ANSWERS TO THE ACS

INSTRUMENT AIRPLANE

VOLUME II: FLIGHT PORTION

REVISION 0

ADDRESSES FAA-S-ACS-8C

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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. Patrick began working for Envoy Air Inc. (formerly known as American Eagle) in 2017 as a first officer on the Embraer 145 regional jet. In 2019, Patrick upgraded to captain on the Embraer 175. In 2022, Patrick began working as an instructor in Envoy's Advanced Qualification Program (AQP) on the Embraer 175. In 2023, Patrick began working for American Airlines as a first officer on the Airbus 320.

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.

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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.

REVISIONS

Revision	0	Date	September 1, 2025	ACS Addressed	FAA-S-ACS-8C
Reason(s) for Revision	NA				

Section	Sub-Section	Change Description
All	All	None - initial issue.

AREA OF OPERATION IV

FLIGHT BY REFERENCE TO INSTRUMENTS

IV. FLIGHT BY REFERENCE TO INSTRUMENTS

A. Instrument Flight

B. Recovery from Unusual Flight Attitudes

This area of operation consists of a set of tasks pertaining to basic attitude instrument flying. It consists of normal instrument flight, which is evaluated throughout the flight portion of the practical test, and recovery from unusual flight attitudes, which are evaluated as a dedicated, stand-alone task.

AREA OF OPERATION IV

TASK A

INSTRUMENT FLIGHT

Task A. Instrument Flight

References:	FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-25
Objective:	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with performing basic flight maneuvers solely by reference to instruments.
Knowledge:	The applicant demonstrates understanding of:
IR.IV.A.K1	Elements related to attitude instrument flying during straight-and-level flight, climbs, turns, and descents while conducting various instrument flight procedures.
IR.IV.A.K2	Interpretation, operation, and limitations of pitch, bank, and power instruments.
IR.IV.A.K3	Normal and abnormal instrument indications and operations.
Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
IR.IV.A.R1	Situations that can affect physiology and degrade instrument cross-check.
IR.IV.A.R2	Spatial disorientation and optical illusions.
IR.IV.A.R3	Flying unfamiliar aircraft or operating with unfamiliar flight display systems and avionics. (see IR.I.A.R4 in Volume I)
Skills:	The applicant exhibits the skill to:
IR.IV.A.S1	Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
IR.IV.A.S2	Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

This task is evaluated throughout the flight portion of the practical test and consists of basic instrument flying.

Knowledge:	The applicant demonstrates understanding of:
IR.IV.A.K1	Elements related to attitude instrument flying during straight-and-level flight, climbs, turns, and descents while conducting various instrument flight procedures.
IR.IV.A.K2	Interpretation, operation, and limitations of pitch, bank, and power instruments.

***Examiner:** "Discuss the instrument scanning method you use in your airplane."*

***You:** "Since my airplane is equipped with an EFIS, I use the control and performance method since the attitude indicator is more accurate and reliable."*

-Cessna 172S with G1000 Nav III

For operation and limitations of flight instruments, see Area of Operation II, Task B in Volume I. The two most recognized instrument scanning methods are the primary and supporting method and the control and performance method. These can then be applied to various instrument procedures.

Primary and Supporting Method

The primary and supporting method is preferred for analog flight instruments since it deemphasizes the attitude indicator. This is important since an analog attitude indicator is powered by a vacuum or pressure pump in most airplanes, which has an elevated likelihood of failing. Instruments are categorized as pitch, bank, and power instruments:

- **Pitch Instruments:** Instruments used as a reference for elevator/stabilator control.
- **Bank Instruments:** Instruments used as a reference for aileron control.
- **Power Instruments:** Instruments used as a reference for power (throttle) control.

Pitch, bank, and power instruments are then subdivided as primary or supporting instruments:

- **Primary Instrument:** A single instrument used for pitch, bank, or power control, respectively.
- **Supporting Instruments:** Instruments used to verify that the primary instrument is providing the correct information.

