

September 11, 2020

Mr. Brandon Roberts
Office of Rulemaking
Acting Designated Federal Official, Aviation Rulemaking Advisory Committee
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591

RE: Airman Certification System Working Group (ACSWG) Interim Recommendation Report

Dear Mr. Roberts,

On September 10, 2020, the Aviation Rulemaking Advisory Committee (ARAC) unanimously voted to accept the Interim Recommendation Report submitted by the Airman Certification System Working Group (ACSWG). This report includes the following: Draft Risk Management Handbook (FAA-H-8083-2) with Recommendations and Suggestions; and recommended new Airman Certification Standards Instrument Instructor – Powered Lift and Private Pilot – Airship.

On behalf of the ARAC members, please accept the ACSWG Interim Recommendation Report, submit to the relevant program offices and move forward to the establishment of a public docket.

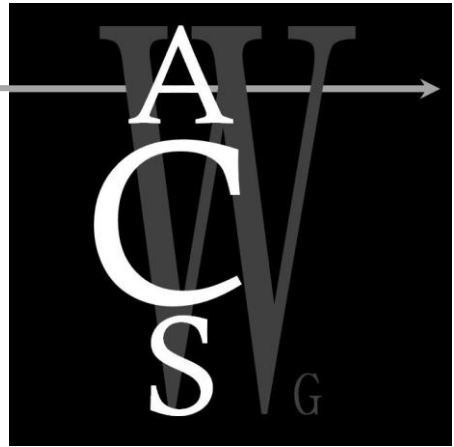
Please do not hesitate to contact me with any questions. Thank you very much.

Sincerely yours,

A handwritten signature in black ink, appearing to read 'Yvette A. Rose', with a stylized, flowing script.

Yvette A. Rose
ARAC Chair
202.293.1032
yrose@cargoair.org

cc: David Oord, ACSWG Chair



Aviation Rulemaking Advisory Committee

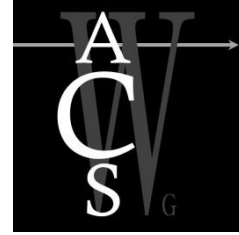
Airman Certification System
Working Group

Interim Recommendation Report

August 10, 2020

August 10, 2020

Yvette A. Rose
Chair, Aviation Rulemaking Advisory Committee
Federal Aviation Administration
800 Independence Avenue, SW
Washington, DC 20591



Dear Ms. Rose,

On behalf of the Airman Certification System Working Group (ACSWG), we submit the following interim recommendation report to the Aviation Rulemaking Advisory Committee (ARAC) for consideration.

The FAA and the aviation industry have continued its collaborative effort to improve airman training and testing throughout this difficult and unprecedented time. The result of that work adds to and continues to improve the new integrated, holistic airman certification system that not only aligns testing with the certification standards, guidance, and reference materials, but also maintains that alignment.

As part of its ongoing tasking, the ACSWG submits the following recommendations for (1) the Risk Management Handbook; (2) the Risk Management Handbook Subgroup recommendations and suggestions; (3) Powered-Lift Instrument Instructor Airman Certification Standard; and (4) Private Pilot – Airship Airman Certification Standard.

Representing the dedicated aviation professionals and members of the working group, we fully support the committee's transmittal of these recommendations to the FAA for further review, incorporation, and implementation. We are confident that, by doing so, the safety of aviation will continue to markedly improve.

Sincerely,

A handwritten signature in blue ink, appearing to read 'David Oord'.

David Oord
ACSWG Chair
Head of Regulatory Affairs Americas
Lilium

A handwritten signature in blue ink, appearing to read 'Susan Parson'.

Susan Parson
FAA Representative
Flight Standards Service
Federal Aviation Administration

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 - Airman Certification Standards

Risk Management Handbook

Draft

FAA-H-8083-2



Chapter 1: Introduction to Risk Management

Introduction

In the context of this handbook, risk management is the process of identifying, assessing, and mitigating the risks presented by aviation hazards. Risk is present in all human activities. Whether we are crossing the street, driving a car, or piloting or repairing an aircraft, we are exposing ourselves to risk. The hazards that create risk can be either obvious, like crossing the street in heavy traffic, or subtle, like failing to confirm you have selected a fuel tank that has fuel in it before takeoff.

For many human activities, such as crossing the street, managing risk can be a matter of applying common sense to address obvious hazards. For more complex activities, however, risk management can require more analysis and be less intuitive. Nevertheless, the art and science of risk management can be applied to aviation activities by following the principles and procedures that will be addressed in this handbook.

Purpose

This handbook has three main purposes:

1. To provide individuals holding any type of Federal Aviation Administration (FAA) airman certificate with a fundamental understanding of risk management principles.
2. To enable applicants for FAA airman certificates to demonstrate their ability to identify, assess, and mitigate risks during practical tests, as required by the applicable FAA certification standards.
3. To serve as a practical guide for risk management when planning and conducting flights in the National Airspace System (NAS).

Many members of the aviation community have been successful in other endeavors besides aviation. These individuals include business owners, technicians, and other professionals. Most of these individuals have had to manage risks in their business or profession. If you are one of these professionals, this handbook will help you apply familiar risk management concepts in an aviation environment. The procedures and techniques described will allow you to sharpen your risk management skills in different situations and settings that you are less familiar with than in your business or profession.

Users of this handbook should not expect it to substitute for appropriate training on risk management principles and procedures. Risk management is an important component of a larger set of skills known as Single-Pilot Resource Management (SRM). Other SRM skills include automation management, task and workload management, and situational awareness. Pilots should consider completing SRM training to ensure that they can operate safely and effectively in the NAS. Pilots who are members of multi-pilot crews should focus on Crew Resource Management (CRM) training. SRM is discussed more thoroughly in Chapter 6, Automation Management.

Risk Management in Aviation

Safety risk management is a core activity of safety management systems (SMS). SMS are encouraged within all segments of aviation: flight operations, airworthiness, manufacturing, airports, aerospace medicine, and airspace. The SMS discipline is defined as the application of special technical and managerial skills to the systematic, forward-looking identification and control of hazards throughout the life cycle of a project, program, or activity. The primary objective of SMS is accident prevention. SMS address risk management from an organizational perspective, where this Risk Management Handbook focuses on the individual airman. You can learn more about safety risk management and SMS from the [FAA safety risk management web page](#).

The FAA and its aviation community partners have determined that risk management proficiency is a crucial skill, which individual airman should demonstrate successfully during practical tests. Accordingly, the airman certification standards (ACS) for all certificates and ratings require applicants to demonstrate proficiency in identifying, assessing, and mitigating aviation risks. It is equally important for applicants to use risk management principles and procedures during actual operations in the NAS. This includes the practical ability to identify, assess, and mitigate risks when planning and conducting operational flights.

Effective risk management is one of the most important skills that a pilot should master to operate safely and avoid accidents. If we examine accident data, we can see that poor risk management is the root cause of many accidents and incidents.

Poor Risk Management and Accident Causality

Traditional Accident Investigation Taxonomy

Aviation accidents are investigated by both the National Transportation Safety Board (NTSB) and the FAA. The role of the NTSB is to determine the probable cause(s) of accidents and make recommendations, while the FAA seeks to determine if the accident revealed deficiencies in pilot training, aircraft certification, air traffic control, or another area of FAA responsibility. The two government entities are usually assisted by other interested parties, such as aircraft manufacturers, to determine the facts surrounding the accident and assign a probable cause.

The NTSB's role is illustrated by reviewing a typical accident report. The sidebar in *Figure 1-1* is an excerpt from an NTSB final report of a fatal accident involving a Mooney MO-20J that occurred in 1993.

National Transportation Safety Board
Aviation Accident Final Report

Location:
Date & Time:
Aircraft:
Defining Event:
Flight Conducted Under:

Analysis

DURING A FOUR HOUR IFR CROSS COUNTRY FLIGHT, IN CRUISE, THE ENGINE'S DRY AIR VACUUM PUMP FAILED. THE PILOT ELECTED TO CONTINUE TO HIS FINAL DESTINATION, ABOUT 180 MILES AWAY, NAVIGATING BY HIS LORAN. THE PILOT WAS NOTIFIED BY AIR TRAFFIC CONTROL PERSONNEL THAT IN ORDER TO CONTINUE TO HIS DESTINATION, IMC COULD NOT BE AVOIDED. THE PILOT STATED THAT IMC WAS NOT A PROBLEM AND HE CONTINUED THE FLIGHT. DURING A NO GYRO VECTOR APPROACH TO THE LOCALIZER IN IMC, AT AN ALTITUDE OF ABOUT 1,900 FEET MSL, THE PILOT BECAME SPATIALLY DISORIENTED AND LOST CONTROL OF THE AIRPLANE. THE AIRPLANE IMPACTED THE TERRAIN AND THE PILOT AND PASSENGER WERE FATALY INJURED. THE DRY AIR VACUUM PUMP WAS EXAMINED. THE EXAMINATION REVEALED THAT THE INPUT SHAFT OF THE PUMP WAS FACTURED PRIOR TO IMPACT.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: THE PILOT'S INADEQUATE IN FLIGHT PLANNING/DECISION TO CONTINUE FLIGHT INTO KNOWN ADVERSE WEATHER CONDITIONS AFTER THE ENGINE'S DRY AIR VACUUM PUMP FAILED AND THE PILOT'S FAILURE TO MAINTAIN AIRPLANE CONTROL DURING APPROACH. A FACTOR IN THE ACCIDENT WAS THE DRY AIR VACUUM PUMP FAILURE.

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Figure 1-1. Sample NTSB final report.

Key findings of the NTSB final report of the Mooney accident, highlighted here in yellow for emphasis, emphasized the pilot's loss of control of the aircraft and inadequate in-flight planning. These findings accurately described the final events of the flight leading to the loss of control. Accident analysis classifies accidents like this one as loss of control.

Root Cause Analysis and Poor Risk Management

The NTSB report on the Mooney accident accurately analyzes the accident facts to arrive at its probable cause finding. Yet, there is more we can learn about the root cause of the accident by examining the pilot's reaction to events during the flight. We can use the acronym PAVE to accomplish this. As shown in *Figure 1-2*, this acronym represents the risk areas relating to Pilot, Aircraft, enVironment, and External pressures. The use of this acronym will be discussed in more detail in Chapter 2, Identifying Hazards and Associated Risks.



Figure 1-2. The PAVE checklist

We can learn more about the Mooney pilot's decision making and risk management approach by reading the [full NTSB report](#) on this accident. From this report, we learn that the vacuum pump failed while the aircraft was in cruise in visual meteorological conditions (VMC), and the pilot reported this to air traffic control (ATC). Why did the pilot elect to continue to his destination rather than divert to an airport while he was still in VMC? The Mooney pilot was aware of the vacuum pump failure and the instrument meteorological conditions (IMC) ahead of him. This generated an aircraft, or "A," hazard because of the failed vacuum pump and a weather, or environment "V," hazard because of the IMC. The combination of those two hazards became unacceptable risks once the pilot decided to penetrate IMC weather. In addition, the pilot's understandable desire to get to his destination likely created an external pressure, or "E," hazard. Finally, the pilot's unwarranted assumption that the pilot could control the aircraft with inoperative attitude instruments created a pilot, or "P," hazard.

In Chapter 3, Assessing Risk, we will discuss how to assess the risk elements that a pilot identifies before and during flight. In the case of the Mooney pilot, a proper risk assessment would have shown that continuing the flight would generate catastrophic risk severity that had a high likelihood of occurring. Accordingly, proven risk management principles would have required the pilot to implement appropriate mitigations. Risk mitigation is discussed in more detail in Chapter 4, Mitigating Risk.

The Mooney pilot's most effective mitigation would have been to divert and land while still in VMC, yet the pilot did not do so. Why was the pilot unable or unwilling to practice effective risk management on this flight? There are several reasons why pilots do not effectively conduct risk management. Some of these relate to training and procedures, such as not having received risk management training, failing to continuously apply risk management, or inaccurately assessing the level of risk. It is also possible that varying levels of risk tolerance, or even intentional disregard of risk, may be a factor. Finally, it is understandable that pilots often desire to get as much use as they can from their aircraft and may intentionally or unintentionally expose themselves to high levels of risk. This may occur when operating the aircraft at or slightly exceeding its limitations in an attempt to maximize performance or utility.

The Mooney pilot could have changed the outcome of this flight if the pilot had chosen to *identify* the risks generated by the IMC weather and inoperative vacuum pump. The pilot would then be able to *assess* these risks to determine that they were unacceptable. Finally, the pilot would have been able to *mitigate* these risks by diverting to an airport while still in VMC. The rest of this handbook will emphasize this risk management process and supporting concepts and tools.

Chapter Summary

Poor risk management is a leading root cause of fatal accidents. Accordingly, pilots and operators should emphasize risk management in all types of operations, from recreational flying to using aircraft for transportation purposes. The risk management cycle requires pilots to identify, assess, and mitigate risks.

Chapter 2:

Identifying Hazards and Associated Risks

Introduction

Hazards versus Risks

As discussed in Chapter 1, Introduction to Risk Management, risk is always present in our lives. There are many hazards that could potentially affect us, yet they do not all become risks. For example, in Chapter 1, we described crossing a street in heavy traffic. The heavy traffic is a hazard, but it does not create a risk until we try to cross the street.

Hazard and Risk Defined

To clarify our discussion of hazard versus risk, let us define these two terms more precisely.

- Hazard – A present condition, event, object, or circumstance that could lead to or contribute to an unplanned or undesired event such as an accident.
- Risk – The future impact of a hazard that is not controlled or eliminated.

Risk can be broken down into different types. These are described in *Figure 2-1*.

Types of Risk	
Total Risk	The sum of identified and unidentified risks.
Identified Risk	Risk that has been determined through various analysis techniques. The first task of system safety is to identify, within practical limitations, all possible risks.
Unidentified Risk	Risk not yet identified. Some unidentified risks are subsequently identified when a mishap occurs. Some risk is never known.
Unacceptable Risk	Risk that cannot be tolerated by the managing activity. It is a subset of identified risk that must be eliminated or controlled.
Acceptable Risk	Acceptable risk is the part of identified risk that is allowed to persist without further engineering or management action. Making this decision is a difficult yet necessary responsibility of the managing activity. This decision is made with full knowledge that it is the user who is exposed to this risk.
Residual Risk	Residual risk is the risk remaining after system safety efforts have been fully employed. It is not necessarily the same as acceptable risk. Residual risk is the sum of acceptable risk and unidentified risk. This is the total risk passed on to the user.

Figure 2-1. *Types of risk identified.*

When Do Hazards Become Risks?

Aviation is a three-dimensional world where hazards abound in every risk area covered by the PAVE checklist. If these hazards are not controlled or eliminated, they will generate various levels of risk. Some will be unacceptable risks and a failure to mitigate them can result in aircraft accidents. This is illustrated in the following example.

Imagine that you regularly operate from the Elkins-Randolph County airport in Elkins, West Virginia (KEKN). This airport sits in a valley at an elevation of 1,987 feet. The terrain and obstacles on the east and west sides rise to as high as 3,631 feet. The images in *Figures 2-2* and *2-3* show a photograph and a sectional aeronautical chart excerpt of the Elkins airport.



Figure 2-2. Elkins, WV airport.

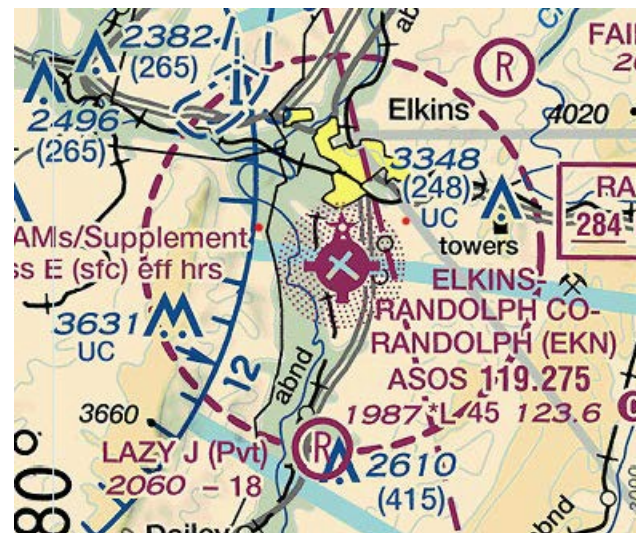


Figure 2-3. Sectional chart excerpt of Elkins, WV airport.

The mountains and the obstructions on both sides of the Elkins airport are hazards. However, on a day with good visibility, few clouds, and light winds, they will not pose a significant hazard to most aircraft engaged in visual flight rules (VFR) operations.

If we change the scenario to one of low ceiling, low visibility, and strong winds requiring a circling approach under instrument flight rules (IFR), and nighttime operation, we find that the risk analysis has vastly changed. In this situation, the risk of controlled flight into terrain (CFIT) or loss of control inflight (LOC-I) is vastly increased in terms of likelihood and severity. Accordingly, operation into Elkins under these conditions would require effective mitigations to reduce the risk. For example, the pilot would need to rigidly follow the instrument approach procedure, use available terrain avoidance equipment in the aircraft, and carry enough fuel for multiple alternate airports. Risk assessment and risk mitigation will be covered in more detail in Chapter 3, Assessing Risk and Chapter 4, Mitigating Risk, respectively.

Critical Aviation Hazards and Associated Risks

Ineffective risk management may be a factor in a significant number of aviation accidents. It is critical that pilots and other airmen use effective methods and tools to identify hazards and risks associated with accident causes. Compliance

with the Code of Federal Regulations (CFRs), by itself, does not ensure that all unacceptable risks are properly mitigated.

Leading Accident Causes Involving Aviation Hazards and Associated Risks

The aviation accident record has improved considerably in recent years, but the reduction in accident rates has not been uniform across the aviation community. For example, the accident rate for air carriers operating under Title 14 of the Code of Federal Regulations (14 CFR) Part 121 was reduced dramatically, falling nearly 80 percent in the ten-year period beginning in the mid-1990s. For general aviation aircraft operating under 14 CFR Part 91, however, the accident rate has not improved dramatically and, in the period from 2000 to 2019, has remained nearly static at about one fatal accident per 100,000 flight hours.

The FAA and the general aviation community have collaborated, through the General Aviation Joint Steering Committee (GAJSC), to analyze general aviation accidents and create safety enhancements that can mitigate leading accident causes. As part of this effort, the GAJSC analyzed hundreds of general aviation accidents and evaluated the causal factors in these accidents. The chart depicted in *Figure 2-4* summarizes the leading causes of general aviation fatal accidents during the period 2008-2018. The acronym CICTT stands for CAST/ICAO Common Taxonomy Team, which developed common taxonomies and definitions for aviation accident and incident reporting. CAST is the Commercial Aviation Safety Team, and ICAO is the International Civil Aviation Organization.

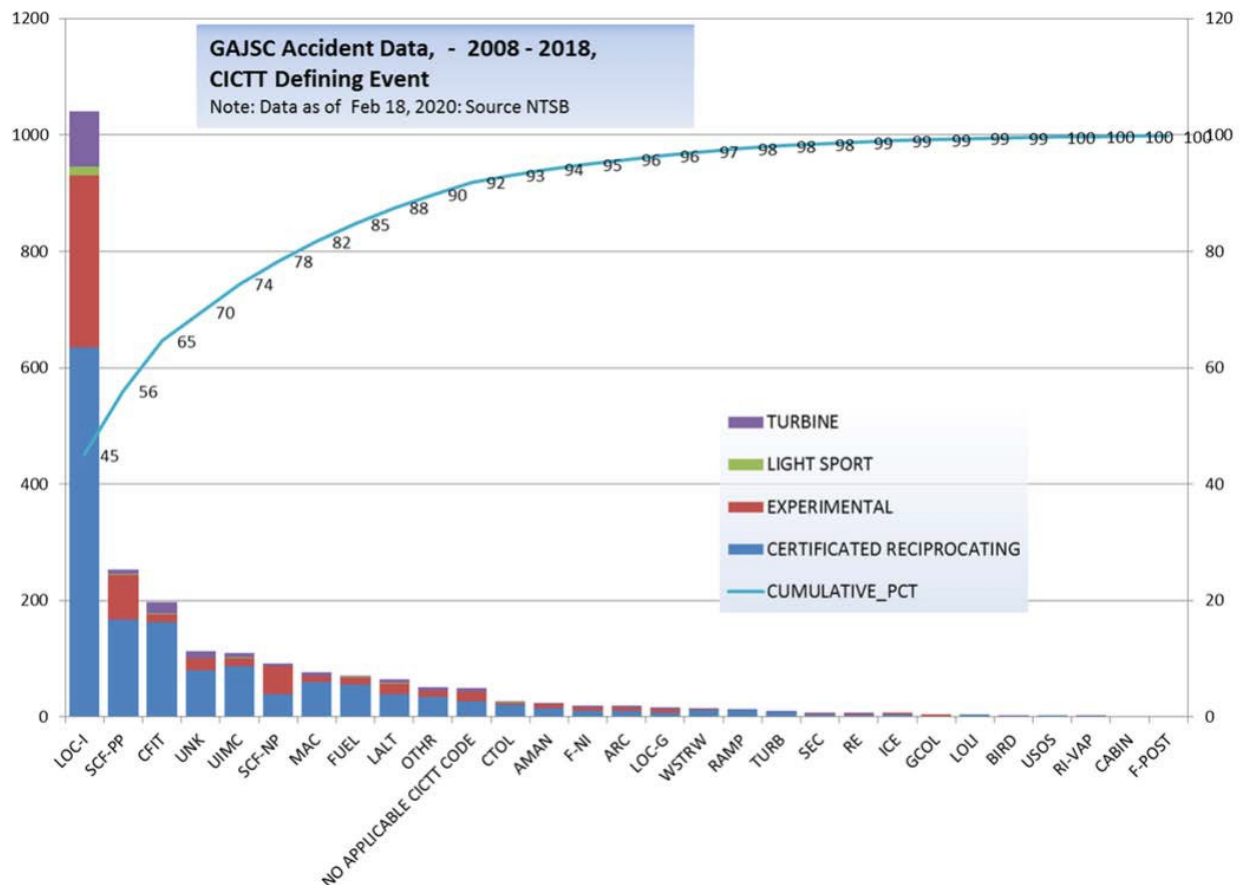


Figure 2-4. General aviation fatal accident analysis, 2008-2018.

The accident chart shows that nearly three out of four general aviation accidents are the result of just four defining events. These include loss of control inflight (LOC-I), controlled flight into terrain (CFIT), system component failure of the powerplant (SCF-PP), and fuel. It is important to remember that these defining events are usually the final event in the accident chain of events. A deeper analysis of many of these accidents often demonstrates that poor risk management may be a root cause.

How can we determine whether poor risk management is a root cause of an accident? If the pilot detected or should have detected the events in the accident chain but failed to identify, assess, and mitigate the risk associated with it, then we may reasonably conclude that poor risk management was the root cause of the accident. For example, ineffective fuel management is the fourth leading defining event in general aviation accidents. This includes fuel

exhaustion and fuel starvation. In many of these accidents, the pilot was or should have been able to detect whether there was sufficient fuel to conduct the flight, or in the case of fuel starvation, whether the selected fuel tank contained an adequate amount of fuel.

