (Washington, DC: Flight Standards Service, 2018), 10-12 through 10-15.

2 FAA. *Pilot's Handbook of Aeronautical Knowledge*. FAA-H-8083-25B. (Washington, DC: Flight Standards Service, 2016), 8-1 through 8-3.

3 FAA. *Instrument Flying Handbook*. FAA-H-8083-15B. (Washington, DC: Flight Standards Service, 2012), 5-1 through 5-3.

4 FAA. *Aviation Maintenance Technician Handbook – Airframe, Volume 2*. FAA-H-8083-31A. 10-16 through 10-22.

5 FAA. *Pilot's Handbook of Aeronautical Knowledge*. FAA-H-8083-25B. 8-3 through 8-7.

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7 FAA. *Aviation Maintenance Technician Handbook – Airframe, Volume 2*. FAA-H-8083-31A. 10-24 through 10-26.

8 FAA. *Pilot's Handbook of Aeronautical Knowledge*. FAA-H-8083-25B. 8-8 through 8-10.

9 FAA. *Instrument Flying Handbook*. FAA-H-8083-15B. 5-8 through 5-10.

10 FAA. *Aviation Maintenance Technician Handbook – Airframe, Volume 2*. FAA-H-8083-31A. 10-22 through 10-24.

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21 Garmin. *Garmin G1000 Pilot's Guide for Cessna Nav III*. 190-00498-07 Rev A. (Olathe, KS: Garmin International Inc, October 2011).

22 Phillips, Darryl. "Mode A and Mode C: The Straight Scoop on How it Works." http://www.aeroelectric.com/articles/Altitude_Encoding/modec.htm.

AREA OF OPERATION II

TASK C

INSTRUMENT FLIGHT DECK CHECK

INSTRUMENT FLIGHT DECK CHECK

OVERVIEW

This task is the first to be evaluated during the flight portion of the practical test and will occur during the preflight, engine start, taxi, and runup/before takeoff checks. The instrument flight deck check is in essence a preflight inspection for instrument flight. This is done in addition to the items that must be checked for a VFR flight.

Task	***C. Instrument Flight Deck Check***
References	14 CFR part 91; FAA-8083-2, FAA-H-8083-3, FAA-H-8083-15, FAA-H-8083-25; AC 91.21-1; POH/AFM
Objective	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with conducting a preflight check on the aircraft instruments necessary for an IFR flight.
Knowledge	The applicant demonstrates understanding of:
IR.II.C.K1	Purpose of performing an instrument flight deck check and how to detect possible defects.
IR.II.C.K2	IFR airworthiness, to include aircraft inspection requirements and required equipment for IFR flight.
IR.II.C.K3	Required procedures, documentation, and limitations of flying with inoperative equipment.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
IR.II.C.R1	Operating with inoperative equipment.
IR.II.C.R2	Operating with outdated navigation publications or databases (see ***IR.II.B.R5***).
Skills	The applicant demonstrates the ability to:
IR.II.C.S1	Perform preflight inspection by following the checklist appropriate to the airplane and determine that the airplane is in a condition for safe instrument flight.

INSTRUMENT FLIGHT DECK CHECK

PURPOSE OF AN INSTRUMENT FLIGHT DECK CHECK

Knowledge	The applicant demonstrates understanding of:
IR.II.C.K1	Purpose of performing an instrument flight deck check and how to detect possible defects.

Technically speaking, during the preflight inspection, *all* equipment on the airplane must be inspected to verify that it is operational. If anything is inoperative, it must be dealt with in accordance with 14 CFR §91.213(d) as discussed in ***Knowledge Element 3***. However, practically speaking, only the equipment required for the intended operation is inspected (VFR day, VFR night, IFR day, IFR night, icing). As an example, for a day VFR flight, all lights are not normally checked for proper operation as they would be for a night flight, nor is an instrument flight deck check performed as it would be for an IFR flight.

It is in this sense that the preflight inspection is intended to be tiered. This can be done based on the operation as discussed previously as well as other factors such as if the airplane has just gotten out of maintenance, flight of the day (e.g. first, second, third), or if it is the first time that the pilot is flying the airplane. As a result, the instrument flight deck check is intended to be a closer inspection of equipment required for flight under IFR. See ***Skill Element 1*** for how to perform the instrument flight deck check and how to detect possible defects.