The scan order is as follows: primary pitch, primary bank, primary power, supporting pitch, supporting bank, supporting power, and then repeated. The primary and supporting pitch, bank, and power instruments differ depending on the phase of flight. The attitude indicator is only a primary pitch or bank instrument when transitioning to a different phase of flight. Table IV-A-1 depicts the primary and supporting pitch, bank, and power instruments for each phase of flight.

Phase of Flight	Primary Pitch	Primary Bank	Primary Power	Supporting Pitch	Supporting Bank	Supporting Power
Straight-and-Level	Altimeter	Heading Indicator	Airspeed Indicator	Attitude Indicator VSI	Attitude Indicator Turn Indicator	Tach/MP
Sustained Climb[1]	Airspeed Indicator	Heading Indicator	Tach/MP	Attitude Indicator	Attitude Indicator Turn Indicator	VSI
Sustained Descent[2]	Airspeed Indicator	Heading Indicator	VSI	Attitude Indicator	Attitude Indicator Turn Indicator	Tach/MP
Transition to or From Climb or Descent	Attitude Indicator	Heading Indicator	Tach/MP	Altimeter VSI	Turn Indicator	Airspeed Indicator
Sustained Level Turn[3]	Altimeter	Turn Indicator	Airspeed Indicator	Attitude Indicator	Attitude Indicator	Tach/MP
Transition to or From Level Turn[3]	Altimeter	Attitude Indicator	Tach/MP	Attitude Indicator VSI	Heading Indicator	Airspeed Indicator

Table IV-A-1: Primary and Supporting Instruments by Phase of Flight

[1]Climbs are recommended to be accomplished at a constant airspeed.

[2]Descents are recommended to be accomplished at a constant rate and airspeed.

[3]Standard rate turn.

Control and Performance Method

The control and performance method is preferred for electronic flight instruments since it emphasizes the attitude indicator, which is much more reliable and accurate than analog attitude indicators. Additionally, the standby instrument/display provided with electronic flight instruments typically includes an attitude indicator. Instruments are categorized as control or performance instruments:

- **Control Instruments:** Control instruments consist of the attitude indicator for pitch and bank control and the tachometer or manifold pressure gauge for power control.

- **Performance Instruments:** Performance instruments primarily consist of the airspeed indicator and VSI. However, the turn rate indicator can be considered a performance instrument for standard rate turns, and the heading indicator and altimeter can be considered performance instruments for straight-and-level flight.

The control and performance method is much simpler than the primary and supporting method. Pitch, bank, and power values are set with reference to the attitude indicator and manifold pressure gauge or tachometer and then verified against the performance instruments.

Tables can be made for different airplanes to know the pitch and power settings for different phases of flight. Table IV-A-2 provides an example for the Cessna 172S.

Maneuver	**Control**		**Performance**	
	Power	**Pitch**	**Airspeed**	**VSI**
Best Rate of Climb	Full	10°	74 knots	Varies with weight & density altitude
Cruise	2400 RPM	2.5°	100 knots	0 FPM
Approach Level	2100 RPM	5°	90 knots	0 FPM
Precision Approach Descent	1800 RPM	-2.5°	90 knots	400 FPM
Non-Precision Approach Normal Descent	1500 RPM	-2.5°	90 knots	700 FPM
Non-Precision Approach Steep Descent	Idle	-5°	90 knots	900 FPM

Table IV-A-2: Control and Performance Values for the Cessna 172S

Applying Scanning Methods to Instrument Procedures

When scanning methods are applied to instrument procedures, another type of instrument must be considered in addition to primary/supporting or control/performance instruments – command instruments. Command instruments prompt transitions to different phases of flight:

- **Climbs or Descents:** The altimeter is a command instrument that prompts the pilot to level off. A rule of thumb for small airplanes is to begin the level-off at an altitude prior to the target altitude, which is 10% of the vertical speed. As an example, for a vertical speed of 500 feet per minute, begin the level-off at 50 feet prior to the target altitude.

- **Turns to Headings:** The heading indicator is a command instrument that prompts the pilot to roll out. A rule of thumb for small airplanes is to begin the rollout on a heading prior to the target heading that is one-third of the bank angle. As an example, for a bank angle of 15 degrees, begin the rollout at 5 degrees prior to the target heading.