While the example of ineffective fuel management is relatively easy to understand, it is also apparent that root-cause analysis shows poor risk management is an underlying cause for many of the top three general aviation accident categories.

- ***Loss of Control Inflight (LOC-I)*** – This category of accidents includes those from a variety of underlying events, many of which occur because the pilot failed to identify risk. For example, loss of control scenarios include unauthorized low altitude operations, continued VFR into IMC, wake turbulence upsets, and loss of control following instrument failure, such as the Mooney accident described in Chapter 1.
- ***Controlled Flight into Terrain (CFIT)*** – These accidents have been largely eliminated in the air carrier community due to the mandatory use of terrain alerting and warning systems (TAWS), improved CRM, and revised flight procedures. However, CFIT accidents occur more often in general aviation operations. A CFIT accident can occur as a result of continued VFR into IMC, following improper procedures on an instrument approach, and as a result of other events. In most of these cases, readily identifiable terrain hazards were not identified by the pilot but could have been.
- ***System Component Failure Powerplant (SCF-PP)*** – This category includes a mixture of accidents, in some of which the pilot or operator could have identified hazards and related risks, while in others the hazard and risk could not have been readily detected. For example, the risk of a catastrophic crankshaft failure in an otherwise well-maintained, low-time, piston engine is often not readily identifiable. On the other hand, if the pilot is aware of progressive wear and tear from repetitive oil analysis and borescope inspection but fails to acknowledge the associated risk, then poor risk management should be considered a causal factor in an accident resulting from powerplant failure.

Methods and Tools for Identifying Hazards and Risks

There are several ways that pilots and other airmen can detect hazards and associated risks. Pilots should use all available methods and tools to detect hazards, such as those included in the following examples:

- ***Visual Observation*** – A pilot's observations provide a primary means of identifying hazards and associated risks. For example, thunderstorm avoidance is most effective when a pilot can visually observe them and separate the aircraft a safe distance from them.
- ***Pre-flight Planning*** – Many hazards can be detected by thorough pre-flight planning, including complete weather briefings, aircraft performance calculations, pre-flight inspections, and other routine procedures.
- ***Aircraft and Portable Equipment*** – The introduction of new panel-mount and portable avionics has vastly improved situational awareness in many general aviation aircraft. Technologies such as datalink weather, moving map navigation, and other new technologies enable pilots to more easily detect hazards.
- ***Radio Communication*** – Voice radio is still an effective means for identifying hazards inflight. Communication with air traffic controllers and flight service specialists can provide pilots with information on weather, air traffic, airspace, and other hazards.
- ***Post-flight Inspections*** – Inspecting and securing the aircraft following the completion of a flight can help a pilot identify any hazard and risk before the next person flies that same aircraft. Common items include condition of tires and brakes, security of access panels and latches, and leaking operating fluids. Properly securing the aircraft can prevent damage if inclement weather approaches.

CFRs and Risk Identification

Some pilots may assume that complying with all CFRs will ensure they are operating safely and minimizing risk. This assumption is not correct. A person can comply with all applicable regulations and still conduct unsafe operations. Regulatory compliance is a necessary but insufficient means of ensuring safe operation. The regulations are a set of minimum standards that provide a "floor" beneath which pilots should never operate. However, staying above that floor does not ensure that all risks are effectively managed. For example, suppose you are contemplating a 200 nautical mile night VFR flight between two non-towered airports, both of which are reporting a ceiling of 1,200 feet overcast and three miles visibility. The conditions between these two airports are similar and the terrain between them is variable and over sparsely populated terrain with few lights on the ground. Although these weather conditions are

“legal” for VFR operation, conducting this flight under VFR might pose unacceptable risks. These could include a high potential for a LOC-I or CFIT accident.

Using the PAVE Checklist for Identifying Risk

As described in Chapter 1, the PAVE checklist is an effective means for identifying risk. Its four areas capture the broad areas of risk and provide pilots and other aviation personnel with convenient risk “buckets.” The following inventory of risk areas using this checklist, while comprehensive, does not necessarily include all potential risk areas.

Pilot Hazards and Risk Sources

Pilot-related risks may be organized into two broad types: capability and aeromedical.

- **Capability** – This risk type has three elements.

Qualification – The most basic measure of capability is whether the pilot possesses the appropriate pilot certificate and category, class, and type ratings needed to operate a specific aircraft under a given set of conditions. While this basic requirement may seem obvious, there are repeated accidents in which the pilot did not possess the required certificate and ratings. For example, some accidents have occurred when pilots have attempted to operate under IFR without holding an instrument rating. A few accidents occur every year when the pilot did not possess any airman certificate.

Currency – The second measure of capability relates to whether the pilot complies with the minimum currency requirements specified in 14 CFR Part 61. These include minimum numbers of takeoffs and landings and instrument approaches, flight reviews, and other required currency events. These requirements only represent minimum levels of currency. Compliance with these events may not be enough to address certain combinations of hazards and associated risks.

Proficiency – The third measure of capability more effectively addresses risk. For any given flight, the level of proficiency required to safely accomplish the flight may exceed the legal currency that the pilot has accomplished. For example, suppose you are planning a 600 nautical mile IFR flight in low IMC. You are required, under Part 61, to have accomplished six instrument approaches, holding, and tracking within the previous six calendar months to be IFR current. However, if these currency events occurred five months ago, you may not be proficient to undertake what could be a difficult flight in low IMC. You might want to fly with an instructor in IMC or simulated IMC before your planned flight to ensure you are proficient.

- **Aeromedical** – This type includes several factors related to a pilot’s physical and emotional health. They may be represented by using the IMSAFE checklist, which is an acronym for Illness, Medication, Stress, Alcohol, Fatigue, and Emotion. [Figure 2- 5]

Illness – You may be suffering from an illness, seeing initial symptoms, or suffering from the aftereffects. These effects may be sufficiently debilitating to create a hazard and an associated risk.

Medication – Both prescription and non-prescription over-the-counter (OTC) drugs have side effects that can affect physical and mental performance.

Stress – Many business and personal events and activities can cause stress, creating distractions that affect piloting performance.

Alcohol – The CFRs governing alcohol use are straightforward. They include a time limit (no consumption within eight hours before a flight), a quantity limit (blood alcohol must be below 0.04 percent), and a performance limit (prohibited while under the influence of alcohol). The last criteria may be the most insidious because you could be experiencing aftereffects of alcohol consumption (dehydration, headaches, etc.) for some time after its consumption, perhaps for longer than eight hours.

Fatigue – You may experience fatigue if you receive insufficient sleep. In addition, you will also be subject to fatigue during a long flight, increasing as the flight lengthens. Fatigue can be magnified by a failure to use supplemental oxygen in a non-pressurized aircraft during flights above 10,000 feet. This threshold may be lower at night or if you have underlying health concerns. For example, while it is legal under current regulations to undertake a nighttime five-hour westbound flight under VFR at 12,500 feet without using supplemental oxygen, such a flight would likely create an aeromedical hazard because of hypoxia reducing piloting performance.

Emotion – It is always a good idea to separate your emotions from the mental tasks needed to undertake even simple flights. An emotional event before your flight can be a distraction and negatively impact piloting performance.



Figure 2-5. IMSAFE checklist.

Aircraft Hazards and Risk Sources

Although aircraft-related factors are not the most common events in many accidents, a failure by the pilot and mechanic to account for aircraft hazards and associated risks can easily lead to an accident.

- **Performance** – Even a perfectly functioning aircraft can create hazards and associated risks if its performance is not adequate to accomplish a given task. Typically, the pilot will need to consider multiple interrelated performance factors in identifying performance hazards and risks.

Fuel and Range – As previously described, fuel exhaustion and fuel starvation continue to be leading causes of general aviation accidents. For example, planning a flight to the aircraft's maximum range can create a risk due to inaccurate calculations, changing conditions, or the aircraft's failure to achieve "book" speeds and fuel consumption. In this case, it would be prudent to plan a mid-point refueling stop.

Takeoff and Landing Performance – Each flight rarely duplicates exactly the aircraft performance on a previous flight. Variations in temperature, aircraft loading, runway conditions, wind, and other factors will affect takeoff and landing performance. Hazards and associated risks are created when the calculated performance approaches the available runway length. For example, if you are planning to takeoff from a 2,000-foot runway and your calculated takeoff distance is 1,950 feet, you might consider a mitigating strategy. This could include a reduced fuel load or taking off when temperature and wind conditions are more favorable.

Altitude Performance – If you operate to or from high altitude airports, or operate in cruise at high altitudes, your aircraft may approach its performance ceiling, especially if it is normally aspirated piston engine-powered. This could create a hazard and an associated risk if, for example, you were trying to get on top of clouds to avoid icing conditions. Let's say your aircraft has a published rate of climb at sea level of about 700 feet per minute at 20°C. Cruising near the freezing level at about 10,000 feet, however, the maximum climb rate is only about 300 feet per minute and may be further reduced if any ice accumulation is present.

Payload – Most aircraft are a compromise among various performance limits. If you are trying to carry the maximum number of passengers and baggage, you may have to limit your fuel load. This could create a

hazard and an associated risk if, for example, you are planning a long flight under IFR and your restricted fuel load limits your selection of alternate airports.

Weight and Balance – Regardless of the amount of payload or fuel load on the aircraft, operating near maximum takeoff weight or near center of gravity limits is a concern. The hazards and associated risks with such loading conditions include difficulty trimming and controlling the aircraft, which could lead to a loss of control in flight.

- **Equipage** – The avionics and other equipment installed in an aircraft greatly affects both its utility and its impact on risk management.

Redundancy – The need for redundant equipage can vary depending on the type of flight contemplated. For example, on a day VFR flight in Class E airspace, having only a single navigation/communication radio may not generate a major hazard were it to fail unexpectedly. However, if the flight proposed is under IFR with low IMC throughout the route, having a potential single-point failure in the radios would create a major hazard and potential risk.

Autopilot – Autopilots should be considered a key safety feature on an aircraft. However, if a pilot does not stay proficient in autopilot use or becomes overly dependent on it, hazards and associated risks can be created. On the other hand, operating a high-performance aircraft in IMC without an operative autopilot greatly increases pilot fatigue, with an associated hazard and risk of loss of control.

Inoperative Equipment – Installed equipment can only be useful if it is operating as designed. Inoperative equipment can create hazards and associated risks. For example, with an inoperative landing light, it may not be advisable to conduct night operations, even though a landing light is not required for Part 91 operations when not for hire.

Environmental Hazards and Risk Sources

The environment is perhaps the greatest source of hazards and associated risks. Factors such as weather, terrain, airports, airspace, time of day, and other factors can create significant hazards that can generate high risk levels.

- **Weather** – Of all the environmental hazards, weather is the least predictable and most likely to generate high-risk levels. Recent improvements in aviation weather forecasting tools and flight deck technologies have made it easier to identify weather hazards and associated risks.

Thunderstorms and Convective Activity – Thunderstorms and their associated weather systems represent a severe hazard to all aviation activities. Severe turbulence, hail, and other phenomena can create the potential for risk from loss of control and even result in structural failure of the aircraft. Attempting to penetrate a line of thunderstorms or “pick your way through” such a line represents a very high level of risk. Aggressive mitigation strategies should be used to avoid convective activity altogether.

Icing – Airframe and powerplant icing, both on the ground and in flight, constitutes a major hazard for aircraft that are not certificated for flight in known icing conditions. Even aircraft certificated for flight in known icing are not designed for sustained flight in severe icing. Airframe icing contamination on the ground can be just as hazardous. Inflight icing on aircraft not certificated for flight in known icing conditions has resulted in loss of control. Carburetor icing is also a significant hazard for aircraft so equipped.

Low Ceilings and Visibility – For pilots and aircraft certificated only for VFR conditions, low ceilings and visibility represent a major hazard. The typical leading proximate event for accidents in this type is “continued VFR flight into IMC.” If pilots do not effectively assess and mitigate this risk, a loss of control or controlled flight into terrain becomes the defining event in the accident chain.

Turbulence and Winds – Inflight turbulence can be either a nuisance or a major hazard with an associated risk. Severe turbulence, although not common, can result in loss of control and even aircraft structural failure. Such turbulence is more common in mountainous areas in the presence of strong winds. Surface winds can constitute a hazard with an associated risk. For example, a strong crosswind that exceeds an aircraft’s demonstrated maximum crosswind component or the pilot’s personal minimum can result in loss of control on the ground (LOC-G).

- **Terrain** – Various kinds of terrain and surface features can represent major hazards with the potential for

generating high risk. CFIT continues to be a prominent factor in general aviation accidents.

Mountains, Hills, and Elevated Terrain – Mountainous terrain generates numerous hazards and affects departure, en route, and arrival operations. Numerous airports in the western United States require the use of special procedures, sometimes even in VMC.

Density Altitude – The combination of high temperature and high elevation airports can create major hazards, especially during takeoffs from airports with high-density altitudes in normally aspirated piston-engine aircraft.

Overwater Operation – Flight over water creates its own set of hazards. For example, takeoff at night over a large body of water can create a “black hole” effect and require the pilot to immediately shift to control by instruments.

Obstructions – Buildings, towers, and other obstacles can create major hazards for aircraft operating at lower altitudes, especially in marginal VFR conditions, at night, and in urban areas.

- **Airport** – Various hazards can be generated by airport operations and these can be aggravated by other environmental factors.

Runway Length – Ensuring adequate runway length for departure and landing is a fundamental risk management task. However, many pilots repeatedly do not adequately identify the hazards and associated risks inherent in operations from marginal-length runways. These include the need to account for pressure altitude, temperature, aircraft weight, wind, runway slope, runway surface (paved or not), and obstacle clearance flight path. Even if the runway length calculations show that the takeoff or landing can be performed on the available runway length under the given conditions, many pilots do not incorporate any additional performance margin or apply any personal minimums.

Approach Aids and Lighting – Trying to operate from an airport without adequate approach aids and lighting for the conditions can create major hazards and associated risks. This is especially true during IMC and night operations.

Runway Contamination – Wet or snow-covered runways can create major hazards. Some aircraft flight manuals (AFM) provide little or no guidance on how to modify takeoff and landing distances for contamination.

- **Airspace, Air Traffic Control, and Other Aircraft** – Generally speaking, airspace designations and ATC services are designed to facilitate safer operations and generally perform this function efficiently. However, under some circumstances, the presence or absence of these services can create hazards.

Prohibited and Restricted Airspace – Each of the numerous types of airspace designations have specific purposes and a failure to comply with the restrictions associated with each category can create hazards and associated risks. For example, entering a prohibited or restricted area without clearance can result in conflicts with military aircraft.

ATC Delays and Service Availability – Regulations required the pilot to become familiar with known traffic delays when planning an IFR flight. This increases the likelihood of holding, route changes, or other en route delays. A lack of adequate fuel for delays becomes the primary risk. The unavailability of ATC services can, for example, prevent pilots from obtaining flight following services, thereby increasing the probability of conflict with other air traffic.

Air Traffic Density and Collision Hazards – Pilots are responsible for seeing and avoiding other aircraft when flying under VFR or in VMC while flying under IFR. However, under certain conditions, it is extraordinarily difficult to see other aircraft because of haze, aircraft positions in relation to each other, and other factors.

- **Night Operation** – During night operations, the effects of hazards and associated risks are greatly magnified.

VFR Operations – Visual operations are often hampered by visibility restrictions at night. This restricts a pilot's ability to see and avoid terrain and obstacles, other aircraft, precipitation, and other hazards.

Single-engine Operations – Aircraft engines have become more reliable over the years, but failures can still occur. Engine-out landing options may be more difficult to discern at night. In addition, the failure of engine accessories, such as alternators, can create major hazards, especially in IMC.

External Pressure Hazards and Risk Sources

External pressures are perhaps the most insidious and difficult to address and will easily create hazards and associated risks that might not otherwise be present. Pilots experiencing these pressures may then expose themselves to the other three major categories of hazards and risks. External pressures can emanate from a variety of personal and business sources. The pressure to get to important events or undertake special flights can be very powerful and, if not effectively assessed and mitigated, puts additional pressure on the pilot to begin or continue a flight in hazardous conditions or circumstances that generate a high risk level.

- **Personal** – External pressures can be generated from a variety of personal circumstances. Examples may include trying to travel to a family celebration, trying to travel to see a terminally ill relative, or some similar high priority personal event. It could also include pressures generated during the flight itself, such as a sick passenger. External pressure can also be generated by a promise to fly some friends on a local scenic flight and then finding that marginal weather conditions would make the flight hazardous on the day everyone has planned.
- **Business** – Using a general aviation aircraft for business travel can be a very efficient way of conducting business. If you are a business or other professional, it is likely that you will often experience time pressures or deadlines that require you to commit to being somewhere at an exact time. These kinds of circumstances can place enormous pressure on the business pilot to conduct the “mission” on time, regardless of the hazards and associated risks present. These pressures are magnified when your boss and other company staff are riding with you.

Creating a Risk Inventory for Flight Planning

Identifying hazards and associated risks often requires careful analysis and comparisons. For most flights, especially complex ones, it is desirable to inventory the hazards and risks as you identify them during pre-flight planning. For this purpose, a convenient means to record and resolve such hazards is to use a Flight Risk Assessment Tool (FRAT).

Identifying Hazards and Risks during Preflight Planning

Traditional pre-flight planning usually includes such tasks as checking weather and Notices to Airmen (NOTAMS), determining the route and calculating performance, and inspecting the aircraft. Typically, these tasks are done on the day of the flight or perhaps the day before.

Risk analysis for some complex multi-stop or multi-day trips should begin days earlier. For example, if you are planning to use your aircraft for a two-week business itinerary with ten stops, you might begin your risk analysis two weeks ahead of the planned trip. You might want to identify potential hazards such as inoperative avionics or an upcoming inspection on the aircraft. Am I out of currency or not as proficient as I should be? Does the long-range weather forecast indicate a system moving in with icing conditions? Should I plan on booking backup airline reservations to reduce the external pressures in case we cannot fly our company aircraft?

Using a Flight Risk Assessment Tool (FRAT)

A convenient way to inventory the hazards and risks that you identify is to record and analyze them with a FRAT. There are a variety of FRATs available and they come in two general types for risk analysis.

- **Numerical FRATs** – These tools provide a fixed list of potential hazards and a “score” to indicate the severity of the hazard. When all the hazard scores are totaled, a final score is derived. Typically, the interpretation section of this FRAT provides three ranges for the final score. If it is below a certain minimum, the FRAT advises it is alright to begin the flight. If it is in an intermediate range, the pilot is advised to seek outside advice or “exercise caution.” If the score is above an upper threshold, the pilot might be advised not to depart.

While this type of FRAT is easy to use, it has several drawbacks, including:

1. The hazards listed may not provide a comprehensive inventory of hazards for any particular flight.

2. The score levels for each threshold may seem arbitrary, thus encouraging a pilot to ignore the resulting conclusion.
 3. This FRAT does not encourage the pilot to delve deeper into each hazard identified. For example, what is the likelihood of the threat and what is the potential severity?
 4. A “go” recommendation may be ill-advised even if the score is low if one of the remaining threats is likely to occur and generate severe consequences.
- **Narrative FRATs** – This type of FRAT is less common and requires the user to identify all potential hazards represented in the entire PAVE checklist, to describe the risk associated with the hazards, to assess each risk in terms of likelihood and severity, and to mitigate those risks that are unacceptable. While taking a little more time to complete, it addresses many of the disadvantages of numerical FRATs.

An example of a narrative FRAT is one contained in the Risk Management Guide for Single-Pilot Light Business Aircraft developed by the National Business Aviation Association (NBAA). Although this guide was developed for business aircraft, it can be effectively used for any aircraft operation. The FRAT contained in the NBAA guide organizes hazards and risks around the PAVE checklist and, in consecutive columns, provides space to assess the risks of each hazard in terms of likelihood and severity. [Figure 2-6] This is then converted into an overall risk level for each risk by using the risk assessment matrix on the back of the FRAT. Finally, the pilot should mitigate those risks that are unacceptable as defined in the FRAT. The rest of the NBAA guide includes some background information on risk management and a case study that is built around the FRAT.

FLIGHT RISK ASSESSMENT TOOL WORKSHEET					
Three step process: IDENTIFY, ASSESS, MITIGATE.					
Conduct before departure and in flight.					
STEP 1: IDENTIFY THE RISKS (Complete second column below)					
RISK CATEGORY	HAZARD & RISK	LIKELIHOOD (Probability)	SEVERITY (Consequences)	OVERALL RISK LEVEL (Color)	MITIGATION/NEW RISK RED - MUST Mitigate YELLOW - SHOULD Mitigate GREEN - ACCEPT No Unnecessary Risk
PILOT					
Qualification / Currency / Proficiency					
Aeromedical / Human Factors					
AIRCRAFT					
Fuel / Range / Payload					
Equipage (Incl. Inoperative Equipment)					
Performance					
ENVIRONMENT					
Weather					
Airspace / ATC / Airports					
Terrain / Day vs. Night					
EXTERNAL PRESSURES					
Work-related and Personal					

Other Data:

Figure 2-6. Example Flight Risk Assessment Tool.

Risk Identification during Flight

A FRAT provides an excellent way to perform a comprehensive risk analysis before the flight. As a pilot becomes more familiar with its use, he or she will become more familiar with the flow of the risk management process—identify, assess, and mitigate. At some point, this can produce enough expertise that will allow a pilot to conduct risk

analysis for less complex flights without the use of a FRAT. Moreover, the FRAT may not be an ideal tool for conducting ongoing risk management during the flight. Its use in the flight deck can be cumbersome and even introduce an unnecessary distraction. Instead, it might be more useful to use a less structured model for inflight risk management.

Using the 3P Model

The 3P model describes the closed-loop process of Perceive, Process, Perform. [Figure 2-7] This process can be used in flight as a comparable process to the risk management cycle of identify, assess, mitigate.



Figure 2-7. The 3P model.

The 3P model can be used to manage inflight risks. A pilot may perceive hazards and risk through several means, as we have previously described. For example, a pilot may *perceive* that the line of thunderstorms on the weather data link display has appeared earlier than forecast and is now moving to block the planned route. The pilot might then *process* this information by concluding that there is a high likelihood it would affect the aircraft if continuing and penetrating the line of storms and that the consequences could be severe. Accordingly, the pilot would *perform* the necessary actions to mitigate this risk by deviating around the convective activity. The pilot would continue to repeat this closed-loop process to monitor progress on the route deviation and to monitor other threats. This simplified model thus accomplishes all the elements of the identify, assess, and mitigate cycle.

Case Study

Background

Perhaps the best way to understand the risk management process is to put it in a real-world context using a case study. The following example will be used in this chapter, as well as Chapters 3 and 4, to illustrate the process for identifying, assessing, and mitigating risk.