- **Tracking Lateral Paths:** When tracking a radial, course, or DME arc, the Course Deviation Indicator (CDI) or DME display is a command instrument that prompts turns to different headings.

- **Tracking Vertical Paths:** When tracking a glideslope or glidepath, the Vertical Deviation Indicator (VDI) is a command instrument that prompts different rates of descent.

A. INSTRUMENT FLIGHT
NORMAL/ABNORMAL INSTRUMENT INDICATIONS/OPERATIONS

K

Knowledge:	The applicant demonstrates understanding of:
IR.IV.A.K3	Normal and abnormal instrument indications and operations.

Examiner: *"Discuss normal and abnormal instrument indications and operations for your airplane."*

You: *"Normal indications include no red or amber Xs on the instruments and realistic indications that correlate with one another. Abnormal indications would include red or amber Xs on certain instruments or unrealistic indications that do not correlate with the remaining instruments. Corrective action in the case of abnormal indications is to use the standby display."*

-Cessna 172S with G1000 Nav III

Table IV-A-3 lists normal and common abnormal indications as well as actions to take in case of abnormal indications for various flight instruments.

Instrument	Normal Indications	Abnormal Indications	Abnormal Operations
Altimeter	Remains steady in straight and level flight and realistic indications in response to climbs and descents.	Stuck at a certain altitude and does not reflect climbs or descents.	Cover and disregard the altimeter. Use GPS, known cloud tops or ceilings, or Mode C readout from ATC.
Airspeed Indicator	Indicates realistic airspeeds based on configuration, power setting, and phase of flight.	Stuck in a single position or erratic indications.	Cover and disregard the airspeed indicator. Use known power settings and pitch angles for different phases of flight.
VSI	Indicates realistic rates of climb and descent that correlate with the altimeter.	Stuck at a certain altitude and does not reflect climbs or descents.	Cover and disregard the VSI.
Attitude Indicator	Remains steady in straight and level flight and realistic indications in response to pitch and bank that correlate with all other instruments.	Oscillations in bank and pitch due to gyro spool down.	Cover and disregard the attitude indicator and use the remaining instruments for attitude control.
Heading Indicator	Remains steady while straight and level and realistic indications in response to turns that correlate with the attitude indicator, turn indicator, and compass.	Constant rotation due to gyro spool down.	Cover and disregard the heading indicator and use either the compass for compass turns or the turn indicator for timed turns.
Turn Indicator	Indicates realistic rates of turn that correlate with the attitude (bank angle) and heading indicators.	Does not move or is sluggish due to gyro spool down.	Cover and disregard the turn indicator.
Magnetic Compass	Rotates freely and indicates known headings.	Stuck on a certain heading due to either a jam or inadequate fluid.	Disregard the magnetic compass. Use GPS for heading if available.
EFIS	No red or amber Xs and instruments displaying realistic indications.	Red or amber Xs on instrument indications.	Use the standby flight instruments or display(s).

Table IV-A-3: Normal Indications, Abnormal Indications, and Abnormal Operations of Flight Instruments

Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
IR.IV.A.R1	Situations that can affect physiology and degrade instrument cross-check.

During the practical test, this is evaluated by observing the applicant perform a fitness for flight assessment and determining personal minimums as discussed in IR.I.A.R2 and IR.I.A.R3 in Volume I.

Identifying Risks

Risks
Spatial disorientation and loss of control.

Accident history shows that fatigue, alcohol, and impairing medications are the most common physiological causes for a degraded instrument cross-check, which can result in spatial disorientation and loss of control.

In 2022, a pilot and two passengers of a Cessna 172S were fatally injured during an accident shortly after takeoff from Duluth International (KDLH).[1] Night instrument meteorological conditions prevailed at the time of the accident, with a ceiling of 200 feet and visibility of 5 SM. After takeoff, the pilot made a turn to the right, then a tight climbing turn to the left, briefly leveled off, then began a rapid descent and subsequently impacted power lines and a single-family home. The NTSB determined that fatigue was likely a contributing factor to the accident.