Setting

It is Friday, July 1, and you just finished a successful week of consulting for clients in Boise, Oklahoma City, Dallas, and Albuquerque. You flew to these locations from your home base in Santa Rosa, California (KSTS) using your 1990 Mooney M20J. You were planning to return directly to Santa Rosa, but on Thursday evening, your neighbors in Santa Rosa, John and Mary Smith, invited you to spend the weekend with them in Durango, Colorado where they have a condominium. You gladly accepted their invitation because Durango is almost directly on your return route to KSTS.

The flight to Durango from Albuquerque was smooth and without any significant problems. You landed at the Animas Airpark (00C), rather than the Durango-La Plata County Airport (KDRO) because the Smith's condo was less than a mile from 00C, towards town. Figure 2-8 shows a sectional chart excerpt from the Durango area.



Figure 2-8. Aeronautical data for Durango, CO area.

You and the Smiths have enjoyed the weekend, with rafting, cycling, and hiking as featured activities along with plenty of wine drinking and temperatures in the low 90s. The Smiths were well-established in the Durango social scene and the three of you went to parties on Friday and Saturday night, with another one scheduled today, Sunday, that is likely to last until the wee hours. Finally, tomorrow, Monday, July 4, there is to be a huge Independence Day celebration in which the Smiths have been asked to help officiate.

It is now late afternoon on Sunday. You and the Smiths are back in their condo drinking wine and discussing the weekend. Coincidentally, both you and Mary Smith just received urgent e-mails from your separate home offices in Santa Rosa, CA alerting you to critical pop-up meetings that are scheduled for Tuesday afternoon, yours at 4 pm and Mary's at 3 pm. John and Mary had bought one-way airline tickets to Durango and were originally planning to return to Santa Rosa sometime late in the week. John just got off the phone and, with a worried look, announced that there were no airline seats available until Wednesday, at the earliest.

Mary Smith then asks, "Would you be willing to fly us home in your Mooney on Tuesday morning?" This would allow all three to enjoy the Monday celebrations and the party Monday night before taking off early on Tuesday to make the afternoon meetings just in time. You replied that you would need to review the weather and do some other planning first and suggested that everybody meet again on the deck in a couple of hours.

You go back to your room and begin your analysis. First, you look at the route that you might take home. Originally, you were planning a direct VFR flight back to Santa Rosa, a nonstop flight of 711 nautical miles, as depicted in the sectional chart excerpt on Figure 2-9.

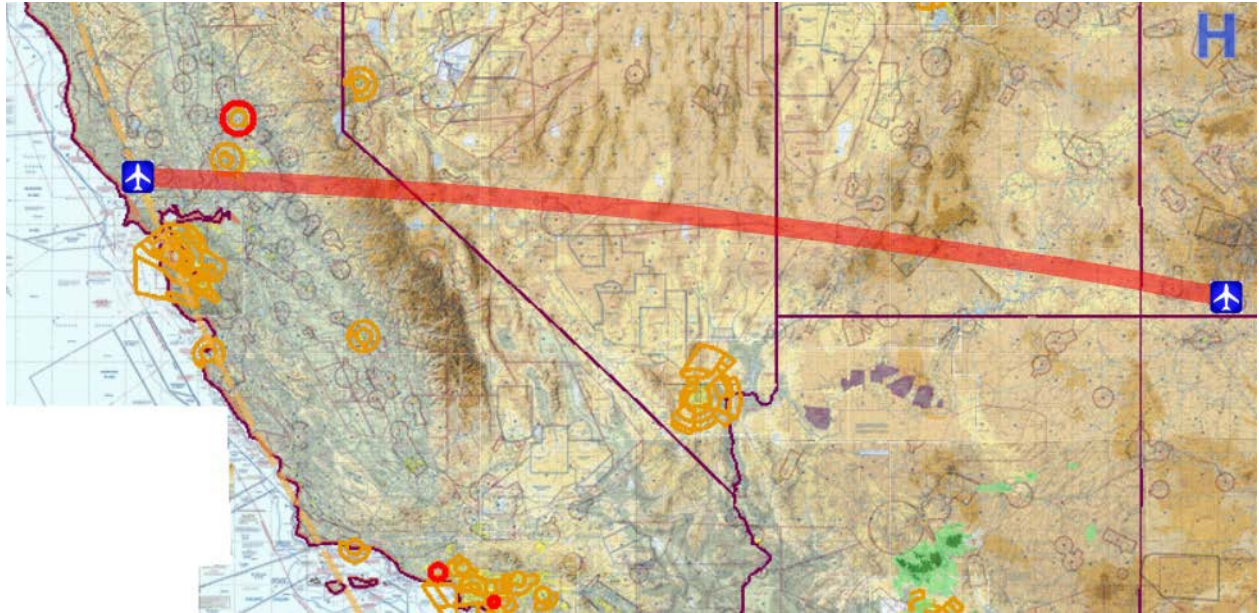


Figure 2-9. *The direct route from Durango to Santa Rosa.*

You made a quick analysis that you could fly this trip nonstop in just under five hours, with 6:45 of endurance with full tanks of 64 gallons. You then get online to evaluate the weather situation and immediately foresee some challenges.

A low-pressure system with a trailing cold front in southern Idaho has moved south into Nevada, Utah, and northwest Colorado. The front is triggering severe convective activity as it collides with warm air and monsoonal moisture in the southwest. Behind the front, the wraparound moisture from the low is creating low ceilings and poor visibility, with mountain obscuration and icing in clouds above 8,000 feet. The weather in Durango is forecast to remain good VFR on Monday morning, with rapid deterioration as the weather system slowly moves southeast. By Tuesday morning, IMC is expected in Durango.

You mull over other factors that might affect your flight and decide to use the recent materials you obtained to conduct a risk analysis for your flight using a FRAT.

Data

The following supplementary data is needed to perform a risk analysis for this scenario.

- ***Pilot and Passenger Data***
 - Current under Part 61 for VFR and IFR
 - Last instrument time logged four months ago
 - Your weight 170 pounds, the Smiths weigh 300 pounds together
 - You have 40 pounds of baggage, the Smiths have 80 pounds
- ***Aircraft***
 - Not certificated for flight in known icing conditions
 - Empty weight: 1903 pounds, Maximum gross weight 2,740 pounds
 - Luggage compartment carries 120 pounds
 - Full fuel 64 gallons (384 pounds), current fuel 25 gallons (150 pounds)
 - Average fuel consumption at 10,000 feet: 8.6 gallons per hour
 - Average true airspeed at 10,000 feet: 152 knots
 - Calculated takeoff distances at 25° C, 6,700 feet pressure altitude, no wind
 - At 2,740 pounds: 4,700 feet over a 50-foot obstacle
 - At 2,500 pounds: 3,600 feet over a 50-foot obstacle
- ***Environment (in addition to weather data in the case study setting section)***
 - Temperatures at 00C: 25° C morning, 35° C afternoons, calm winds
 - California weather forecast: Good VFR except morning fog on the coast
 - Arizona weather forecast: Good VFR weather on Monday, marginal VFR Tuesday

Risk Identification Analysis

You decide to begin your risk analysis by identifying the potential hazards and associated risks for the flight to Santa Rosa, using the PAVE checklist.

- ***Pilot***

You are IFR current, but probably not as proficient as you would like because it has been four months since your last proficiency event. This hazard could increase the risk of loss of control in IMC.

You have been drinking moderately since arriving in Durango and would probably still be affected after departing early on Tuesday. This could be magnified by the altitude and result in dehydration. This hazard could increase the risk of making errors.

You have been going to bed late and getting up early in Durango. This fatigue hazard could increase the risk of making errors.

- ***Aircraft***

You are concerned about the takeoff from 00C airport at gross weight, considering the runway length. This potential hazard could create a risk for an overrun or stall after takeoff. Your personal minimum is a runway length that includes a 20 percent additional margin over calculated takeoff distance.

You are concerned about the range/payload tradeoff for the Mooney. This could induce a hazard if you attempt to stretch the range and increase the risk of fuel exhaustion.

- ***Environment***

The weather system in Nevada and Utah is the main environmental hazard affecting the flight to Santa Rosa. The presence of both convection and icing could increase the risk of loss of control or, if attempting to stay underneath the clouds in VFR, the risk of CFIT.

The high, rough terrain throughout the intermountain west represents a hazard on most routes to Santa Rosa. This requires relatively high cruising altitudes which may approach the performance limits of the Mooney.

- ***External pressures***

The deadlines created by the required meetings back in Santa Rosa on Tuesday generate external pressures from both the Smiths as well as you. In addition, the external pressures on the Smiths to be present in Durango on Monday create a hazard by narrowing the departure window to Tuesday morning only. If these pressures are not mitigated, a forced departure on Tuesday morning would generate other risks from the pilot, aircraft, and environmental factors.

As you tally up the hazards and associated risks for your planned flight to Santa Rosa, you record them on the FRAT, as shown in *Figure 2-10*. You must then assess these risks in terms of their likelihood and severity. You strive to complete the risk analysis so you can return and discuss the situation with the Smiths.

The risk assessment and mitigation for this case study will be continued in Chapters 3 and 4, respectively.

FLIGHT RISK ASSESSMENT TOOL WORKSHEET

Three step process: **IDENTIFY, ASSESS, MITIGATE.**

Conduct before departure and in flight.

STEP 1: IDENTIFY THE RISKS (Complete second column below)

RISK CATEGORY	HAZARD & RISK	LIKELIHOOD (Probability)	SEVERITY (Consequences)	OVERALL RISK LEVEL (Color)	MITIGATION/NEW RISK RED - MUST Mitigate YELLOW - SHOULD Mitigate GREEN - ACCEPT No Unnecessary Risk
PILOT					
Qualification / Currency / Proficiency	Not IFR proficient: Loss of control possible.				
Aeromedical / Human Factors	Alcohol and lack of sleep: error potential.				
AIRCRAFT					
Fuel / Range / Payload	Cannot carry full fuel: potential fuel exhaustion.				
Equipage (Incl. Inoperative Equipment)	Not certified for known ice: loss of control potential.				
Performance	Marginal takeoff performance: loss of control potential.				
ENVIRONMENT					
Weather	Thunderstorms, icing, low ceilings: LOC and CFIT potential.				
Airspace / ATC / Airports	Marginal runway length: potential overrun.				
Terrain / Day vs. Night	High terrain: potential for CFIT.				
EXTERNAL PRESSURES					
Work-related and Personal	Meeting deadlines for everyone: increased risk in all other categories.				

Other Data:

Figure 2-10. Case study FRAT with risks identified.

Chapter Summary

Aeronautical hazards abound in the four major areas representing Pilot, Aircraft, enVironment, and External pressures. These hazards are often associated with risks, which the pilot should identify before the risks can be assessed and mitigated. Poor risk management may be a root cause of many general aviation accidents. Pilots can use a variety of means to detect hazards and associated risks, and tools are available to enhance this analysis.

Chapter 3: Assessing Risk

Introduction

Once hazards and their associated risks have been identified, they should be assessed to determine the overall risk level presented by each hazard. This process should start before the flight and continue progressively as the flight continues. An accurate risk assessment is needed to determine which of the identified risks are severe enough to require mitigation. While risk assessment may seem subjective at first, pilots can achieve proficiency by using risk assessment tools and through practice.

Risk Assessment Process

Preflight

Once risks have been identified during preflight planning, each one should be assessed in terms of its *likelihood* (probability) and *severity* (consequences). This can be accomplished in several ways, with a risk assessment matrix being the most common tool for this purpose.

Risk Assessment Components

Defining the total risk for each hazard is the sum of the combined effects of the risk likelihood and severity. Both risk likelihood and severity can be defined by progressive levels of each of these parameters. The following guidelines define these levels.

Risk Likelihood

- Probable – An event may occur several times.
- Occasional – An event may occur sometime.
- Remote – An event is unlikely to occur but is possible.
- Improbable – An event is highly unlikely to occur.

To illustrate risk likelihood levels, consider the situation of encountering a level 6 cell when trying to penetrate a line of thunderstorms and subsequently losing control. It is likely that the airframe's structural limits could be exceeded each time this occurs, making this hazard and an associated risk "probable."

As another example, consider a case where a pilot operates regularly into an airport with marginal runway length and unforested but rough terrain off every runway end that is just long enough to provide landing distance within calculated flight manual distances. This hazard could generate a risk of a runway overrun on landing. Given this data, you would probably label the likelihood of an overrun as "occasional," that is, it may occur sometime.

Risk Severity

- Catastrophic – Results in fatalities and/or total airframe loss.
- Critical – Severe injury or major airframe or property damage.
- Marginal – Minor injury or minor airframe or property damage.
- Negligible – Less than minor injury or damage.

To illustrate risk severity levels, consider the example above of penetrating a thunderstorm. A loss of control event exceeding airframe structural limits may, in most cases, result in either severe injuries or fatalities and airframe loss, creating either a "critical" or a "catastrophic" event.

In the other example of the marginal runway length, an overrun is likely to cause major damage to the aircraft and possible severe injuries, or a "critical" outcome.

Using a Risk Assessment Matrix

Once risk likelihood and severity have been determined, we need to determine the joint impact of these two parameters. This is best accomplished by using the risk assessment matrix, as displayed in *Figure 3-1*.

RISK ASSESSMENT MATRIX				
Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	HIGH	HIGH	SERIOUS	MEDIUM
Occasional	HIGH	SERIOUS	MEDIUM	LOW
Remote	SERIOUS	MEDIUM	MEDIUM	LOW
Improbable	MEDIUM	MEDIUM	MEDIUM	LOW

Figure 3-1. Risk Assessment Matrix.

As can be seen by cross-matching given levels of risk likelihood and severity, you can determine the overall risk level. Consider the examples previously cited. The thunderstorm penetration, with “catastrophic” severity and either “probable” or “occasional” likelihood, constitutes a high (red) risk level. The runway overrun, with “critical” severity and “occasional” likelihood, constitutes a serious (yellow) risk level.

What Is an Acceptable Risk Level?

Perhaps readers think that it is not possible to establish levels of acceptable risk and that each person’s tolerance for risk is different. However, the International Civil Aviation Organization (ICAO) issued its Safety Management Manual (Document 9859) which establishes acceptable levels of risk. This document defines the following three levels of risk.

- Acceptable – No further action needed unless the risk can be further reduced with little cost or effects.
- Undesirable (or tolerable) – Must be prepared to live with the risk that is mitigated as best as possible.
- Unacceptable – Condition or operation must cease until the risk is reduced to at least tolerable.

These three ICAO risk assessment level definitions are directly analogous to the three overall risk levels in the risk assessment matrix of medium (green), serious (yellow), and high (red), respectively.

The “acceptable” (or medium) risk level is straightforward in that it implies a “go” decision for a planned or ongoing flight. Even in this case, however, it implies that risk should still be mitigated even lower if possible.

The key phrases in the “undesirable” (or serious) and “unacceptable” (or high) categories revolve around what risks are “tolerable.” Translating this to the definitions in the risk assessment matrix, the ICAO standard clearly states that a high (red) risk is unacceptable, and implies a firm “no go” decision for a planned or ongoing flight, unless the risk can be mitigated to a lower level of likelihood or severity such that they are “tolerable.” It is also implied that risks that are serious (yellow) need to be mitigated to a level that they too are tolerable.

So, what exactly is “tolerable” concerning risk? Air carrier, charter, and fractional operations conducted under 14 CFR Parts 121, 135, and 91 Subpart K, are held to a standard that prohibits operations in either serious or high-risk categories. Corporate turbojet operators also generally adhere to this standard. In addition to regulatory requirements, the entire scope of these operations is governed by concepts, procedures, and tools such as safety management systems (SMS) that ensure all risks are identified, assessed, and, if necessary, mitigated to medium or low overall risk levels.

Smaller Part 91 operations using piston and small turbine-powered aircraft carry passengers who are usually not cognizant of the level of risk they are exposed to when they are passengers in such operations. Therefore, duty will invariably dictate that the pilot manage risk in a manner like commercial and other professional flight operations when carrying passengers. Even without passengers, there is a duty owed to innocent persons on the ground that may be affected by flight operations in which risk is not managed to the higher standard discussed above. Finally, even when operating alone in an aircraft over unpopulated terrain, there are inevitably relatives, aircraft co-owners, and others who would be severely affected if you did not manage risk to the standard described above.

Logically, the bottom line is that all risks should be managed such that they are mitigated to medium (green) levels or lower. Serious (yellow) risks need to be mitigated as low as possible and only incurred after due consideration is given concerning innocent passengers, bystanders, and others. Finally, pilots should never begin or continue flights that have high (red) risks until such risks are mitigated to lower levels of likelihood and/or severity.

Risk Assessment Process

Inflight

As discussed in Chapter 2, Identifying Hazards and Associated Risks, using a FRAT to conduct a full risk analysis can be an effective way to manage risks for the planned flight. We also noted that modifying a FRAT or completing a new one inflight can be cumbersome, potentially distracting, and perhaps not timely enough. Accordingly, it is appropriate to use the 3P model and CARE checklist to conduct inflight risk assessment.

Using the 3P Model

The 3P model [Figure 3-2], discussed in Chapter 2, serves as an effective means to assess risk inflight. It can enable timely assessment of inflight hazards so that those hazards that generate high and serious risk levels can be effectively mitigated.



Figure 3-2. The 3P model.

The cycle of perceive, process, and perform allows pilots to monitor previously identified threats and detect new ones. Regarding risk assessment, the pilot should *process* previously identified or new threats by weighing their likelihood and severity, as during the preflight risk assessment. This process could, for example, change the level of risk of a previously identified hazard from medium to serious or even to high, thus requiring mitigation.

Using the CARE Checklist

The CARE checklist includes of Consequences, Alternatives, Reality, and External pressures. This checklist is focused on risk assessment. The four elements of the checklist assist with organization of likelihood and severity of each hazard identified by the PAVE checklist and prompt the pilot to question each hazard.

Consequences – If I do nothing, what is the likelihood and severity of this hazard and associated risk and the impact on the overall risk level?

Alternatives – How can I mitigate the likelihood or severity by taking some alternate course of action?

Reality – Shouldn't I recognize that the conditions aren't going to improve and act now to mitigate this risk?

External pressure – Shouldn't I let my passengers know that we will not arrive on time because I need to mitigate some risks?

The CARE checklist works best when it is integrated with the PAVE checklist and 3P model. The flow chart in Figure 3-3 shows this integration. Risk mitigation using the TEAM checklist, will be discussed in Chapter 4.

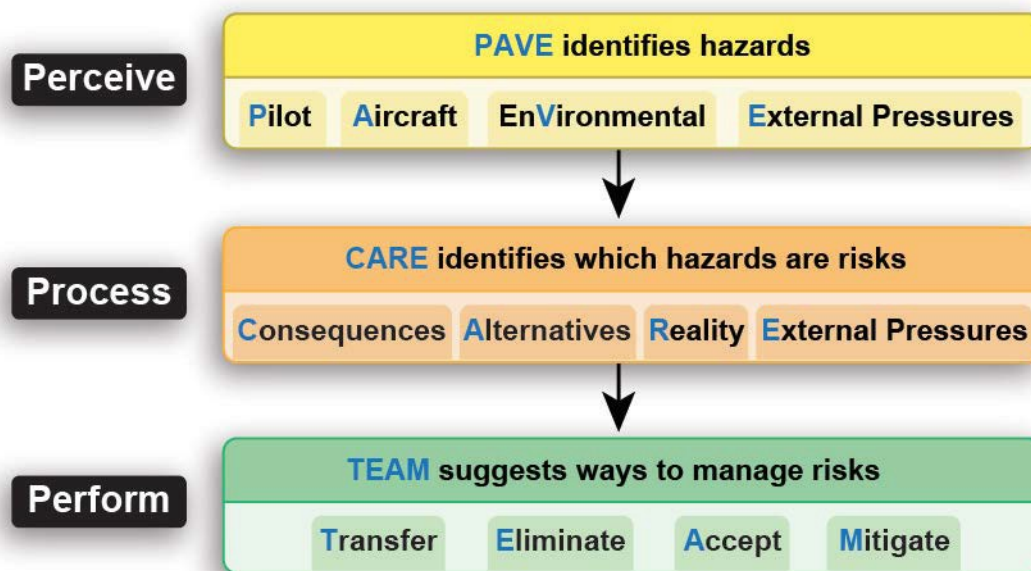


Figure 3-3. 3P, PAVE, CARE, and TEAM working in unison.

The CARE checklist can also be an effective inflight risk management tool. As an example, consider a pilot who is flying under IFR and encounters icing conditions that were not forecast and which were therefore not accounted for in a preflight risk assessment. He might assess that the *consequences* of continued flight in icing conditions would significantly increase the risk level. *Alternatives* could include asking ATC for a higher or lower altitude or diverting to the nearest airport. The *reality* of the situation is that doing nothing is not an option and some action must be taken. Acknowledging that *external pressures* generated by trying to arrive at the original destination on time may be inhibiting the pilot's decision to implement one of the alternatives.

Interpreting Overall Risk Levels and Risk Assessment Results

The risk assessment process, although appearing subjective, can become more precise as you gain experience with the process. As you gain such experience, you should keep in mind several principles and factors regarding risk assessment. These include conservatism, accuracy, and variability.

Conservatism

While conducting a risk assessment, your analysis may occasionally reveal risks for which the likelihood or severity may appear to encompass two different levels. This is especially true if you have little experience in assessing risk. In such cases, it is prudent to apply a conservative standard and assess the risk at a higher level.

Accuracy

The risk assessment matrix has a fixed number of cells that represent a given level of likelihood, severity, and total risk for each hazard. In the real world, of course, there are infinite levels of risk likelihood and severity. For example, after mitigating a serious risk you might determine that it is probably still serious, but is approaching a medium risk level. Your mitigation may be adequate, even though precise risk level measurement is not possible.

Variability

Aviation is a dynamic world and the environment is constantly changing with respect to all the hazards and risks represented by the PAVE checklist. The risk analysis you completed before takeoff has likely changed by the time you depart the local area. It is essential that you continue the entire risk analysis process and use tools such as the 3P model and CARE checklist to continually identify, assess, and mitigate existing and new risks as the flight progresses.

Case Study

Risk Assessment Analysis

Note: Refer to the case study section of Chapter 2 as needed as you continue the case study below. You may wish to complete your own risk assessment of this flight before continuing below.

As the Mooney pilot, you have already completed the risk identification phase of your risk analysis. You have identified nine separate hazards and associated risks that will affect your originally planned non-stop flight direct from

Animas Airpark in Colorado to the Santa Rosa, California airport, following a direct route. You now begin the process of assessing these risks that include all four elements of the PAVE checklist.

Pilot

You have identified both capability and aeromedical pilot-related risks. You conclude that your lack of recent IFR proficiency means that a LOC-I event, while unlikely, is possible and that a LOC-I event, especially in convection or icing conditions, could result in a fatal accident. This combination of “remote” likelihood and “catastrophic” severity constitutes a serious (yellow) risk in the Risk Assessment Matrix.

You also assessed your aeromedical risks using the IMSAFE checklist. You have identified alcohol and fatigue as potential hazards. The risks associated with these hazards could lead to multiple aeronautical decision-making errors that could result in major damage or injury. Collectively, you assess these risks as having “occasional” likelihood and “critical” severity, thus constituting a serious (yellow) risk in the Risk Assessment Matrix.

Aircraft

You have identified three areas with aircraft-related risk. Your original plan to fly non-stop to Santa Rosa is now unlikely because of payload and range tradeoffs. If you continued to try for a non-stop flight and had to deviate extensively around weather, the likelihood of fuel exhaustion increases and could result in fatalities and aircraft loss over the rugged western terrain. This assessment results in a “remote” likelihood with “catastrophic” consequences, thus constituting a serious (yellow) risk in the Risk Assessment Matrix.

You also noted that the Mooney is not certificated for flight in known icing conditions and that a flight along the originally planned route would encounter icing conditions at some point, or “occasional” likelihood. This could again generate a CFIT or LOC-I event with fatalities, or “catastrophic” consequences, producing an overall high (red) risk in the Risk Assessment Matrix.

Finally, your Mooney may have marginal takeoff performance at Animas Airpark, with a 5,000-foot runway, at gross weight. You were originally planning a departure with full fuel and only yourself on board at a weight of 2,500 pounds and a calculated takeoff distance over a 50-foot obstacle of 3,600 feet. Even with your added 20 percent safety margin, this runway length would be enough. However, even with a reduced fuel load, including the Smiths and everyone’s baggage would require a takeoff at the Mooney’s maximum gross weight of 2,740 pounds and a calculated takeoff distance of 4,700 feet. Adding your 20 percent safety factor produces a required runway length of 5,700 feet. Under these conditions, you assess that an overrun is possible at least some of the time and could cause major damage or severe injuries. This “occasional” likelihood and “critical” severity produces a serious (yellow) risk level in the Risk Assessment Matrix.

Environment

You have identified three environmental hazards and associated risks. The combined weather hazards on the direct route to Santa Rosa include thunderstorms, icing, and low ceilings. There could be severe turbulence in the convective activity, which covers most of your original route and poses at least an upset potential at some time, producing an “occasional” likelihood. An upset in severe turbulence could produce a LOC-I event with the potential for aircraft loss and fatalities, or a “catastrophic” likelihood and an overall high (red) risk in the Risk Assessment Matrix.

The Animas Airpark and its immediate environment pose a hazard by itself. You have already assessed the Mooney’s performance limits, but even if a gross weight takeoff was successful, the hazard would be a very low rate of initial climb and the potential for colliding with terrain or a stall and loss of control. An early liftoff and stall or descent into terrain could occur at least some time, or an “occasional” likelihood, and produce fatalities or aircraft loss, or a “catastrophic” severity level. This generates an overall high (red) risk level in the Risk Assessment Matrix.

Your original proposed route traverses some of the highest and most rugged terrain in the intermountain west. If you were to attempt to fly under the low ceilings and weather, the terrain would be a hazard with an associated CFIT risk. A CFIT event, while unlikely for a pilot of your experience would still be possible and could produce fatalities. This “remote” likelihood level and “catastrophic” severity level produces an overall serious (yellow) risk level in the Risk Assessment Matrix.

External Pressures

External pressures can be subtle or overt and produce some of the worst hazards with the highest risk levels, amplifying existing risks and producing awkward social settings.

Consider putting yourself in the position of the Mooney pilot and his friends, the Smiths. They are both facing pop-up business events that appear to be very critical, given their positions in their respective firms. This already generates

enormous pressures as the Smiths are unable to find airline transportation and are looking to you and your airplane to provide a solution to their transportation requirement.

You have your own business on your mind and feel the urgency of returning to Santa Rosa before the Tuesday meeting. You are feeling additional pressure from the Smiths because they are expected to officiate at Independence Day festivities and then party into the night on Monday. They probably see no reason why you could not depart early on Tuesday and get to Santa Rosa just in time for their meetings, just as they have probably done before via the airlines. Last, but not least, you are feeling personal pressure because the Smiths are good friends and you do not want to disappoint them.

You conclude that these external pressures are magnifying all your other identified risks, producing a “probable” likelihood and “catastrophic” severity with high (red) risk levels. You finish recording your risk assessment analysis [refer to *Figure 3-4*] and begin pondering ways to mitigate all these risks (see the case study section in Chapter 4, Mitigating Risk). You will soon need to meet the Smiths again to discuss the next steps.

FLIGHT RISK ASSESSMENT TOOL WORKSHEET					
Three step process: IDENTIFY, ASSESS, MITIGATE.					
Conduct before departure and in flight.					
STEP 1: IDENTIFY THE RISKS (Complete second column below)					
RISK CATEGORY	HAZARD & RISK	LIKELIHOOD (Probability)	SEVERITY (Consequences)	OVERALL RISK LEVEL (Color)	MITIGATION/NEW RISK RED - MUST Mitigate YELLOW - SHOULD Mitigate GREEN - ACCEPT No Unnecessary Risk
PILOT					
Qualification / Currency / Proficiency	Not IFR proficient: Loss of control possible.	LOC unlikely but possible. REMOTE	LOC could involve fatalities. CATASTROPHIC	Serious YELLOW	
Aeromedical / Human Factors	Alcohol and lack of sleep: error potential.	Errors could occur sometime. OCCASIONAL	Error could cause major damage. CRITICAL	Serious YELLOW	
AIRCRAFT					
Fuel / Range / Payload	Cannot carry full fuel: potential fuel exhaustion.	Fuel ex unlikely but possible. REMOTE	Fuel exhaust could cause total loss. CATASTROPHIC	Serious YELLOW	
Equipment (Incl. Inoperative Equipment)	Not certified for known ice: loss of control potential.	Icing could occur sometime. OCCASIONAL	Icing could cause fatalities and loss. CATASTROPHIC	High RED	
Performance	Marginal takeoff performance: loss of control potential.	Overrun could occur sometime. OCCASIONAL	Overrun could cause major damage. CRITICAL	Serious YELLOW	
ENVIRONMENT					
Weather	Thunderstorms, icing, low ceilings: LOC and CFIT potential.	Severe turbulence will occur some- time. OCCASIONAL	Turbulence could cause LOC and loss of life / aircraft. CATASTROPHIC	High RED	
Airspace / ATC / Airports	Marginal runway length: potential overrun.	Early liftoff / stall could occur. OCCASIONAL	Stall after takeoff could cause fatal. CATASTROPHIC	High RED	
Terrain / Day vs. Night	High terrain: potential for CFIT.	CFIT unlikely but possible. REMOTE	CFIT could cause fatalities. CATASTROPHIC	Serious YELLOW	
EXTERNAL PRESSURES					
Work-related and Personal	Meeting deadlines for everyone: increased risk in all other categories.	Tuesday departure and direct flight could trigger all other risks. PROBABLE	Incurring multiple risks could cause loss of aircraft and / or fatalities. CATASTROPHIC	High RED	

Other Data:

Figure 3-4. Case study FRAT with risks identified and assessed.

Chapter Summary

Risk assessment is a critical element in the risk analysis process. To determine overall risk levels, the pilot assesses both risk likelihood and risk severity for all risks identified through the PAVE checklist. The primary tool for this process is a risk assessment matrix. Risk assessment should continue inflight using the 3P model and CARE checklist. Risk assessment proficiency can improve with practice.

Chapter 4: Mitigating Risk

Introduction

Risk mitigation is the process of reducing risk likelihood and/or severity to lower levels. Once hazards and their associated risks have been identified and assessed, those risks that are unacceptable should be mitigated by reducing risk likelihood or severity. As discussed in Chapter 3, Assessing Risk, all high (red) and serious (yellow) risks should be mitigated as low as possible. While high (red) risks should lead to a no-go decision, departing or continuing with serious (yellow) risks present is a non-normal situation that calls for special consideration and mitigation. The risk mitigation process should start days before a flight and continues until completion of the flight.

Risk mitigation is the payoff for conducting risk management. In many cases, it may allow you to undertake or complete a flight that otherwise would be subject to unacceptable hazards and associated risks. Conversely, when conducted in a timely manner, the risk mitigation process can reveal when the risks to a planned flight cannot be mitigated sufficiently, allowing you to make alternate plans.

Risk Mitigation Process

Preflight

As part of the pre-flight process, risk mitigation is another step in the risk management process. The risk management process is a continual process of hazard and associated risk identification, assessment, and mitigation.

Mitigating Risk Likelihood

Risk likelihood can be reduced by changing the probability of a risk event occurring. For example, suppose you are flying a non-ice protected aircraft that has an optimum cruising altitude for a planned IFR flight of 8,000-10,000 feet. Upon receiving your weather briefing, you note that clouds generally extend from 1,000-12,000 feet along your route and moderate icing is forecast between 7,000-12,000 feet. You note that the minimum en route altitudes are all below 2,000 along your coastal route. You decide to file for 6,000 feet. You conclude that this may reduce the likelihood of icing and as a backup, you can descend to 4,000 or even 2,000 feet. In this case, you cannot change the severity of the icing conditions where they exist, so reducing its likelihood is your best option if the trip is made.

Mitigating Risk Severity

Risk severity can be mitigated by reducing the consequences of incurring a given risk. For example, suppose you are preparing to take off in your single-engine piston aircraft at night from an airport surrounded by a dense urban environment. The control tower offered you an intersection takeoff with 4,000 feet remaining on the 9,000-foot runway. You only need 2,000 feet for the takeoff. You quickly assess the risks involved, especially the remote chance that your engine could fail on takeoff, with possibly catastrophic consequences if you decide to reject the intersection takeoff and request a full-length departure. This action reduces the severity of the engine failure risk because you will be much higher if the engine quits. In this case, you cannot change the likelihood of an engine failure, but can mitigate the severity of the event should it occur.

You might not reject an intersection takeoff at the 4,000-foot point on a 9,000-foot runway during a day takeoff from a rural airport in Kansas, surrounded by wheat fields. In this case, the risk severity is less than in a night, dense urban environment. Still, you might reject the intersection takeoff anyway, choosing to reduce risk even when it is already medium or low.

Using the TEAM Checklist to Mitigate Risk

Mitigating risk could be considered less complex than assessing risk because mitigating risk requires unambiguous action while assessing risks requires deeper analysis. Nevertheless, a tool is available to conduct mitigation in a methodical way. Using the TEAM checklist can aid in conducting the entire mitigation process. The acronym stands for Transfer, Eliminate, Accept, and Mitigate. The acronym TEAM is easy to remember, but due to the order in which these steps most logically occur, it is more effective if the checklist is used in the sequence TEMA. The TEMA checklist is especially suited for operations of small general aviation piston-engine aircraft because operations using such aircraft normally need to transfer or eliminate risk more often than larger, more capable aircraft, as discussed below. Nevertheless, this checklist can work equally well for all categories and classes of aircraft.

Transferring Risk

Risk mitigation should begin before the day of most proposed flights, sometimes many days in advance. For example, suppose you are the Mooney pilot in our scenario, and you are planning a flight in January from Santa Rosa, CA to Bellingham, WA to attend a conference at which you are speaking. You would want to begin your mitigation as much as ten days in advance of the flight, as the long-range weather forecasts become available. If you determine, as may

frequently be the case along this route in January, that a multi-day low-pressure system will be present, with icing at 3,000 feet and above, you might conclude that the risks are too high to use the Mooney for this trip. You would therefore *transfer* the risk of this trip to the airlines, which are equipped, trained, and organized to mitigate the forecast risks to a very low level.

Eliminating Risk

Sometimes, risk can be eliminated by simply canceling or postponing a trip. In our above example, let's suppose the purpose of the trip was simply to visit a friend in Bellingham. In this case, rather than transfer the risk to the airlines, you and your friend might decide to postpone your visit to another month when the weather is better. This *eliminates* any risk for the flight because the Mooney remains in the hangar.

Mitigating Risk

Let's suppose that your speaking engagement in Bellingham is in May. As you begin the mitigation process ten days in advance, you note that the weather pattern in the Northwest is stable, with marine air and low overcasts predicted, but with cloud tops no higher than 7,000 feet and no icing forecast. As the departure day approaches and the forecast weather remains stable, you conclude that the trip is feasible in the Mooney and you continue to *mitigate*. You continue your analysis and the risk management process, including mitigating any identified hazards and risks. For example, seeing that IMC weather will continue in the Northwest, you schedule an instrument proficiency check with an instrument flight instructor before departure, to ensure that your IFR proficiency is adequate.

Accepting Remaining Risk

If you cannot completely transfer, eliminate, or mitigate the risk, you may need to *accept* any risk that remains. You should accept remaining risk not only for yourself but also for your passengers and any third parties affected by the flight. You accept the risk through positive action, possibly including disclosure to your passengers. Remaining risk that is too great and is not acceptable should lead you to alter your flight planning or make a no-go decision.

Risk Mitigation Process

Inflight

As with risk identification and assessment, risk mitigation should continue throughout the flight. Both the 3P model and CARE checklist can be used for this purpose. Good aeronautical decision-making can greatly expand your options inflight as well as before takeoff.

Using the 3P Model

As your flight progresses, you should perceive and process hazards and risks, including those identified before flight and those that appear after departure. The 3P model then suggests that you *perform* whatever actions are needed to mitigate unacceptable risks to lower levels of likelihood and/or severity.

Using the CARE Checklist

Inflight risks can also be mitigated using the CARE checklist. Once you identified and assessed risks and the *consequences* are known, you can consider *alternatives* that can mitigate these risks. You may find that the *reality* of the situation is such that some risks cannot be mitigated. You should still factor *external pressures* into your mitigation strategy.

Typical Risk Mitigation Strategies and Techniques

There is almost no limit to the strategies and techniques that can be used to mitigate risks. The strategies and actions used for any individual flight vary greatly. Nevertheless, there are a few common strategies that are effective for each risk component. Pilot, aircraft, and external pressure risks respond well to early, direct action, while many environmental risks cannot be changed and avoidance becomes a key mitigation strategy.

Mitigating Pilot Risks

Proactive actions best mitigate both pilot capability and pilot aeromedical risks. For example, you should pursue a proficiency program that exceeds the regulatory minimum. This should include both ground and flight elements. For regulatory required events such as the flight review required by 14 CFR Part 61, §61.56, consider an enhanced review that covers more than just maneuver-based skills. For example, for your flight review, you might work with your instructor to create a scenario-based review that emphasizes knowledge, risk management, and skill elements involving a flight that you would typically make.

Proactive mitigation is also the best approach for aeromedical risks. The health issues represented by the IMSAFE checklist suggest that individual monitoring and addressing health issues positively and promptly helps to reduce risks associated with these aeromedical factors. For example, you might ask your doctor to review the side effects of any

prescription and over-the-counter (OTC) medicines you are taking.

Mitigating Aircraft Risks

Aircraft risks can also be mitigated by proactive action, especially if you own, rather than rent aircraft. One key mitigation tool is to know your aircraft's performance envelope, especially regarding range, payload, and takeoff and landing performance. Factoring performance data to create safety margins can provide effective mitigation of some risks. Additionally, addressing discrepancies and conducting regular preventive maintenance can increase reliability and reduce outages that can create risk. Developing and using thorough pre-flight and post-flight inspection procedures to identify discrepancies also mitigates aircraft risks. Even with these steps, remember that all aircraft have limitations regarding some environmental hazards and risks.

Mitigating enVironmental Risks

The environment produces the broadest range of hazards and risks of all the categories in the PAVE checklist. These hazards range from convective activity, icing, low ceilings, and other meteorological phenomena, to complex airspace, limited airports, and inhospitable terrain. Some mitigation strategies could allow you to be near or in the hazard. For example, if low ceilings are present, you may be able to continue if you are IFR-proficient, are flying an IFR-equipped aircraft, and file an IFR flight plan.

For many environmental hazards, flight in their proximity may incur high risks and high severity levels and avoidance strategies are needed. Your main strategy is to lower risk likelihood. This can take many forms and requires pilots to plan, exercise patience, remain flexible, and be creative. Some effective avoidance strategies include the following examples.

Go Around the Hazard

For some hazards, such as convective activity and very high terrain, the best mitigation is to circumnavigate the hazard. The earlier this technique is employed the less disruption will be incurred. For example, imagine you are flying the Mooney in our example from the Glasgow Valley County Airport (KGGW) in Glasgow, Montana to the Great Falls International Airport (KGTF) in Great Falls, Montana, a straight-line distance of 196 NM. There is a military operations area (MOA) on your direct path to KGTF. You might instead decide to re-route your flight north of the MOA via the Havre VOR as depicted in *Figure 4-1*. The dogleg route is 218 NM. The extra 22 NM will only require an additional nine minutes of flight to reach Great Falls. You could, of course, call ATC to see if the MOA is not active and, if so, go ahead with the direct flight.

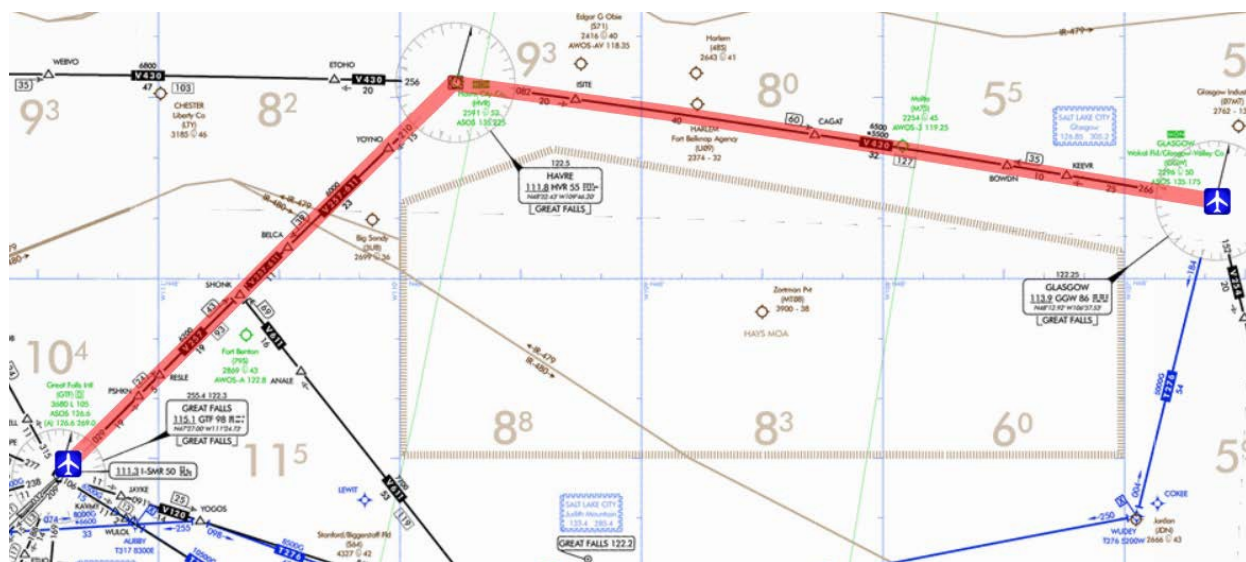


Figure 4-1. Circumnavigating a hazard.

Go Above or Below the Hazard

Sometimes it is possible to mitigate risk likelihood by flying at a different altitude. For example, if you do not have an instrument rating or the aircraft is not IFR equipped, you could choose to fly above or below a scattered to broken cloud deck. However, in some cases this could create a new hazard with an associated risk if the cloud deck became a solid overcast or the ceiling decreased to a marginal level.

Change Departure Time or Date

You may be able to reduce the likelihood of a hazard by advancing or delaying your departure. For example, on a day when a line of afternoon thunderstorms is forecast, you might choose to make an early morning departure or wait until the thunderstorms dissipate and depart late in the afternoon. For some meteorological hazards, such as an incoming low-pressure system, you might choose to depart the day before you had originally planned.

Change the Fuel Load

When faced with fuel and payload tradeoffs or aircraft performance limitations, you might choose to vary the fuel load. For example, when making a long-distance flight, you might choose to add more fuel, or if you have a maximum passenger and baggage load, take on less fuel and add a mid-trip fuel stop. If you are faced with runway length performance limitations, you may again choose to reduce the fuel load.

Mitigating External Pressure Risks

External pressures can be either subtle or overt. Because they often involve passengers and other third parties, it is best to address these risks directly with those individuals.

Local versus Transportation Flights

A key factor in risk mitigation is the purpose of the flight. A local pleasure flight can still be subject to external pressures, but it is easier to cancel than a scheduled flight for transportation purposes. When planning a local flight with friends, for example, it would be a good idea to reduce external pressures by telling your passengers that the flight could be canceled at the last minute due to weather or other reasons. For a transportation flight, it is a good idea to tell the parties expecting you at the destination that they should not wait for you at the airport. Instead, you could call them when you arrive.

Personal versus Business Flights

Typically, you have more control over your personal schedule than your business, work, or professional schedule. It is easier to change plans with family members and friends than with business associates. This is particularly true when you are planning to carry your boss or other company officials on the flight. In these cases, you should manage expectations and even consider transferring the risk to the airlines or an automobile.

Case Study

Risk Mitigation Analysis

Note: Refer to the case study supporting data in Chapter 2, Identifying Hazards and Associated Risks, and the risk assessment matrix in Chapter 3, Assessing Risk, as you continue the risk mitigation phase of the case study.

You have diligently identified and assessed the risks of your proposed flight from Durango, CO to Santa Rosa, CA. You should now mitigate the high and serious risks that you identified during the assessment phase. You identified four high and five serious risks that you should mitigate by reducing risk likelihood and severity.

You start by reconsidering your strategy for this flight. You can no longer make a non-stop flight because carrying the Smiths and their baggage will require that you take off with a reduced fuel load. In addition, you will not be able to take the direct route due to thunderstorm, icing, low ceiling, and terrain hazards. Furthermore, you will need to leave the next day, early Monday morning, rather than Tuesday, because of the incoming front and low-pressure area. You also note that there may be an issue with fog and low ceilings at Santa Rosa due to the coastal marine layer. This often dissipates by noon, but it is not possible to predict that this far ahead of arrival.

You start by calculating your allowable fuel load. With an empty weight of 1,903 pounds and a maximum allowable gross weight of 2,740 pounds, you have a useful load of 837 pounds. You weigh 170 pounds, the Smiths together weigh 300 pounds, and together you have 120 pounds of baggage, for a total of 590 pounds of cabin payload. You also have seven pounds of cockpit devices and charts. This leaves 240 pounds for fuel, which is 40 gallons. The Mooney has 25 gallons on board, so you can add 15 gallons.

There is a serious, or yellow hazard with attempting a gross weight takeoff from the Animas Airpark (00C). You mull this over and then decide you will ask the Smiths to take a taxi to the main Durango airport, Durango – LaPlata County Airport (KDRO), only 7 NM away. It has a 9,200-foot runway and taking off there at gross weight will not create a serious hazard. You add three gallons to your fuel order so will be able to take off from KDRO with 40 gallons. You know you will have to make at least one fuel stop and deviate around the hazardous weather in Utah and Nevada. You then access your flight planning tools to consider an alternative

route.