On the day before the accident, the pilot flew with one of his students on a night cross-country flight. The flight began at about 7 pm and ended at about 11:15 pm. The student stated that during the flight, the pilot/instructor mentioned that he had to fly to a wedding the following morning. He said he was nervous about the flight because he was not confident in his instrument flying abilities. On the morning of the accident, the pilot and two passengers had to fly from South St. Paul Municipal (KSGS) to KDLH for the wedding. The pilot and two passengers were departing KDLH to return to KSGS after the wedding and reception during the accident flight, which was shortly after 11 pm. The accident pilot also lived approximately 30 minutes driving distance from KSGS.

In 2011, the pilot of a Cessna 310R and two passengers departed Louis Armstrong International (KMSY) en route to McComb Field (MCB) at about 4 am after going to a bar.[2] Although the pilot was instrument-rated, they did not obtain a weather briefing or file an IFR flight plan. Night IMC prevailed at the destination airport. The airplane departed uneventfully, and at 4:23 am, the pilot reported the destination airport in sight and elected to cancel Flight Following. At that time, the destination airport was still 24 miles away and under two broken cloud ceilings and an overcast ceiling; thus, the pilot most likely did not have the destination airport in sight.

The airplane subsequently overflew the destination airport and initiated a left turn. The last radar target was recorded at 4:32 am, at an altitude of 2,600 feet MSL, which was above the two broken cloud ceilings and slightly below the overcast ceiling. The airplane impacted the ground shortly thereafter, resulting in fatal injuries to everyone onboard. Toxicological testing revealed that the pilot was impaired due to alcohol ingestion.

Assessing Risks

◇ **Severity (Catastrophic):** Spatial disorientation, regardless of the cause, often leads to fatal accidents.

◇ **Likelihood:** Likelihood is dependent on the pilot's fitness for flight assessment and personal minimums determination, if one is used at all.

◇ **Example:** For the proposed flight, the likelihood of impairment resulting in a degraded instrument cross-check is improbable since the pilot thoroughly determines fitness for flight and personal minimums for each flight. Using the ***Risk Assessment Matrix***, this makes impairment resulting in a degraded instrument cross-check a low-risk item.

Mitigating Risks

The following are risk mitigation measures for situations that can affect physiology and degrade instrument cross-check:

- Always perform a fitness for flight assessment (see IR.I.A.R3 in Volume I) before any flight and increase scrutiny for instrument flights due to the higher demand of flying and cognitive skills.

- Utilize a personal minimums system (see IR.I.A.R2 in Volume I) and increase personal minimums if any fitness for flight factor (PAVE) is not optimal.

Spatial Disorientation and Optical Illusions

Risk Management:	The applicant is able to identify, assess, and mitigate risk associated with:
IR.IV.A.R2	Spatial disorientation and optical illusions.

During the practical test, this is evaluated by observing the applicant using an instrument scan and cross-check, not attempting to fly by the seat of their pants, and utilizing the autopilot to the maximum extent if equipped and permissible.

Identifying Risks

Risks
Loss of control due to spatial disorientation caused by optical illusions or not properly referencing the flight instruments.

Although spatial disorientation is typically associated with non-instrument-rated pilots who inadvertently enter IMC or experience various illusions, instrument-rated pilots can and do fall victim to this as well. Table IV-A-4 summarizes select accidents involving instrument-rated pilots that experienced spatial disorientation in IMC with no equipment failures between 2012 and 2022, all of which were fatal.

Date	Time	Aircraft	Pilot Hours	Phase of Flight	Cond.
OCT 2022[3]	2317 (night)	C172	646	After Takeoff	LIFR
JUN 2022[4]	0800 (day)	M20K	2,459	After Takeoff	LIFR
FEB 2022[5]	2241 (night)	PA-32	1,137	Approach	IFR
DEC 2021[6]	1840 (night)	V35	2,428	After Takeoff	LIFR
NOV 2020[7]	0604 (night)	C150	238	Enroute	IFR
MAR 2020[8]	2247 (night)	PA28R	1,507	Enroute	IFR
SEP 2018[9]	1103 (day)	LC41	1,945	Approach	IFR
OCT 2013[10]	1209 (day)	C340	5,541	Missed approach	IFR

Table IV-A-4: Select Spatial Disorientation Accidents Involving Instrument-Rated Pilot with No Equipment Failures (2012-2022)

It can be seen that the two most significant contributors to these accidents are conditions (night IMC) and workload (flying an approach or missed approach). In the case of the November 2020 accident, which occurred en route, the pilot believed that they were experiencing pitot tube icing, although they were below the freezing level. Additionally, they were attempting to avoid precipitation/IMC in night conditions over an area with little to no lighting. These distractions and the attempt to remain in VMC likely contributed to the accident.