After a thorough analysis and weather briefing, you decide to fly from Durango to the Barstow-Daggett, CA airport (KDAG) for a fuel stop, via Winslow, AZ (INW) VOR. This route is 490 NM and you calculate this flight should take 3:15 and you will have 4:30 endurance. From there, you will fly to Santa Rosa via Palmdale, CA (PMD) VOR. This route is 390 NM and you calculate it should take 2:45 with 4:30 endurance. Your overall route is depicted in *Figure 4-2*.

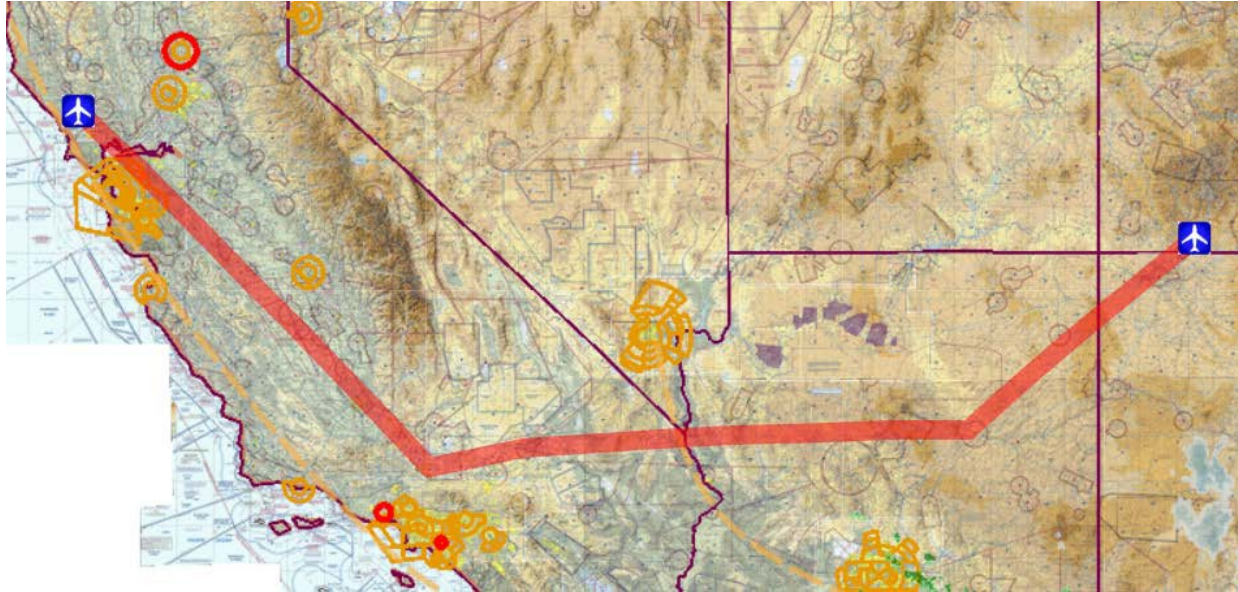


Figure 4-2. *Modified case study route.*

The total distance along this route is 880 NM, versus the straight-line distance of 711 NM. The additional 169 NM will only add about 1+15 to the total flight time.

You have now accounted for aircraft and environmental risks in your risk mitigation strategy. You should also deal with the external pressure risks associated with leaving a day early, given the need for the Smiths to forego the Monday festivities in Durango. An early departure is also needed to reduce the external pressure associated with making the Tuesday afternoon meetings on time. You will need to explain your risk analysis to the Smiths and convince them that an early departure is necessary.

You close your risk analysis by considering pilot risk factors. You are concerned about your instrument proficiency and the possible need to execute an instrument approach to low ceilings at Santa Rosa. To compensate for this, you decide to add 500 feet to your personal minimums for the approach. This might require a landing at a suitable alternate airport. With your predicted fuel load, you calculate that Sacramento Executive Airport (KSAC), 62 NM from KSTS and well inland, would be a good alternate.

You should also consider aeromedical pilot risks. First and foremost, you need to eschew alcohol for the rest of the day, have an early dinner, and go to bed early. You also will increase your intake of water. These actions should help you avoid dehydration. You will also advise the Smiths to take the same actions.

Having addressed all the risks, you already identified and assessed, you complete the FRAT for the proposed trip, listing all of your mitigations. The completed FRAT in *Figure 4-3* shows that all the risks have been mitigated to medium or low levels.

FLIGHT RISK ASSESSMENT TOOL WORKSHEET

Three step process: **IDENTIFY, ASSESS, MITIGATE.**

Conduct before departure and in flight.

STEP 1: IDENTIFY THE RISKS (Complete second column below)

RISK CATEGORY	HAZARD & RISK	LIKELIHOOD (Probability)	SEVERITY (Consequences)	OVERALL RISK LEVEL (Color)	MITIGATION/NEW RISK RED - MUST Mitigate YELLOW - SHOULD Mitigate GREEN - ACCEPT No Unnecessary Risk
PILOT					
Qualification / Currency / Proficiency	Not IFR proficient: Loss of control possible.	LOC unlikely but possible. REMOTE	LOC could involve fatalities. CATASTROPHIC	Serious YELLOW	Add 500' to minimums. Now IMPROB / CATAST. Medium (GREEN)
Aeromedical / Human Factors	Alcohol and lack of sleep: error potential.	Errors could occur sometime. OCCASIONAL	Error could cause major damage. CRITICAL	Serious YELLOW	No more alcohol. Early to bed. REM / MARG Medium (GREEN)
AIRCRAFT					
Fuel / Range / Payload	Cannot carry full fuel: potential fuel exhaustion.	Fuel ex unlikely but possible. REMOTE	Fuel exhaust could cause total loss. CATASTROPHIC	Serious YELLOW	Partial fuel load. Refuel stop. IMPROB / NEGL Low (WHITE)
Equipment (Incl. Inoperative Equipment)	Not certified for known ice: loss of control potential.	Icing could occur sometime. OCCASIONAL	Icing could cause fatalities and loss. CATASTROPHIC	High RED	Avoid all icing (reroute) REMOTE / MARGINAL Medium (GREEN)
Performance	Marginal takeoff performance: loss of control potential.	Overrun could occur sometime. OCCASIONAL	Overrun could cause major damage. CRITICAL	Serious YELLOW	Depart from KDRO. REMOTE / CRITICAL Medium (GREEN)
ENVIRONMENT					
Weather	Thunderstorms, icing, low ceilings: LOC and CFIT potential.	Severe turbulence will occur some- time. OCCASIONAL	Turbulence could cause LOC and loss of life / aircraft. CATASTROPHIC	High RED	Deviate through AZ REMOTE / CRITICAL Medium (GREEN)
Airspace / ATC / Airports	Marginal runway length: potential overrun.	Early liftoff / stall could occur. OCCASIONAL	Stall after takeoff could cause fatal. CATASTROPHIC	High RED	Depart from KDRO. REMOTE / CRITICAL Medium (GREEN)
Terrain / Day vs. Night	High terrain: potential for CFIT.	CFIT unlikely but possible. REMOTE	CFIT could cause fatalities. CATASTROPHIC	Serious YELLOW	Deviate through AZ IMPROBABLE / CRITICAL Medium (GREEN)
EXTERNAL PRESSURES					
Work-related and Personal	Meeting deadlines for everyone: increased risk in all other categories.	Tuesday departure and direct flight could trigger all other risks. PROBABLE	Incurring multiple risks could cause loss of aircraft and / or fatalities. CATASTROPHIC	High RED	Brief Smiths. Depart Monday AM. Shuttle to KDRO. Refuel stop. IMPROBABLE / NEGLIG. Low (WHITE)

Other Data:

Figure 4-3. Case study FRAT with risks mitigated.

Of the nine risks assessed, you originally assessed four as high (red) and five as serious (yellow). According to your analysis and mitigations, the risk levels are now reduced to seven medium (green) and two low (white) risks.

You then meet again with the Smiths. They are astonished at the level of your analysis and agree with you on the early departure from KDRO and the other mitigations. John Smith then makes a few phone calls and quickly returns with word that all of Monday's Durango events will go forward, but without the Smiths being there.

This hypothetical flight with its risk analysis was complex, yet all the identified risks were mitigated with six discrete actions. To do this, you:

1. added a safety margin to your personal minimums for instrument approaches;
2. abstained from further alcohol consumption and went to bed early;
3. reduced your departure fuel load and added a fuel stop;
4. departed a day early;
5. departed from the main Durango Airport, rather than the Animas Air Park; and
6. flew along a more southerly route, through Arizona, to avoid weather hazards.

Inflight

On Monday morning, you depart KDRO at 0730, as planned, and follow your southerly route through central Arizona. Initially, the sky is nearly clear with high cirrus, but you soon note that a high thin overcast is forming at around 16,000 feet. Using the 3P model, you *perceive* both the changing sky and the approach of higher terrain after passing Winslow. You *process* this information and decide to *perform* mitigation by climbing to 12,500 feet. You perceive and process another hazard of potential hypoxia and perform the mitigation, as you and the Smiths don masks and use your portable oxygen system. You are later able to progressively descend to 10,500 and later 8,500 feet as you fly over lower terrain.

You continue the second leg of your flight after a routine fuel stop in Daggett, CA. Departing Daggett you continue to monitor the weather on your ADS-B-in-panel display and note that the fog and low ceilings are persisting at Santa Rosa. You use the CARE checklist and identify the resulting *consequences* of slightly elevated risk during an ILS approach with a 200- to 300-foot ceiling. You confirm your *alternatives* by noting that your alternate of KSAC is reporting clear skies. You acknowledge to yourself the *reality* of diverting to KSAC. You relieve these *external pressures* by communicating this information to the Smiths, who say they accept whatever decision you make as a pilot in command.

Within an hour after departure, your panel display shows that the fog at Santa Rosa has lifted. Upon arrival, you execute a routine landing.

Several days later, you receive a complimentary note from the Smiths, along with a very expensive bottle of wine from the Sonoma winery that the Smiths co-own. In the letter, they complement your approach to the flight and note that their prior experience in a general aviation aircraft was not as positive. That pilot seemed to have adequate physical skills, yet they were uncomfortable with his failure to identify, assess, and mitigate what they saw as several obvious hazards and risks.

Balanced Approach to Risk Management

The hypothetical case study used in Chapters 2 through 4 represents a moderately complex, yet typical scenario covering the flight of a general aviation aircraft on a typical transportation flight. Many flights may be less complex than this one while other flights may be even more complex.

It is always appropriate to conduct a full risk management process for any flight, including the use of a FRAT. However, for less complex flights, such as a flight in the vicinity of the airport on a sunny day with no wind, the completion of a FRAT may not be necessary. If you have the proper approach to risk management and enhance your risk management knowledge and skill, you may find that your risk management proficiency will become intuitive and you will need to use a FRAT for only the most complex of flights.

If you elect to enhance your risk management skill to this level, consider taking the following steps:

- Take a risk management and/or an SRM course.
- Obtain risk management training from a flight or ground instructor.
- After receiving training, use a FRAT, such as the one in this case study, for the next five to ten flights you make.
- Even when not using a FRAT, continue to use the 3P model and PAVE, CARE, and TEAM checklists to identify, assess, and mitigate risks on all flights.
- On your next flight review or other proficiency event, ask the flight instructor to make the proficiency event risk-based.

Chapter Summary

Risk mitigation is the payoff for conducting the risk management process. Risk mitigation may allow you to reduce the likelihood or severity of identified risks and undertake or complete a flight that would otherwise generate too much risk. In other cases, the risk mitigation process may identify high and serious risks that cannot be mitigated, allowing you to make alternate plans. A FRAT can enhance any risk mitigation activity, but may not be required for simpler flights, provided you have received appropriate training and take other steps to enhance your risk management proficiency.

Chapter 5:

Threat and Error Management

Introduction

The process of risk management described in earlier chapters is a vital part of safe flight. The process is based largely on planned, or predicted, levels of probability and severity. The process takes time and thought and requires the collection of information pertinent to the flight. However, once the planned operation begins, it is inevitable that unforeseen hazards and their associated risks will be encountered. These hazards come in the form of threats and errors. Having the tools available to manage them is critical in preventing an incident or accident.

Acceptance of Human Error

Before acquiring the tools necessary to manage threats and errors, the pilot should first accept two truths about aviation. One, many threats are faced in every operation. Threats are not dangers, but simply the hazards that are inevitably present. The dynamic environment in which aviation activities take place always presents unique challenges.

Two, pilots are human beings, and human beings are fallible creatures. As a pilot, you will make errors. No amount of training, experience, or planning can prevent you from making mistakes. You will be affected by emotional, psychological, and physiological stressors. You will lose attention or misallocate it. You will be pressured, whether self-induced or externally-induced, to complete a mission. You will be caught off-guard by changing technologies, new equipment, and even old equipment.

Threats, Errors, and Undesired Aircraft States

Having accepted these truths about the aviation environment and human behavior, the foundation is laid to begin to understand exactly what threats and errors are and the consequences they cause.

What Is a Threat?

A threat may be characterized by three components:

1. Threats occur outside the influence of the flight crew; they are present in the environment. Threats are not caused by the flight crew.
2. Threats increase the operational complexity of a flight; they are often contradictory to and act to prohibit error-free completion of a flight.
3. Threats require attention; they must be addressed and dealt with. Threats require effective management to contain risk within acceptable levels.

An exhaustive list of possible threats is too long to include here and is largely dependent on the specific type of flight operation. However, using the PAVE checklist, some common threats can be identified to further understand their nature. *[Figure 5-1]*

Threats	Examples
Pilot	
Experience	Lack of recent experience, lack of total experience, time in type, recent training, currency, proficiency
Fitness	Illness, medication, stress, alcohol, fatigue, eating, emotions
Aircraft	
Aircraft	Systems, engines, flight controls, or automation anomalies or malfunctions; MEL items with operational implications; other aircraft threats requiring attention
Maintenance	Aircraft repairs, maintenance log problems, maintenance errors
Manuals and Charts	Missing or incomplete information, document errors
Environment	
Weather	Thunderstorms, turbulence, poor visibility, wind shear, crosswind, icing conditions, IMC
Collision Hazards	Terrain, traffic, traffic alerts, TCAS TA/RA, obstacles
Airport	Poor signage, faint markings, runway/taxiway closures, INOP navigational aids, poor braking action, contaminated runways/taxiways
ATC	Tough-to-meet clearances/restrictions, reroutes, language difficulties, controller errors, radio congestion
External Pressure	
Operational Pressure	On-time departure/arrival pressure, enroute delays, late arriving passengers or crew
Cabin and Passengers	Cabin events, flight attendant errors, distractions, interruptions
Dispatch and Paperwork	Load sheet or weight and balance errors, flight plan changes or errors
Ramp Operations	Baggage/cargo loading events, fueling errors, improper ground support, de-icing

Figure 5-1. Examples of common threats identified using the PAVE checklist¹.

What Is an Error?

An error may also be characterized by three components:

1. Errors are deviations from intended or expected actions; they cause confusion and increase workload and absorb attention. Errors are caused by the flight crew.
2. Errors reduce safety margins; they may result in exceedance of established performance standards or operating limitations.
3. Errors increase risk; they enhance the probability of adverse operational events. Errors require effective management to contain risk within acceptable levels.

An exhaustive list of possible errors is an even greater challenge to produce than that for threats because they are a result of human factors failures. However, some common errors can be identified to further understand their nature. [Figure 5-2] It's important to note that errors made by personnel outside the control or influence of the flight crew, such as maintenance personnel or air traffic control, are considered threats by the flight crew.

¹ Adapted from – Merritt, A. & Klinec, J. (2006). Defensive Flying for Pilots: An Introduction to Threat and Error Management. *The University of Texas Human Factors Research Project: The LOSA Collaborative*.

Errors	Examples
Skill	
Manual Flying	Vertical, lateral, or speed deviations
Automation	Incorrect altitude, speed, heading, autothrottle settings; incorrect mode selection
Flight Control	Incorrect flaps, trim, speed brake, autobrake, thrust reverser, or power settings
Systems and Equipment	Incorrect pressurization, wrong altimeter setting, fuel management error, wrong frequency
Decision	
Abnormal or Emergency Procedure	Wrong response, inadequate systems knowledge, failure to memorize immediate action items
Pilot Flying / Pilot Not Flying	Incorrect duties performed, improper positive exchange of flight controls
Briefings and Callouts	Missed or omitted items
Checklists	Missed or omitted items, wrong challenge/response, performed late or at wrong time
SOPs	Failure to follow, lack of familiarity, misinterpretation
Regulatory	Deviation from regulations, lack of rest, duty time exceedance
Perception	
Air Navigation	Visual illusion; spatial disorientation; misjudged position, distance, altitude, or speed
Ground Navigation	Attempted wrong taxiway/runway, missed taxiway/runway/gate
Communication	Missed/misinterpreted ATC calls, incorrect read-backs, wrong information communicated, incorrect crew coordination
Documentation	Wrong performance data, fuel information, ATIS or clearance recorded; misinterpreted items on paperwork and flight plans

Figure 5-2. *Examples of common skill, decision, and perception errors².*

Within a human factors analysis context, it is important to explain the types of errors and differentiate errors from violations. Errors are accidental in nature. Although caused by flight crew actions, the actions taken were not intended. There are three types of errors.

The first type of error is a skill error. In aviation, skills are analogous to the colloquial “stick-and-rudder” abilities, but skill errors are faults in attention, memory, or technique.³ For example, suppose that when approaching the destination airport for landing, the pilot tunes the control tower frequency into radio number one. However, the radio frequency is similar to that of another, which is already tuned into radio number two. After tuning the frequency, the pilot incorrectly sets radio number two as the active radio and begins communicating with the wrong ATC facility. The pilot fails to confirm the correct radio was selected before transmitting. The confusion is eventually cleared up and the pilot selected the correct radio. This is an attention-related skill error.

The second type of error is a decision error. They are “honest mistakes” that are intentional and caused by planned and executed flight crew actions.⁴ For example, suppose the same pilot who made the radio tuning frequency is now descending to enter the traffic pattern at traffic pattern altitude. The pilot intends to level off at 1,000 feet above the ground, knowing this is the typical traffic pattern altitude for most airports. The pilot is able to set an altitude bug on the altimeter as reminder, completes the descent, and levels off as planned. However, the control tower operator calls the pilot to provide notification of a possible traffic conflict with an aircraft conducting photo work above the airport at 1,300 feet. The pilot later learns that the traffic pattern altitude for the airport is actually 800 feet above the ground. This decision error is the result of a lack of knowledge regarding the destination airport.

² Adapted from – Merritt, A. & Kline, J. (2006). *Defensive Flying for Pilots: An Introduction to Threat and Error Management*. The University of Texas Human Factors Research Project: The LOSA Collaborative.

³ Wiegmann, D. A. & Shappell, S. A. (2003). *A Human Error Approach to Aviation Accident Analysis: The Human Factors Analysis and Classification System*, pp 51-53. Aldershot: Ashgate.

⁴ Wiegmann, D. A. & Shappell, S. A. (2003). *A Human Error Approach to Aviation Accident Analysis: The Human Factors Analysis and Classification System*, p 53. Aldershot: Ashgate.

The third type of error is a perception error. Perception errors are the result of misjudging or misunderstanding reality due to degraded sensory input.⁵ Continuing the same scenario as before, suppose the pilot who incorrectly transmitted on the wrong frequency and then descended to the wrong traffic pattern altitude is now preparing to turn from base leg to final approach for landing. The pilot is cleared to land by the control tower operator. The runway and taxiway markings are faded and it is dusk. The taxiway that parallels the runway is the same width as the runway. On short final approach after the runway and taxiway markings are more easily visible, the pilot realizes the aircraft is lined up with the taxiway rather than the runway. This perception error is the result of reduced visibility in low light and poor airport markings.

In comparison to errors, violations are flight crew actions that were done willfully or with disregard for safety. There are two types—routine violations and exceptional violations. Routine violations are commonly referred to as “bending the rules” because they are habitual and often condoned by supervisors. Consider your last drive to the airport for a flight. Did you intentionally drive five or even ten miles per hour over the speed limit? Did you consider it to be acceptable? Doing so is a routine violation. Exceptional violations, on the other hand, are less common, are not normalized behaviors, and are not condoned by supervisors.⁶

What Is an Undesired Aircraft State?

With an understanding of threats and errors, it becomes clear that they are precursors to situations that are not intended. These situations are called undesired aircraft states. Undesired aircraft states may be characterized by three components:

1. Undesired aircraft states are incorrect position, speed, attitude, or configuration; they cause confusion and increased workload and absorb attention. Undesired aircraft states are caused by flight crew errors.
2. Undesired aircraft states reduce safety margins and greatly increase risk; they are exceedances of established performance standards or operating limitations.
3. Undesired aircraft states require immediate attention and effective management to return within acceptable levels of performance and risk and stop the occurrence of an incident or accident.

Position, speed, and attitude ultimately define the aircraft’s flight path, so undesired aircraft states necessitate the need for proper flight path management. [Figure 5-3] Flight path management will be covered in greater detail in Chapter 6, Automation Management.

Undesired Aircraft States	Examples
Aircraft Handling	Vertical, lateral, or speed deviations; unstabilized approach; long, floated, firm, or off-centerline landings
Air Navigation	Unnecessary weather penetration, wrong route/airway/procedure
Ground Navigation	Runway/taxiway incursions/excursions; wrong taxiway, ramp, gate, or hold positions; above taxi speed limit
Aircraft Configuration	Automation, engine, flight control, system, or weight and balance events/exceedances

Figure 5-3. Examples of undesired aircraft states⁷.

Managing the Human Error Chain of Events

As stated previously, undesired aircraft states, the errors that caused them, and the threats that preceded such errors, may lead to an incident or accident. Understanding this chain of events is important so that the proper countermeasures and defenses can be applied to different situations to break the chain. [Figure 5-4]

⁵ Wiegmann, D. A. & Shappell, S. A. (2003). *A Human Error Approach to Aviation Accident Analysis: The Human Factors Analysis and Classification System*, p 54. Aldershot: Ashgate.

⁶ Wiegmann, D. A. & Shappell, S. A. (2003). *A Human Error Approach to Aviation Accident Analysis: The Human Factors Analysis and Classification System*, p 55. Aldershot: Ashgate.

⁷ Adapted from – Merritt, A. & Kline, J. (2006). *Defensive Flying for Pilots: An Introduction to Threat and Error Management. The University of Texas Human Factors Research Project: The LOSA Collaborative.*

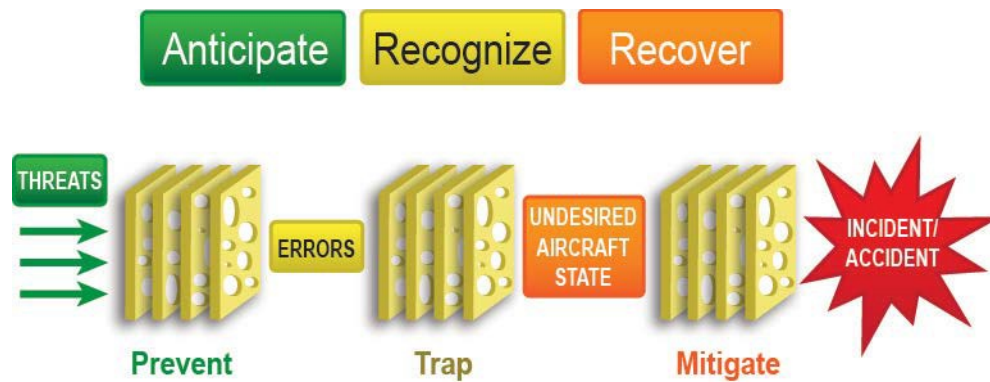


Figure 5-4. The prevent, trap, and mitigate methodology forms the foundation of threat and error management and is based on James Reason's Swiss cheese model of accident causation.

Anticipate and Prevent Threats

The first step in managing the human error chain of events is prevention. The goal is to prevent a threat from causing the flight crew to make an error. Recall that threats are external to the flight crew, including errors made by other personnel. They are part of the environment. Anticipation of a threat is best accomplished by employing clear communication and briefings, especially in multi-pilot flight decks, thorough what-if planning strategies, and efficient time management techniques.

Recognize and Trap Errors

The second step in managing the human error chain of events is trapping. In the event a threat was not prevented from impacting the performance of the flight crew, an error will likely result. The goal is to trap the error to maintain acceptable levels of risk and maintain safe flight parameters. Recognition of an error is best accomplished by using clear communication and briefings, cohesive teamwork, proficient automation management, and effective situational awareness.

Recover and Mitigate Undesired Aircraft States

The third step in managing the human error chain of events is mitigation. An error that was not trapped will cause an undesired aircraft state. At this point, acceptable risk levels have already been exceeded and safety margins have been reduced. It is vital to quickly manage the undesired aircraft state and recovery to safe flight parameters. Recovery from an undesired aircraft state is best accomplished by again using clear communication and briefings, cohesive teamwork, proficient automation management, and effective situational awareness. However, slightly different or additional techniques within each of those areas may be required because the preceding error was not trapped. One additional response is the use of fundamental flying skills to recover to safe flying parameters.

The prevent, trap, and mitigate methodology can be easily depicted using a familiar model. James Reason originally proposed the Swiss cheese model of accident causation. He explained that an accident proceeds from preconditions at the managerial level of a complex system, to an initial unsafe act of an individual, and finishes with failure of error defenses after the unsafe act.⁸ If each piece of cheese is used to represent a layer of defense, each hole represents a weakness in that defense. The goal of threat and error management (TEM) is to either close or misalign the holes throughout the block of cheese.

TEM Defenses

To prevent, trap, and mitigate threats, errors, and undesired aircraft states, it is important to understand the specific defenses available to the flight crew. Some of the defenses are already provided to the flight crew. Other defenses are provided by the flight crew. [Figure 5-5]

⁸ Reason, J. (1990). *Human Error*, pp 208-209. New York: Cambridge University Press.

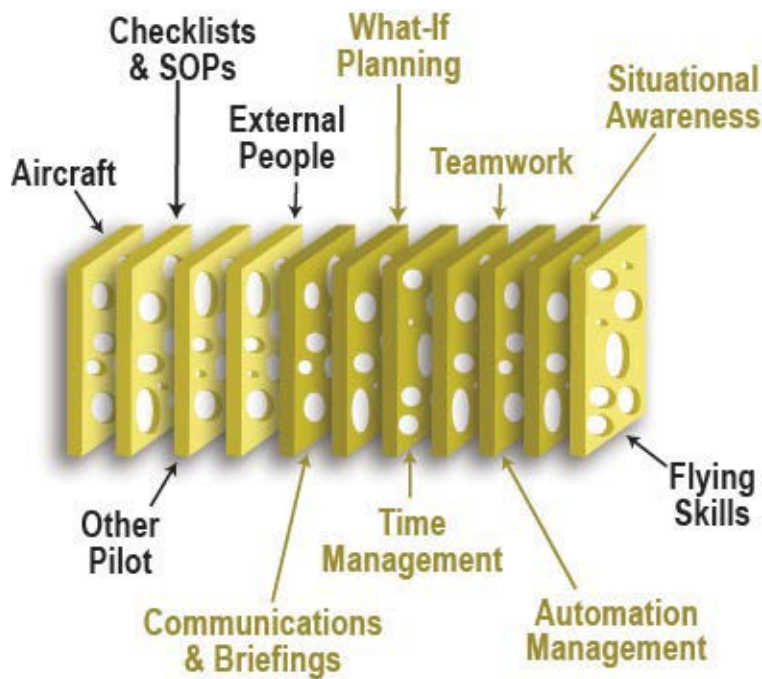


Figure 5-5. TEM defenses are either provided to the pilot or provided by the pilot. The defenses provided by the pilot form the TEM Toolkit.

Defenses Provided to You

Defenses that are provided to you are normally products of the organizational culture and operations requirements of the particular flight mission. These defenses may come from the company you work for, the flight school you train at, the fixed base operator (FBO) you rent from, or the manufacturer you purchase your aircraft from. Regardless of the flight mission, some aspects of it will always be predetermined.

The Aircraft

You normally do not have a choice of the specific aircraft you are flying. It is either assigned to you, one of a limited number to choose from when renting or flying in a club, or is the one you purchased and normally fly. The aircraft's airworthiness and the functionality of all installed equipment are vital to a safe flight. Using the proper risk management process to complete the preflight assessment with regard to aircraft airworthiness will help to ensure that this defense is ready to protect you from threats and errors.

Checklists, Standard Operating Procedures, and Best Practices

Like the aircraft, its approved checklists are normally provided to you. The manufacturer's approved checklist is the basis for everything else. If you own your airplane, this may be all that is available. Many flight schools, flying clubs, and larger flight departments may develop checklists and standard operating procedures (SOPs) that enhance the basic manufacturer's checklist. Many aircraft owners also participate in type-specific owner organizations that develop and share best practices that assist with operation of the aircraft. Regardless of the source, it is vital to follow approved checklists and operating guidance to defend against threats. Familiarity with the checklist, memorization of immediate action items, and understanding of any SOPs will help reduce the likelihood of making an error.

The Other Pilot

Much of your flying may be accomplished with another pilot on board. Even though you may be flying a single-pilot aircraft, currency and proficiency requirements may require you to fly with a flight instructor or safety pilot. Check-out flights at flight schools and FBO or for insurance purposes may also require you to fly with a flight instructor or safety pilot. In larger aircraft, two pilots may be required and the flight crew assignments are normally dictated by company operations or crew scheduling. In any case, the other pilot you are with is a valuable resource. Use that resource to help you manage threats and errors. Involve the other pilot in the threat and error management process by using clear communication and briefings and cohesive teamwork. However, understand that the other pilot may have an entirely different set of experiences and abilities from you and could introduce threats to the operation.

External People and Resources

For any flight, even when operating single-pilot or even solo, there are people available as a resource that can help you manage threats and errors. Air traffic control can assist with traffic avoidance, weather avoidance, terrain avoidance, and navigation. However, keep in mind that in some cases, ATC workload may limit the amount of assistance they can provide, so do not get complacent. If necessary, communicate clearly to ATC that you need help or declare an emergency. Flight service personnel are another valuable resource, especially for weather avoidance and flight plan changes. If you rent from a flight school or FBO, other pilots, students, and flight instructors can give valuable guidance before or after a flight. During flight, do not be afraid to call the flight school or FBO over the radio. In larger operations or on multi-pilot aircraft, your dispatch center can normally coordinate all communications and assistance.

Regardless of the resources you rely on, be sure to use clear communication and briefings and cohesive teamwork to help manage threats and errors.

Defenses You Provide Yourself

Defenses you provide yourself come in the form of the soft-skills commonly associated with crew and single-pilot resource management techniques. More importantly, these defenses are dependent on your ability to arrive for the flight mission well-rested, in a safe frame or state of mind, and guarding against hazardous attitudes and operational pitfalls. Your ability to employ these defenses will vary from day to day and from flight to flight. However, these defenses are the most effective at trapping errors and breaking the human error chain of events. These defenses are:

- Communication and Briefing Skills
- What-if Planning
- Time Management
- Teamwork
- Automation Management
- Situational Awareness

TEM Toolkit

The defenses you provide yourself during each flight operation form the foundation of the TEM Toolkit. For each of the defenses, actionable and simple to follow guidelines will help you employ it effectively.

Clear Communication and Briefings

The first layer of defense in the TEM Toolkit is clear communication and briefings. Whether operating as a single pilot or as part of a crew, communication is the foundation for finding the information you need and conveying your intentions. *[Figure 5-6]*

Communication and Briefing Tools	
Think Out Loud	If something doesn't seem right, tell the other pilot, ATC, maintenance, or dispatch personnel.
Ask Questions	Find out the information needed from the other pilot, ATC, maintenance, or dispatch personnel.
Be Specific	When thinking out loud or asking questions, be specific. For example, "The number 4 cylinder temperature is red-lining, do you agree with a power reduction followed by troubleshooting using the engine overheat checklist?"
Be Assertive	When communicating with other flight crewmembers, state the other person's name to get their intention; speak clearly and in a loud enough voice to be heard over noise and distraction.
Brief Expectations	Complete all required briefing items every time, but emphasize what's different each time.
Brief Bottom Lines	Discuss and agree on personal minimums with other flight crewmembers and passengers; review company and manufacturer restrictions.

Figure 5-6. *Tools to aid in producing clear communication and briefings.*

Thorough What-if Planning

The second layer of defense in the TEM Toolkit is thorough what-if planning. This what-if planning draws many objectives from the overall risk management and aeronautical decision-making processes. *[Figure 5-7]*

What-If Planning Tools	
Be Skeptical	Challenge assumptions and ask what-if questions, always double-check whenever there is doubt.
Plan for the Worst	Always have an out, keep emergency landing locations in mind and within range, over-estimate fuel usage.
Choose Conservatively	Use ADM and risk management processes to make decisions, reconsider the need for a particular operation or maneuver.

Figure 5-7. Tools to aid in completing thorough what-if planning.

Efficient Time Management

The third layer of defense in the TEM Toolkit is efficient time management. The passage of time cannot be interrupted but can be indirectly manipulated. On the ground, the most effective way to do so is to stop the aircraft. Do not continue to taxi if the necessary tasks cannot be properly accomplished. Once airborne, the movement of the aircraft cannot physically be stopped. However, scheduling tasks, budgeting time, and slowing down the aircraft will aid your ability to manage and complete the many tasks required. It is important to understand that multitasking is a misnomer. Human beings cannot perform simultaneous tasks in a literal manner. Time and task management instead provide the deception of multitasking as each element of a task is completed in rapid succession. [Figure 5-8]

Time Management Tools	
Schedule Tasks & Budget Time	Stay ahead but stay in order – accomplish successive tasks without delay, accomplish tasks during low workload/threat environments such as cruise flight. For example, obtain the ATIS and brief the instrument approach as early as possible.
Slow Down	Reduce the aircraft's speed, reduce climb or descent rate, hold, add extra time to pre-flight and post-flight periods.
Set Priorities	Safety first, fly the airplane - aviate, navigate, communicate.

Figure 5-8. Tools to aid in executing efficient time management.

Cohesive Teamwork for Single- and Multi-Pilot Operations

The fourth layer of defense in the TEM Toolkit is cohesive teamwork. Whether operating as a single pilot or as part of a crew, teamwork will enable you to manage task loading with additional flexibility than provided by efficient time management alone. The workload will inevitably become too great, so you should find a way to reassign task loading to others. [Figure 5-9]

Teamwork Tools	
Balance Tasks Within the Flight Deck	CRM – if one pilot is busy and the other is not, redistribute tasks. SRM – if a passenger can assist, ask for their help.
Off-Load Tasks Outside the Flight Deck	CRM – call dispatch, ATC, etc. SRM – call flight service, ATC, etc.

Figure 5-9. Tools to aid in fostering cohesive teamwork for single- and multi-pilot operations.

Proficient Automation Management

The fifth layer of defense in the TEM Toolkit is proficient automation management. The use of automation from automatic flight control systems, advanced, glass-cockpit avionics, and area navigation computers demand familiarity and proficiency in their operation. [Figure 5-10] Automation management will be discussed in greater detail in Chapter 6, Automation Management.

Automation Management Tools	
Visualize	Understand how the automation works, what will happen after a button is pushed or a knob is turned, preview the action and maneuver in your mind.
Act	Execute button pushes and knob turns to implement the desired automation.
Compare	Anticipate the aircraft's or avionics' response, ensure the aircraft or avionics performs as expected, matches your inputs, and matches your intentions.

Figure 5-10. Tools to aid in practicing proficient automation management.

Effective Situational Awareness

The sixth layer of defense in the TEM Toolkit is effective situational awareness (SA)⁹. [Figure 5-11] Situational awareness is a topic of lengthy research spanning decades, with influential research proposed by Mica Endsley. That research ultimately resulted in a three-level, serial model of situational awareness. [Figure 5-12]¹⁰ A later study found that over 76% of general aviation situational awareness errors were caused by failures in perception of the environmental variables necessary for achieving or maintaining situational awareness.¹¹

⁹ Endsley, M. R. (1988). Situation awareness global assessment technique (SAGAT). *Proceedings of the IEEE 1988 National Aerospace and Electronics Conference*, 3, 789-795. doi:10.1109/NAECON.1988.195097

¹⁰ Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 37, 32-64. doi:10.1518/001872095779049543

¹¹ Endsley, M. R., & Garland, D. J. (2000). Pilot situation awareness training in general aviation. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 357-360. doi:10.1177/154193120004401107

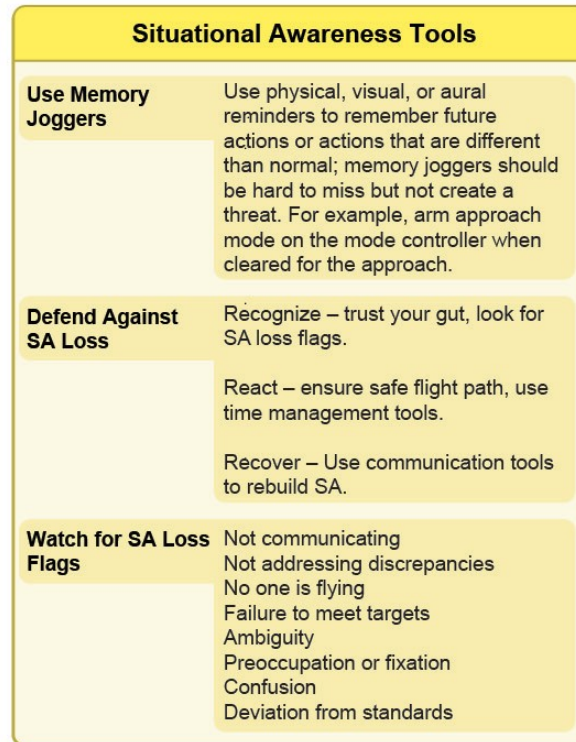


Figure 5-11. Tools to aid in maintaining or regaining effective situational awareness.

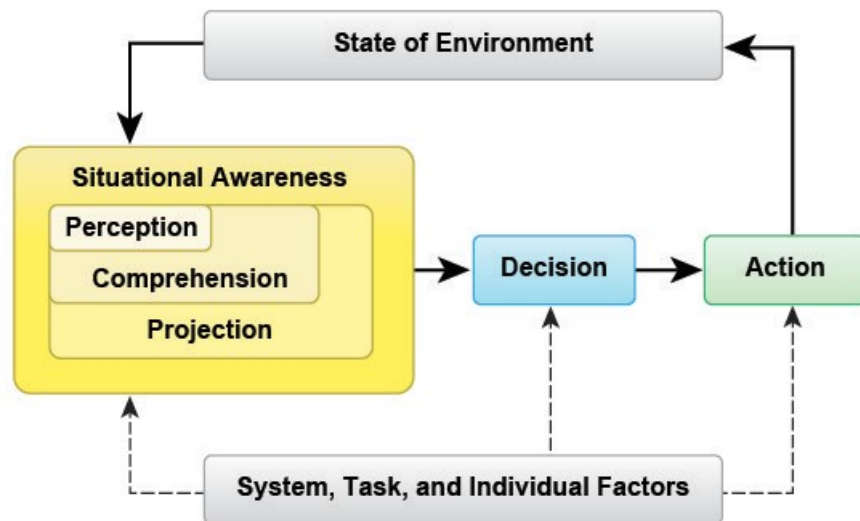


Figure 5-12. Situational awareness is composed of three levels—perception of the variables in the environment, comprehension of their meaning, and projection of their status in the near future. With accurate situational awareness, effective decision-making can take place. System, task, and individual factors can affect the accuracy of situational awareness or the decisions or actions based on it.

Your Flying Skills (The Last Resort)

The last line of defense is your fundamental flying skills. Employing this defense becomes necessary after experiencing an undesired aircraft state that cannot be remedied with other defenses alone. Your ability to take full control of the aircraft and return to safe flying parameters is of critical importance. The need to do this resulted because of failures to employ the proper defenses in preventing threats and trapping errors before they impacted the flight operation. However, some of those same defenses may now be required in conjunction with manually flying the airplane, such as regaining or maintaining situational awareness.

There is one thought that is easy to remember to help avoid these precarious undesired aircraft states. You should never have to know how good of a pilot you really are. With this in mind, it is important to always train, remain current, remain proficient, improve knowledge, risk management, and skill, and always be prepared to handle any situation. Ideally, however, you should never have to rely

on this last defense because your ability to defend against threats and errors will improve through proficiency and discipline.

Proficiency

With regard to proficiency, a pilot who remains proficient is better prepared to defend against threats, errors, and undesired aircraft states, and becomes a defense themselves. A pilot who seeks to improve proficiency over time is even better defended. This can be depicted by again viewing proficiency in the context of the Swiss cheese model. [Figure 5-13] Remember that each piece of Swiss cheese is a defense against threats, errors, and undesired aircraft states. Each of the holes in the cheese is a weakness in those defenses. The greater the level of proficiency you exhibit and pursue, the smaller the holes are and the stronger your defenses. For example, do you remain instrument current by renting an FTD at your local flight school every six months? When you do, do you fly familiar approaches? Or, do you challenge yourself and fly approaches in new areas that are more challenging than the ones you normally encounter? Do you rent the FTD more often than every six months? Do you go with an aviation instructor in actual instrument conditions when they are present to get real-world experience? These are the types of questions you can ask yourself to decide if you are proficient, or simply remaining current.

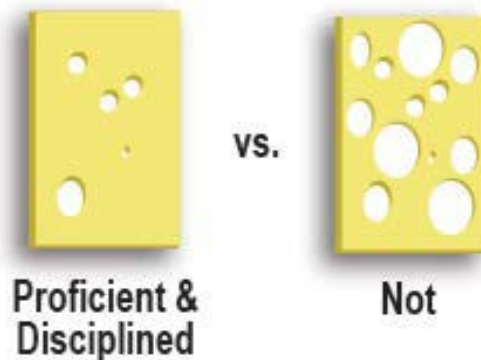


Figure 5-13. Increased proficiency and discipline reduce the likelihood of threats and errors from passing through the TEM defense layers.

Discipline

The same can be said of discipline. Just like proficiency, discipline will make the holes in each piece of cheese, the weakness in one's defenses, smaller. Discipline stems from good training and foundational habit patterns. A disciplined pilot will perform a task in a similar manner each time regardless of proficiency. For example, completing the preflight inspection of the aircraft by using and following the approved checklist every time is a mark of discipline. Discipline also affects aeronautical decision making. A disciplined pilot will be guarded and inoculated against the hazardous attitudes and operational pitfalls, as shown in Figure 5-14 and explained in Chapter 2 of the *Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)*. In general, a disciplined pilot will always do the right thing, even when nobody is watching. A personal minimums checklist can help form a foundation for disciplined decision making. Personal minimums and aeronautical decision making will be discussed later in Chapter 7, ADM, SRM, and Personal Minimums.



Figure 5-14. Discipline reduces the likelihood of falling victim to hazardous attitudes and operation pitfalls.

Chapter Summary

The risk management process used during the planning phases of a flight goes a long way toward reducing risk and ensuring a safe operation. However, as humans, pilots are prone to error and will not be able to plan for every threat faced during flight. It is important to recognize and accept the fact that pilots make mistakes. Threat and error management is an effective method of managing the threats that are faced during flight and the resultant errors made by pilots. The TEM Toolkit provides pilots with simple, actionable management techniques. If a threat or error is not properly managed, recovery from the resultant undesired aircraft state is necessary to avoid an incident or accident. In addition, emphasis on proficiency and discipline can strengthen a pilot's ability to perform defensive flying.

Chapter 6:

Automation Management

Introduction

A greater amount of technology is included in aircraft with each new entrant into the market or for each new model year of an existing airframe. It has become appropriate to define these aircraft for purposes of training and proficiency. In general aviation, these aircraft are called technically advanced aircraft. According to 14 CFR Part 61, technically advanced aircraft, or TAA, are aircraft that have an advanced avionics system that includes a primary flight display (PFD) showing the six primary flight instruments, a multifunction display (MFD) that has a moving map showing aircraft position based on a global positioning system (GPS), and a two-axis autopilot capable of tracking heading and navigation guidance signals. The information required to be displayed on the PFD and MFD must be continuously visible.

Most TAA have greater functionality, integration, and information display capabilities than the minimum requirements. *[Figure 6-1]* Here is an explanation of some of these technologies:

- Electronic navigation and charting databases allow access and display of procedures, routing, and charting information.
- Data links and hazard databases provide the capability to display real-time traffic, weather, terrain, and obstacle information on the moving map relative to the aircraft's position.
- Integrated flight management systems (FMS) provide an efficient means of loading and programming horizontal and vertical flight path information that can be tracked by the autopilot or followed manually by the pilot using flight director and other guidance cues.
- Synthetic vision systems replicate the terrain, airspace, and traffic information in a three-dimensional, computer-generated image on the PFD.
- Electronic flight bags (EFB), either portable or integrated, allow the pilot to carry all necessary aeronautical, performance, weight and balance, and aircraft checklists in digital form and may allow remote manipulation of the avionics through wireless radio connections.



Figure 6-1. Electronic flight instrumentation comes in many systems and provides a myriad of information to the pilot.

TAA are electronically complex like airplanes with retractable landing gear, flaps, and a controllable pitch propeller are mechanically complex. In both cases, specific knowledge, risk management, and skill are necessary to safely operate these aircraft. Proper automation and flight path management is critical for reducing risk. This chapter will guide you through risk management elements of operating TAA and provide you the tools and techniques needed to be proficient when operating TAA.