In the case of the March 2020 accident, which also occurred en route, the pilot was cleared for the approach and nearing the IAF when they began experiencing heavy turbulence, downdrafts, and autopilot problems (likely due to the former). The preparation for the approach and these conditions, coupled with night IMC, likely contributed to the accident.

Assessing Risks

◇ **Severity (Catastrophic):** Accidents due to spatial disorientation are often catastrophic.

◇ **Likelihood:** Night IMC, high workload (approach and missed approach), and distractions all increase the likelihood of spatial disorientation.

◇ **Example:** For the proposed flight, the likelihood of spatial disorientation is elevated to **remote** since low IFR conditions are present at the departure airport. However, the pilot is current and proficient in instrument flying in preparation for their instrument checkride. Using the ***Risk Assessment Matrix***, this makes spatial disorientation a **serious**-risk item.

Mitigating Risks

The following are risk mitigation measures for spatial disorientation and optical illusions:

- Use the autopilot (if available) to the maximum extent when flying in IMC.
- If the natural horizon cannot be clearly discerned, fly the airplane solely by reference to the flight instruments.

A. INSTRUMENT FLIGHT
IN-FLIGHT TASK

S

Skills:	The applicant exhibits the skill to:
IR.IV.A.S1	Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
IR.IV.A.S2	Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

Skill Element 2 is expected to be performed throughout the entirety of the flight portion of the practical test. However, the tolerances of Skill Element 1 only apply when maneuvering outside of holding, instrument approaches (including missed approach), and intercepting and tracking navigational systems and DME arcs. These include Area of Operation III, Task A, Compliance with Air Traffic Control Clearances and Area of Operation V, Task B, Departure, En Route, and Arrival Operations, of which the tolerances match.

REFERENCES

1 NTSB. "Aviation Accident Final Report." Accident Number ERA23FA001. 14 November 2024.

2 NTSB. "Aviation Accident Final Report." Accident Number ERA11FA232. 27 December 2011.

3 NTSB. "Aviation Accident Final Report." Accident Number ERA23FA001. 14 November 2024.

4 NTSB. "Aviation Accident Final Report." Accident Number WPR22FA210. 18 April 2024.

5 NTSB. "Aviation Accident Final Report." Accident Number CEN22FA131. 28 June 2023.

6 NTSB. "Aviation Accident Final Report." Accident Number WPR22FA054. 26 April 2023.

7 NTSB. "Aviation Accident Final Report." Accident Number ANC21LA007. 14 September 2022.

8 NTSB. "Aviation Accident Final Report." Accident Number CEN20LA127. 6 May 2022.

9 NTSB. "Aviation Accident Final Report." Accident Number ERA18FA251. 19 May 2020.

10 NTSB. "Aviation Accident Final Report." Accident Number ERA14LA006. 5 January 2016.

APPENDICES AND ADDENDA

APPENDICES AND ADDENDA
OVERVIEW

Appendices expand on pertinent information referenced throughout this book. Addenda contain information that has recently changed, which permits for rapid deployment of revisions. Over time, addenda (if present) will be integrated back into the main body of the book in the appropriate location.

Appendices

APPENDIX 1

RISK ASSESSMENT MATRIX

APPENDICES AND ADDENDA

1. RISK ASSESSMENT MATRIX

The following risk assessment matrix is referenced in all risk elements throughout this book:

Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	High	High	Serious	Medium
Likely	High	Serious	Medium	Low
Remote	Serious	Medium	Low	Low
Improbable	Low	Low	Low	Low