Flight Deck Automation Study

Concerns about the effect of automation on flight skills are not new. In 1995, the erosion of manual flight skills due to automation was examined in a study designed by Patrick R. Veillette and R. Decker. Their conclusions are documented in “Differences in Aircrew Manual Skills and Automated and Conventional Flightdecks,” published in the April 1995 edition of the Transportation Research Record, an academic journal of the National Research Council. In the February 2006 issue of Business and Commercial Aviation (BCA), Dr. Patrick R. Veillette returned to this topic in his article “Watching and Waning.”

The Veillette-Decker study on automation came at a time when automated flight decks were entering everyday line operations and concern was growing about some of the unanticipated side effects. Deterioration of basic pilot skills was one of these concerns. While automation made the promise of reducing human mistakes, in some instances it created larger errors. When this study was undertaken, the workload in an automated flight deck in the terminal environment seemed higher than in the conventional flight decks. At other times, automation seemed to lull the flight crews into complacency. Fears arose that the manual flying skills of flight crews using automation deteriorated due to an over-reliance on computers. The British Airline Pilots Association (BALPA) voiced the fear that pilots using automation have less stick-and-rudder proficiency when those skills were needed to resume direct manual control of the aircraft.

Thus, the Veillette-Decker study sought to determine what, if any, possible differences exist in manual flight skills between aircrews assigned to conventional and automated flight decks. Limited to normal and abnormal operations in terminal airspace, it sought to determine the degree of difference in manual flight path management. Commercial airline flight crewmembers flying the conventional transport aircraft or the automated version were observed during line-oriented flight training.

The data set included various flight path parameters such as heading, altitude, airspeed, glideslope, and localizer deviations, as well as pilot control inputs. These were recorded during a variety of normal, abnormal, and emergency maneuvers during four-hour simulator sessions. All experimental participants were commercial airline pilots holding airline transport pilot certificates. The control group was composed of pilots who flew an older model of a common twin-jet airliner equipped with analog instrumentation. The experimental group was composed of pilots who flew newer models of that same aircraft equipped with an electronic flight instrument system (EFIS) and FMS.

When pilots who had flown EFIS for several years were required to fly various maneuvers manually, the flight path parameters and flight control inputs showed some erosion of flying skills. During normal maneuvers, the EFIS group exhibited somewhat greater deviations than the conventional group. Most of the time, the deviations were within the then-effective practical test standards, but the pilots did not maintain the localizer and glideslope as smoothly as the conventional group. The differences in hand-flying skills between the two groups became more significant during abnormal maneuvers such as steeper than normal visual approaches.

Analysis of the flight path data consistently showed pilots of automated aircraft had greater deviations from assigned courses and aircraft state parameters, and greater deviations from normal pitch and bank attitudes, than the pilots of conventional flight deck aircraft. *[Figure 6-2]* The most significant differences were found to occur during the approach and landing phases. It is industry practice to tolerate very little flight path deviations from the recommended values during approach and landing.



Figure 6-2. Two flight decks equipped with the same information but in two different formats: analog and digital. What are they indicating? Chances are that the analog pilot reviews the top display before the bottom display. Conversely, the digitally trained pilot reviews the instrument panel on the bottom first.

Another situation used in the simulator experiment reflected common approach changes assigned on short notice. While the pilots' lack of familiarity with the EFIS was often an issue, the approach would have been made easier by disengaging automated systems and manually flying the approach.

The emergency maneuver, engine-inoperative instrument landing system (ILS) approach, also showed the same performance differences in manual flying skills between the two groups. The conventional pilots tended to fly by referencing raw data and, when given an engine failure, they performed it expertly. When EFIS crews had their flight directors disabled, their instrument scan began a more erratic searching pattern and their manual flying subsequently suffered. According to Dr. Veillette's 2005 article, those who reviewed the data "saw that the EFIS pilots who better managed the automation also had better flying skills."

While the Veillette-Decker study offered valuable information on the effects of flight deck automation flight path management, experience now shows that increased workload from advanced avionics occurs during critical phases of flight. Prior to the increase in automation, pilots were busiest during takeoff and approach or landing. Now, most of the workload occurs before takeoff and before landing when it is common to receive routing and approach changes that require reprogramming the avionics.

Reprogramming tasks that occur during the approach to landing phase are threats that can trigger pilot errors and result in flight path deviations or other undesired aircraft states. Whether operating as a single pilot or part of a multi-pilot crew, it is important to anticipate these changes and use the tools in the TEM Toolkit to help you. Doing so may allow you to prevent the threats from creating errors and deviating from the desired horizontal and vertical flight path parameters and aircraft state.

Balancing Automated and Manual Flight

Flight in TAA can involve the use of varying levels of automation. This range can be from completely manual flight using only visual or raw data instrument references to completely automated flight using advanced FMS and autopilot functions from just after takeoff to just prior to landing. The best method is a balanced mixture of automated and manual flight that takes into consideration your workload and proficiency with the equipment and avionics. Risk management strategies should guide you to using automation as an aid to managing workload instead of as a crutch to make up for manual flying proficiency. Consider using a level of automation that eases your workload but allows you to remain engaged and alert and actively monitor the flight path and aircraft state.

An example of how increasing the level of automation use can assist you with workload occurs during the arrival phase of flight. Imagine you are flying along your desired route of flight using manual flight control inputs while tracking the course deviation indicator (CDI). The CDI is selected to show deviation from GPS route programmed and displayed on the MFD. You are using the CDI for lateral flight path deviations and you are referencing the altimeter and vertical speed indicator for vertical flight path deviations. You are flying accurately and within acceptable standards. However, the time has come for you to listen to and record the automatic terminal information service (ATIS) at the destination airport. The ATIS informs you of the active runway and approach. So, you retrieve, load, and brief the appropriate instrument approach procedure. You also decide to review and complete the arrival or descent checklist. Many of these tasks will take your attention away from monitoring and controlling flight path, and deviations are likely to occur. You decide to engage the autopilot, setting it to track the CDI and maintain the assigned altitude. In this example, the use of the autopilot substitutes for your manual control inputs to accurately maintain the desired flight path, while allowing the attentive and physical capacity to complete these other tasks quickly and efficiently.

An example of how decreasing the level of automation use can prevent excessive workload occurs during the approach phase of flight. Continuing the scenario above, imagine that after completing the tasks above you decide to remain on automated flight for the remainder of the arrival and instrument approach. The GPS or FMS is programmed to the destination and you loaded the instrument approach. The autopilot's approach mode is armed. You pass the initial approach fix (IAF) and ATC clears you for the instrument approach. However, after only a couple minutes, ATC cancels your approach clearance and issues vectors back to the IAF, asking you to hold for 20 minutes. The aircraft that landed in front of you became disabled and the runway is temporarily closed. This change is unexpected. You know that you will first have to select different autopilot modes to comply with the ATC vectors. Then, because the aircraft is already past the initial approach fix, it will take some effort to reprogram the GPS or FMS to go back to the IAF and enter holding. You realize that all this reprogramming will suddenly increase workload. You decide to disengage the autopilot and manually fly the aircraft, complying with the heading and altitude assignment from ATC. You select the IAF as the active waypoint in the GPS or FMS, but manually manipulate the OBS as necessary to set the holding course and prepare for the holding pattern entry. You also reconfigure the aircraft for holding. In this example, the continued use of the autopilot and FMS would have created an excessive workload, likely leading to errors and flight path deviations. Reducing the level of automation allows you to quickly respond to unexpected changes.

The scenario above illustrates how automation tools from the TEM Toolkit and the programming category of the 5P check was used during the descending phase of flight to effectively manage workload and flight path. The TEM Toolkit was discussed in greater detail in Chapter 5, Threat and Error Management, and the 5P check for single-pilot resource management will be covered in detail in Chapter 7, ADM, SRM, and Personal Minimums.

It is recommended that you occasionally disengage the automation and manually fly the aircraft to maintain manual flying proficiency. Manual flying proficiency should remain within the standards outlined in the appropriate ACS or PTS.

Interacting with Automation

Regardless of the level of automation you choose to use, you should always visualize, act, and compare when

interacting with it. [Figure 6-3] This repeating cycle has the following steps:

1. **Visualize** – Understand how the automation works, what will happen after a button is pushed or a knob is turned, and preview the action and maneuver in your mind.
2. **Act** – Execute button pushes and knob turns to implement the desired automation.
3. **Compare** – Anticipate the aircraft's or avionics' response and ensure the aircraft or avionics performs as expected, matches your inputs, and matches your intentions.

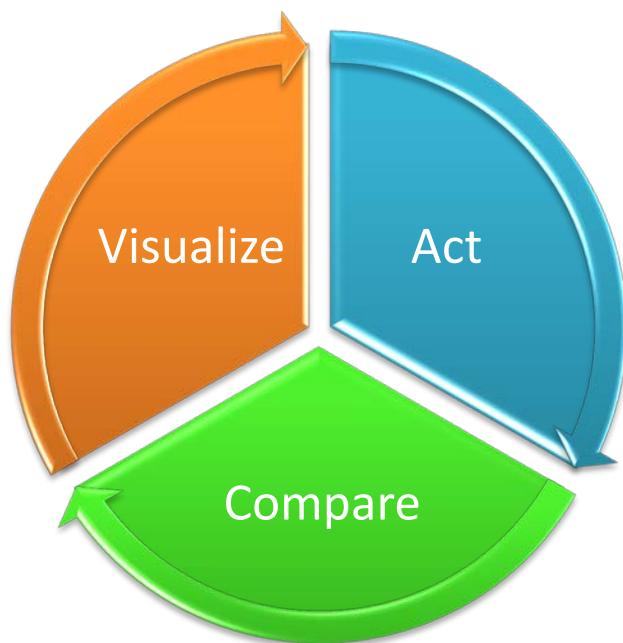


Figure 6-3. An effective cycle for proper interaction with automated systems

Particular to autopilot systems, it is important to understand the mode of operation at any time during this interaction cycle. Knowledge about the operation of the mode controller and displays and indications of the mode annunciator are critical in applying the visualize, act, and compare cycle. Figure 6-4 shows a typical mode annunciator displayed on the PFD of a general aviation integrated flight deck. The mode annunciator shows whether the autopilot is engaged, which horizontal and vertical flight path modes are active, and which horizontal and flight path modes are armed and waiting to take over, if applicable. Typically, green annunciators show active modes and white annunciators show armed modes. Yellow, red, or flashing annunciators show various methods of mode cancellation or autopilot disengagement. Audio tones may be associated with certain autopilot functions.

LOC	HDG	AP	ALT	9000FT	GS
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Figure 6-4. Mode annunciator showing the autopilot is engaged, tracking heading, and maintaining 9,000 feet MSL. The approach mode is armed and the autopilot is waiting to capture the localizer and glideslope for an ILS approach.

Proper automation management also requires a thorough understanding of how the autopilot interacts with the other systems. For example, with some autopilots, changing the navigation source on the horizontal situation indicator (HSI) from GPS to localizer (LOC) while the autopilot is engaged in NAV (course tracking mode) causes the NAV mode to automatically disengage. This may be annunciated by a flashing NAV annunciator, indicating interruption of the navigation source. Horizontal flight path control may default to wings level mode until the pilot acts to reengage the NAV mode to track the new navigation source.

Failure to Visualize, Act, and Compare

Technically advanced aircraft may offer increased safety with enhanced situational awareness. However, without

a well-planned information management and an automation management strategy, they can also make it more likely for a pilot to become complacent and unprepared.

Consider the pilot whose plan is to load the course in the GPS and simply follow the magenta line on the moving map. There may be an increased risk of CFIT or unauthorized airspace penetration if no other considerations are made. The risk becomes greatly enhanced if the moving map or GPS fails and the pilot is not prepared or proficient with an alternate means of navigation.

Risk is also increased when the pilot fails to monitor automated systems. By failing to visualize, act, and compare, the pilot becomes disengaged from and complacent with aircraft operation. This type of complacency led to tragedy in a 1999 aircraft accident in Colombia. A multiengine aircraft flown by two flight crewmembers struck the face of the Andes Mountains. Examination of the FMS revealed the pilots incorrectly entered a waypoint into the FMS, resulting in a flight path taking them to a point 60 nautical miles off the intended course. The pilots were equipped with the proper charts, their route was posted on the charts, and they had a paper navigation log indicating the direction of each leg. They had all the tools to manage and monitor the flight path but instead allowed the automation to fly unchecked. The system did exactly what it was programmed to do; it flew on a programmed path into a mountain, resulting in multiple deaths. The pilots' error created a flight path deviation or undesired aircraft state. In this case, an avoidable accident became a tragedy through simple pilot error and complacency.

Not only did the pilots fail to fully monitor the aircraft's flight path, they also failed to retract the spoilers after adding full thrust. This prevented the aircraft from climbing above the slope of the mountain. Simulations of the accident indicate that, had the aircraft been equipped with automatic spoiler retraction (spoilers automatically retract upon application of maximum thrust), or had the pilots remembered to retract the spoilers, the aircraft probably would have missed the mountain.

Getting Proficient with Automated Systems

The key to working effectively with automation is getting beyond the deliberate, conscious inputs that are normal when first learning to fly TAA. This mechanical interaction indicates a lack of proficiency with the system and increased risk when attempting to use it. Through repeated practice and training, you should strive to operate automated systems in an organic and natural way just like manual flight control inputs become second nature and seem to be accomplished with little thought. To do this, focus on the knowledge, risk management, and skill elements of automated systems operation.

Knowledge elements should include understanding the system design and integration with other systems. The individual system components should also be understood. For example, an autopilot system will not only include the mode controller and mode annunciator but also several flight control servos. Knowledge of system limitations and operating restrictions is also important. You should also memorize any pertinent emergency procedures and be aware of and able to quickly locate abnormal checklists. Reviewing the system documentation and aircraft flight manual supplements is critical to developing this knowledge.

Risk management elements include understanding when and how to use automation as an aid to reduce workload and enhancing situational awareness. Use of autopilot systems is an excellent risk control measure when attempting mitigate risks associated complex flight environments. Autopilots are especially useful during single pilot operations, but only if used at the appropriate time and at the appropriate level. While use of automation helps reduce risk associated with other hazards, lack of proficiency with automation can become its own hazard and introduce unique risks.

Skill elements include being able to accurately use automated systems throughout all phases of flight. As will be discussed in Chapter 7, ADM, SRM, and Personal Minimums, the 5P check makes a good framework around which you can structure your training and practice. Be sure you can use the automation and autopilot systems during each of those five phases of flight. You should train and practice under VFR with an appropriately qualified and knowledgeable flight instructor or safety pilot before attempting IFR flight.

However, do not neglect manual flying skills. Before training and practicing with automation, you should be able to fly the aircraft manually within appropriate standards. A safety issue identified by the FAA concerns pilots who develop an overreliance on automation, believing the equipment compensates for lack of manual flying proficiency. Also involved is improper aeronautical decision-making. An FAA technically advanced aircraft safety study found that poor aeronautical decision-making seemed to afflict new TAA pilots at a rate higher than that of general aviation as a whole. The review of TAA accidents cited in this study showed that the majority are caused by lack of experience and a chain of poor aeronautical decisions. One consistent theme in

many of the fatal accidents was continued VFR flight into IMC.

Chapter Summary

The increased use of automated systems, autopilots, and integrated flight decks in general aviation has led to the designation of aircraft with these systems as technically advanced aircraft, or TAA. Autopilots, while permitting automated flight path management, are not the only automated systems on board, and many automated systems provided capability that far exceeds the minimum requirements defined by regulation. Balancing the use of automation with manual flying skills is necessary for pilots to remain engaged and alert with the progression of the flight. Using TEM tools and single-pilot resource management techniques is important. Interacting with the automated systems in a proficient manner may reduce risk and help prevent incidents and accidents.

Chapter 7:

ADM, SRM, and Personal Minimums

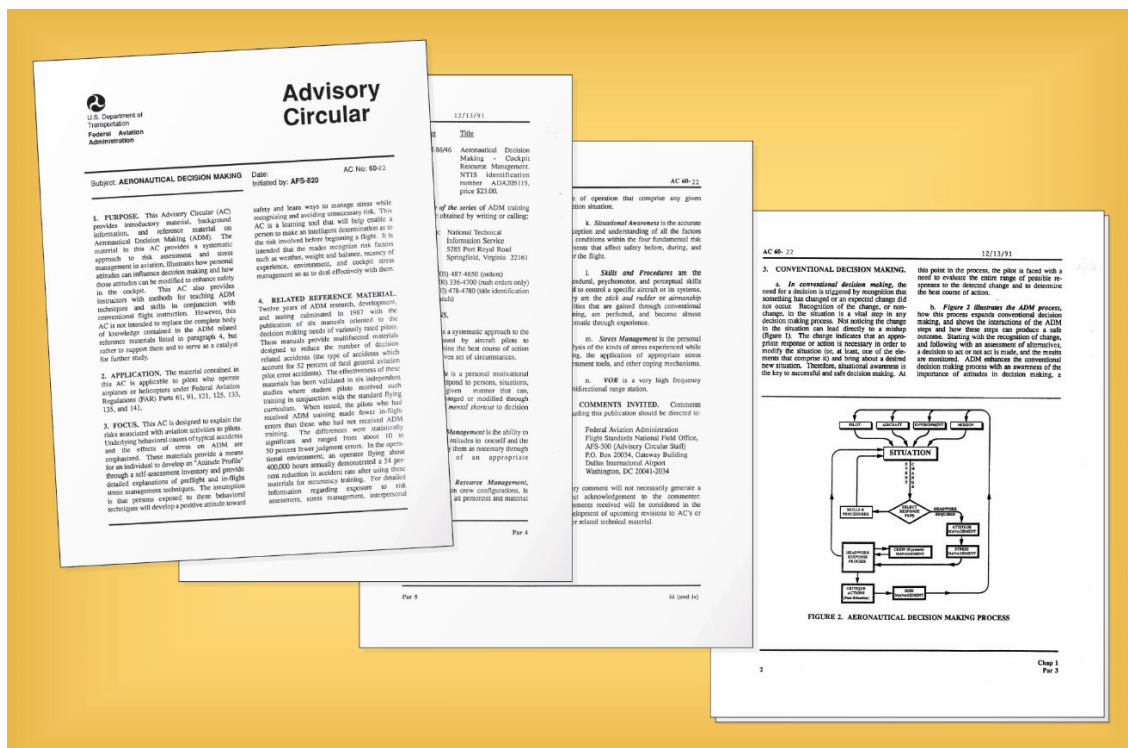
Introduction

Aeronautical Decision-Making (ADM) is a cornerstone in managing risk. ADM provides a structured framework utilizing known processes and applying recognized pathways, which individually and collectively have a positive effect on exposure to hazards. This is not achieved by reducing the hazard itself, but by helping the pilot recognize hazards that need attention.

ADM is a systematic approach to the mental process used by pilots to consistently determine the best course of action in response to a given set of circumstances. It is what a pilot intends to do based on the latest information he or she has.

The importance of learning and understanding effective ADM skills cannot be overemphasized. While progress is continually being made in the advancement of pilot training methods, aircraft equipment and systems, and services for pilots, accidents still occur. Despite all the changes in technology to improve flight safety, one factor remains the same: the human factor, which leads to errors.

This chapter focuses on helping the pilot improve his or her ADM skills to mitigate the risk factors associated with flight. Advisory Circular (AC) 60-22, Aeronautical Decision-Making, provides background references, definitions, and other pertinent information about ADM training in the general aviation environment. [Figure 7-1]



History of ADM

For many years, the importance of good pilot judgment, or ADM, has been recognized as critical to the safe operation of aircraft, as well as accident avoidance. Research in this area prompted the Federal Aviation Administration (FAA) to produce training directed at improving the decision-making of pilots and led to

current FAA regulations that require that decision-making be taught as part of the pilot training curriculum. ADM research, development, and testing culminated in 1987 with the publication of six manuals oriented to the decision-making needs of differently rated pilots. These manuals provided multifaceted materials designed to reduce the number of decision-making-related accidents. The effectiveness of these materials was validated in independent studies where student pilots received such training in conjunction with the standard flying curriculum. When tested, the pilots who had received ADM training made fewer in-flight errors than those who had not received ADM training. The differences were statistically significant and ranged from about 10 to 50 percent fewer judgment errors. In the operational environment, an operator flying about 400,000 hours annually demonstrated a 54 percent reduction in accident rate after using these materials for recurrent training.

Good judgment can be taught. Tradition held that good judgment was a natural by-product of experience, and as pilots continued to log accident-free flight hours, a corresponding increase of good judgment was assumed. Building upon the foundation of conventional decision-making, ADM enhances the process to decrease the probability of human error and increase the probability of a safe flight. ADM provides a structured, systematic approach to analyzing changes that occur during a flight and how these changes might affect a flight's safe outcome. The ADM process addresses all aspects of decision-making in the flight deck and identifies the steps involved in good decision-making.

Steps for good decision-making are:

1. Identifying personal attitudes hazardous to safe flight.
2. Learning behavior modification techniques.
3. Learning how to recognize and cope with stress.
4. Developing risk assessment skills.
5. Using all resources.
6. Evaluating the effectiveness of one's ADM skills.

ADM results in helping to manage risk. When a pilot follows good decision-making practices, the inherent risk in a flight may be reduced or even eliminated. The ability to make good decisions is based upon direct or indirect experience and education.

Consider automobile seat belt use. Seat belt use has become the norm, placing those who do not wear seat belts outside the norm, but this group may learn to wear a seat belt by either direct or indirect experience. For example, a driver learns through direct experience about the value of wearing a seat belt when he or she is involved in a car accident that leads to a personal injury. An indirect learning experience occurs when a loved one is injured during a car accident because he or she failed to wear a seat belt.

Analytical Decision-Making

Analytical decision-making takes both time and evaluation of options. A form of this type of decision-making is based upon the acronym DECIDE. It is a six-step process for the pilot to logically make good aeronautical decisions. The scenario below is based on a pilot who flew from Houston, Texas to Jacksonville, Florida in a two-engine turbo propeller airplane, and failed to use the decision-making process correctly and to his advantage.

Detect a change or hazard. In the case at hand, the pilot was running late after conducting business meetings early in the morning. He and his family departed one hour later than expected. In this case, one would assess the late departure for impact to include the need to amend the arrival time. However, if the pilot is impulsive, these circumstances translate into a hazard. Because this pilot was in a hurry, he did not assess for impact and, as a result, did not amend the arrival time. The key in any decision-making is detecting the situation and its subtleties as a hazard; otherwise, the pilot takes no action. It is often the case that the pilot fails to see the hazard evolving. On the other hand, a pilot who perceives and understands the hazard, yet decides to ignore it, does not benefit from a decision-making process; the issue is not one of decision-making, but one of attitude.

Estimate the need to counter or react to the change. As the pilot progressed to the destination, it became apparent that the destination weather for Jacksonville Executive at Craig (KCRG) was forecast to be below approach minimums due to fog at the time of arrival. However, weather at an alternate airport just 40 miles away was visual flight rules (VFR). At this time, the pilot should have assessed several factors to include the probability of making a successful approach and landing at KCRG versus using an alternative destination. In one case, the approach is certainly challenging, but it is an approach at the intended destination. The other location unaffected by weather is inconvenient to the personnel waiting on the ground, requiring that they drive 40 miles to meet the pilot and his family, but has better weather and a greater probability of a successful approach and landing.

Choose a desirable outcome for the flight. Selecting a desirable outcome requires objectivity, and this is when pilots make grave errors. Instead of selecting the outcome with consideration to challenges of airmanship, pilots typically select an outcome that is convenient for both themselves and others. And without other on board or external input, the choice is not only flawed but also reinforced by their rationale. In this case, the pilot intends to attempt an approach at KCRG despite 100-foot ceilings with ¼ mile visibility.

Identify actions that can successfully control the change. In the situation being discussed, the pilot looks at success as meeting several objectives:

1. Being on time and landing at the planned airport
2. Not inconveniencing his relatives waiting on the ground
3. Meeting his predisposed objective of landing at KCRG

The pilot considered these objectives as a success but failed to consider the safety of his family as a success.

Do take the necessary action. In this case, the pilot contaminates his decision-making process and selects an approach to the instrument landing system (ILS) approach to runway 32 at KCRG where the weather was reported far below the minimums.

Evaluate the effect of the action. In many cases like this, the pilot is so sure of his or her decision that the evaluation phase of the action is simply verifying the aircraft is on track and glideslope, despite impossible conditions for a safe landing. Because the situation seems in control, the pilot does not evaluate the flight's progress.

The outcome of this accident was predictable considering the motivation of the pilot and his failure to monitor the approach. The pilot, well above the decision height, saw a row of lights to his right that the pilot thought was the runway environment. Instead of confirming his aircraft's position, the pilot took over manually, and flew toward the lights, descended below the glidepath, and impacted terrain. The passengers survived, but the pilot was killed.

Automatic Decision-Making

In an emergency, a pilot might not survive if he or she rigorously applied analytical models to every decision made; there is not enough time to go through all the options. Under these circumstances, how does a pilot find the best possible solution to every problem?

Research into how people make decisions reveals that when pressed for time, experts faced with a task loaded with uncertainty, first assess whether the situation strikes them as familiar. Rather than comparing the pros and cons of different actions, experts quickly imagine how possible courses of action will play out. Experts take the first workable option they can find. While it may not be the best of all possible choices, it often yields remarkably good results.

In the automatic decision-making model (sometimes called naturalistic decision-making), the emphasis is recognizing a problem paired with a solution that is cultivated through both experience and training. In theory, the automatic decision-making model seeks a quick decision at the cost of absolute accuracy where prolonged analysis is not practical. Naturalistic decision-making is generally used during emergencies where slow responsiveness is problematic and potentially additive to a problem.

The terms naturalistic and automatic decision-making describe this type of decision-making. These processes were pioneered by Mr. Gary Kleinn, a research psychologist famous for his work in the field of automatic/naturalistic decision-making. Kleinn discovered that laboratory models of decision-making could not describe decision-making during rapidly changing and uncertain conditions.

His processes have influenced changes in the ways the United States Marines and Army train their officers to make decisions and are now impacting decision-making as used within the aviation environment. The ability to make automatic decisions holds for a range of experts from firefighters to police officers. It appears the expert's ability hinges on the recognition of patterns and consistencies that clarify options in complex situations. Experts appear to make provisional sense of a situation, without actually reaching a decision, by launching experience-based actions that in turn trigger creative revisions.

This is a reflexive type of decision-making anchored in training and experience and is most often used in times of emergencies when there is no time to practice analytical decision-making. Naturalistic or automatic decision-making improves with training and experience, and a pilot may use a combination of decision-making tools that correlate with individual experience and training. *Figure 7-2* illustrates the differences between traditional, or analytical decision-making and naturalistic decision-making.

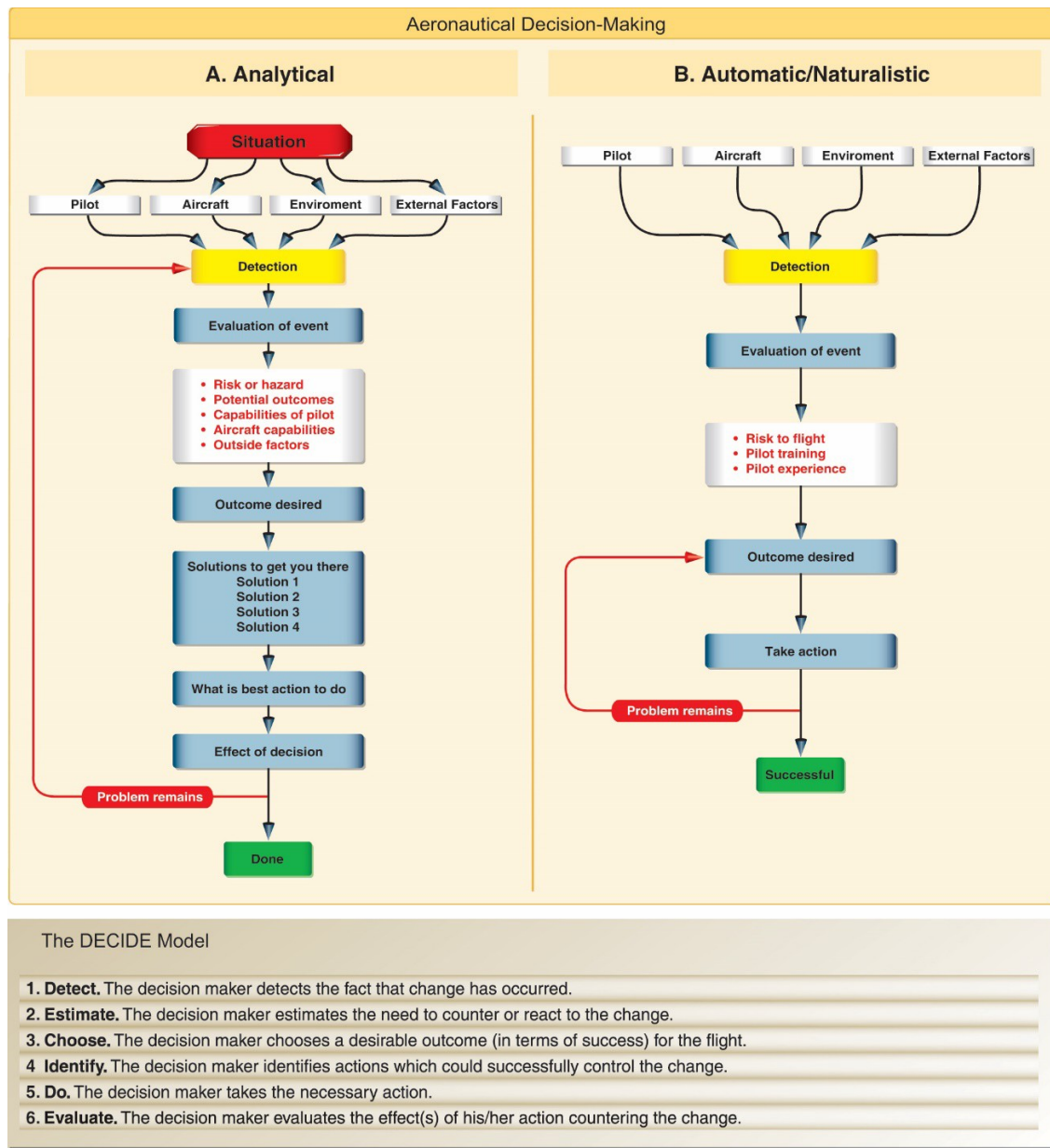


Figure 7-2. The illustration shows how the DECIDE model is used in decision-making and follows the five steps shown.

Single-Pilot Resource Management

Single-pilot resource management (SRM) is the set of competencies that include situational awareness, communication skills, teamwork, task allocation, aeronautical decision making, risk management, controlled flight into terrain (CFIT) awareness, and automation management. SRM specifically refers to the management of all resources available to the single pilot. Resources are found both inside and outside the flight deck. Many of the concepts are similar to crew resource management (CRM). The use of available resources, such as air traffic control (ATC) and flight service, replicates the principles of CRM.

Useful tools and sources of information may not always be readily apparent. Learning to recognize these resources is an essential part of SRM. In addition to identifying resources, a pilot should develop the skills to evaluate whether there is time to use a particular resource. For example, ATC assistance may be very useful if a pilot becomes lost, but there may be no time to contact ATC in an emergency. During an emergency, a pilot makes an automatic decision and prioritizes tasks and workload accordingly. Calling ATC may take away from the time available to solve the problem. However, there is often more time available than the pilot realizes. The perception of time “flying” or “dragging” is based on various factors. If the pilot were to repeat the time-critical event but had been briefed on the impending situation and could plan for it, the pilot would not feel the pressure of time “flying.” This demonstrates that proper training and physiological well-being is critical to flying safety.

SRM and the 5P Check

As explained previously, SRM involves the management and effective use of all resources available to the single pilot. It is important for the PIC to learn how to organize and manage both internal and external resources and to gather and use the information each of those resources provides. Doing so may strengthen the PIC’s ability to identify hazards and associated risks, assess and manage risk, manage threats and errors, and make informed aeronautical decisions. One practical method of single-pilot resource management is the 5P check. [Figure 7-3] The 5 Ps, along with some examples, are:

Plan	Plane	Pilot	Passengers	Programming
<ul style="list-style-type: none"> •Flight Plan •Weather •Charts •EFB 	<ul style="list-style-type: none"> •Avionics •MFD •Data Links •Instruments 	<ul style="list-style-type: none"> •Manage Risk •Communicate •SA •ADM 	<ul style="list-style-type: none"> •Confirm Gear •Alert the pilot •Briefings •Emergencies 	<ul style="list-style-type: none"> •FMS •Autopilot •Auto systems •Workload

Figure 7-3. The 5P check is used by the single pilot to organize resources and information that impact hazard identification, risk assessment, and ADM.

The Plan

The first P of the 5P check is the plan. The plan can also be called the mission or the task. It contains the basic elements of cross-country planning: weather, route, fuel, current publications, etc. The plan should be reviewed, updated, and referenced several times during the flight. It is incumbent on the pilot to collect all possible information during the preflight planning process. More importantly is the ability to effectively organize the information in an accessible manner. The pilot should attempt to think of all possible scenarios that may be encountered during the flight. Even if the scenario has a remote chance of occurring, such as a diversion or precautionary landing, it will be greatly beneficial to have any needed information at hand.

For example, while en route to an airport that has your favorite lunch spot nearby, the alternator fails. After completing the appropriate checklist, the alternator remains offline. You know the airplane’s battery will only provide electricity for a short time, so you decide to divert to the nearest airport to get it fixed. Now is when the plan comes into play. Did you familiarize yourself with airports along the route of flight that are suitable to land at? Which of those airports have a maintenance facility available? Did you note these airports and organize your personal and flight deck resources to be able to easily access information such as communication frequencies and navigation aids?

It is important to note that the plan in the 5P check is not about gathering all the information ahead of time, but about organizing the informational resources you have available to quickly access and use the information those resources provide when needed. Some pilots may make notations or other markings directly on their sectional or low altitude en route charts. Others may create binders or kneeboard pockets that are dedicated to specific types of planning information pertinent to the flight. Still others may make use of modern technology and bookmark or save information in an organized manner in their electronic flight bag. Keep in mind that just because the information is available does not mean that it is accessible or usable.

The Plane

The second P of the 5P check is the plane. The plane, in this case, represents any type of aircraft. The aircraft you fly includes many resources available to your disposal. Avionics are normally thought of first. Avionics allow you to communicate with air traffic control and navigate using a variety of navigation aids. Modern, technically advance aircraft often include moving map displays, real-time weather and traffic data link

capabilities, hazard avoidance cautions and warnings, and synthetic vision and other augmented navigational capabilities.

In addition to avionics and autopilots, traditional aircraft systems and instrumentation are also resources to you. If available, backup or emergency systems may be activated when needed. Instrumentation can be used to confirm indications, noises, or suspicions about mechanical issues. A pilot should have a thorough understanding of all the equipment and systems in the aircraft being flown. Lack of knowledge, such as knowing if the oil pressure gauge is direct reading or uses a sensor, is the difference between making a wise decision or poor one that leads to an error.

Regardless of the systems and equipment on board, the plane in the 5P check is all about learning how those systems operate, how and when they should be most effectively used, and ultimately how they can help you manage workload and assist with aeronautical decision-making.

The Pilot

The third P of the 5P check is the pilot. Interestingly, the single pilot is his or her own resource. How can this be? As a single pilot, you are required to rely on yourself to handle all aspects of the flight and make decisions. Another pilot is not available to help. You may even be solo and have no other person on board the airplane. Going back everything in the handbook, your resources are your abilities in the following areas:

- Understanding knowledge and having awareness of accident causation,
- Identifying hazards and associated risks,
- Assessing risk,
- Mitigating risk,
- Communicating with external resources,
- Managing time and automation,
- Maintaining situational awareness, and
- Performing aeronautical decision-making.

Of greatest importance is your ability to seek help from external resources such as air traffic control or flight service. Accessing these external resources and getting the specific help that you need will require you to use the communication and briefing tools from the TEM Toolkit.

To promote the safe, orderly flow of air traffic around airports and along flight routes, ATC provides pilots with traffic advisories, radar vectors, and assistance during emergencies. Although it is the PIC's responsibility to make the flight as safe as possible, a pilot with a problem can request assistance from ATC. For example, if a pilot needs to level off, be given a vector, or decrease speed, ATC assists and becomes integrated as part of the crew. The services provided by ATC can not only decrease pilot workload but also help pilots make informed inflight decisions. In addition to ATC, flight service can communicate directly with pilots for briefings, filing flight plans, inflight advisory services, search and rescue initiation, aircraft emergencies, and notices to airmen (NOTAMs).

Internal resources that are also important are the communication and briefing, time management, teamwork, automation management, and situational awareness tools form the TEM Toolkit. When flying alone, communicate to yourself aloud; verbalize things. Verbal communication reinforces an activity. For example, touching an object while communicating further enhances the probability an activity has been accomplished. For this reason, many solo pilots read the checklist aloud; when they reach critical items, they touch the switch or control. For example, to determine if the landing gear is down, the pilot can read the checklist and point to the gear handle until there are three green lights. Verbal communication coupled with physical action is most beneficial.

Checklists are essential flight deck internal resources. They are used to verify that aircraft instruments and systems are checked, set, and operating properly. They also ensure the proper procedures are performed if there is a system malfunction or inflight emergency. Your ability to maintain discipline regarding checklist usage is critical. Student pilots reluctant to use checklists can be reminded that pilots at all levels of experience refer to checklists, and that the more advanced the aircraft is, the more crucial checklists become. In addition, the pilot's operating handbook (POH), Airplane Flight Manual (AFM), or Rotorcraft Flight Manual (RFM) is required to be carried on board the aircraft and is essential for accurate flight planning and resolving inflight equipment malfunctions.

Realize that the pilot in the 5P check is all about skills, proficiency, and discipline regarding the ability to know which resources are available and how to use them effectively. While the pilot's flying skills are very important, proper risk management skills are even more critical.

The Passengers

The fourth P of the 5P check is the passengers. One of the most underutilized resources could be the person in the right seat, even if the passenger has no flying experience. When appropriate, the PIC can ask passengers to assist with certain tasks, such as watching for traffic or reading checklist items. [Figure 7-4]



Figure 7-4. When possible, have a passenger reconfirm that critical tasks are completed.

Examples of how a passenger can assist the PIC are:

- Providing information in some situations, especially if familiar with flying (a strange smell or sound may alert a passenger to a potential problem),
- Confirming after the pilot that the landing gear is down,
- Learning to look at the altimeter for a given altitude in a descent, and
- Listening to logic or lack of logic.

Also, the process of conducting a verbal briefing, which can happen whether or not passengers are aboard, can help the PIC in the decision-making process. For example, assume a pilot provides the passenger a briefing of the forecasted landing weather before departure. En route, the ATIS is received at the destination and the weather is significantly different than forecast. While verbally comparing this report with the forecasted weather, the pilot may need to explain to the passenger the significance of the disparity. The pilot should explain the situation in a way that can be understood by the passenger. Therefore, integrating passenger briefings is of great value for a better understanding of a situation.

The passengers in the 5P check should be considered valuable. Just because a flight is flown single-pilot does not mean the pilot is alone in the airplane.

The Programming

The fifth and final P of the 5P check is the programming. This normally refers to an autopilot. However, even aircraft not equipped with autopilots may have advanced avionics, flight management systems, or other instrumentation that are automated and require pilot input. If available, an autopilot should be used to offload manual flying duties when other matters require your attention. For example, you are nearing the end of the cruise portion of your flight and need to prepare for the arrival portion. This transition will require you to access the information you organized as part of the first P in the 5P check—the plan. You may need to change charts, reconfigure your electronic flight bag, reprogram navigation and communication systems, and listen to and record the ATIS broadcast. While performing these tasks, the autopilot can be used and programmed

to continue navigating along the planned or ATC-cleared route of flight. Autopilot use and automation management was discussed in greater detail in Chapter 6, Automation Management.

Using the 5P Check

Now that the five Ps of the 5P check are understood, it is important to know how and when to use the 5P check during a flight. Just like the 5P check contains five categories of resources available to the pilot, it should be implanted at five phases of each flight. [Figure 7-5]

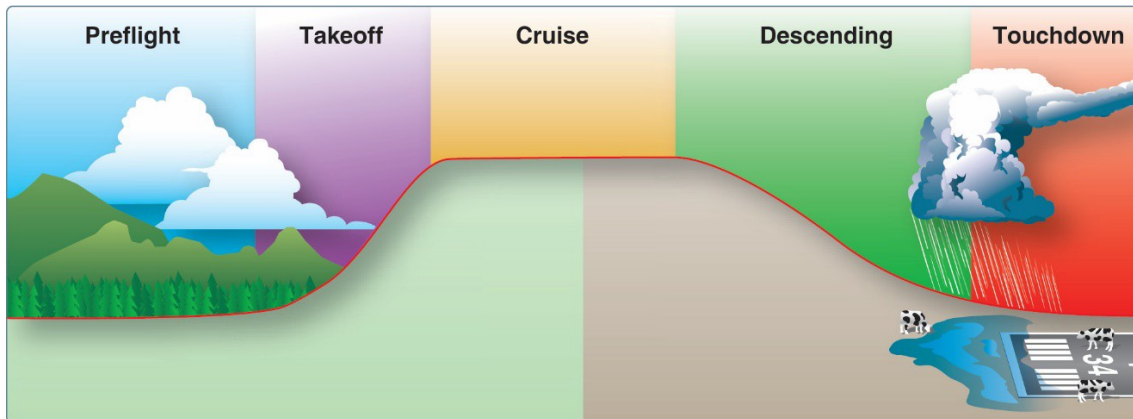


Figure 7-5. *The 5P check should be applied during each phase of flight.*

Preflight

Begin during the preflight assessment. During this phase of flight, you should organize all of your flight planning and informational resources. Do so by categorizing the information and placing it in a chronological order that matches the progression of the proposed flight. Research and understand the aircraft's recent mechanical discrepancies, inspection records, and any inoperative equipment. Doing so will allow you to inventory possible resources that are available and exclude those that are not. If you have flown the same aircraft recently, this may not take very long. If you have not flown the aircraft recently or at all, pay special attention to any unique equipment or systems and be sure to understand how they operate and how they may be used as a resource to you. Review your recency and proficiency. A good tactic for emergency procedures and checklist usage is to briefly review and practice memorization of any immediate action items or flow items. These types of checklist items will improve your time management skills. Be sure all passengers are briefed about the plan for the flight and any roles you may want them to have to help you, especially during emergencies. Finally, be sure all automated systems are functioning properly, pre-programmed, and up to date.

Takeoff

The next phase is the takeoff phase. This includes immediately before takeoff while completing any run-ups or pre-takeoff checklists that may be required. During this phase of flight, briefly compare your flight plan to the actual route. The actual route of flight may have been modified by ATC or you may have to change it based on weather or other factors. Be sure to review the information you organized for the next phase of flight and have it ready to be accessed. The takeoff and departure phase of flight happens quickly, so it is important to be prepared for the following phase. Be sure all aircraft systems are functioning properly and all checklists are completed. In addition to the current communication and navigation frequencies, set the next frequencies in standby or a second radio that will be needed, if the capability exists. Verbalize your takeoff briefing to yourself and include any ATC restrictions, hazard avoidance procedures such as for wake turbulence avoidance, obstacle avoidance, and terrain avoidance. Ensure all pre-takeoff checklists are completed accurately. Review passenger briefing items that pertain to the takeoff and departure phase with passengers and remind them to fasten their seatbelts. If you have autopilot and plan to use it, if able, program it now. Depending on the type of autopilot, verify the proper modes are selected and the correct annunciations are displayed. Remember, the takeoff phase of flight is busy and happens fast. It is better to have any automation pre-programmed so that you can simply activate it after takeoff rather than trying to program it along with everything else that is happening.

Cruise

The third phase is cruise flight. You should not let the relative calm of cruise flight make you feel complacent; do not get lazy. Continuously gather new information and update information you already have. Compare the information with what you gathered during preflight. Update your plan as necessary. Any flight rarely

proceeds exactly as you planned during preflight. Begin to prepare your charts, checklists, flight plan, kneeboard, and electronic flight bag for arrival. Continuously monitor aircraft systems. Crosscheck instruments. Monitor communication and navigation systems to verify they remain operational. Remember the time management tools in the TEM Toolkit. Implementing these tools now will allow you to take advantage of reduced workload to prepare for arrival. If the flight is a long duration, stay engaged with external resources and with passengers. Keep passengers informed about the flight's progress. However, do not let the passengers become a distraction. Maintain situational awareness. Remember the automation management tools in the TEM Toolkit and practice active monitoring of any automated systems. Remain engaged with the operation of the aircraft.

Descending

The fourth phase is descending. It is easy to be caught off guard in this phase in one of two ways. In one situation, you may be cruising at a high altitude or fast true airspeed. If that is the case, the descent and arrival portion of the flight can sneak up on you and you can find yourself underprepared and behind the airplane. In another situation, you may be cruising at a low altitude or slow airspeed. If that is the case, the descent and arrival portion of the flight will not last long, leaving little time to accomplish tasks. In both situations, you may suddenly realize that you did not take advantage of the cruise portion of the flight to prepare and get ahead on certain tasks and now have an excessive workload during descent and arrival. This excessive workload can cause you to forget or fail to access information in your plan, cause you to miss aircraft system and equipment annunciations, cause you to omit checklist items or skip checklist completion altogether, cause you to neglect your passengers, and cause you to make automation errors and lose situational awareness. Just like the takeoff phase, the descending phase is already marked with high workload and quick task completion, so it is important to use the time management skills in the TEM Toolkit to assist.

Touchdown

The fifth and final phase is touchdown. This phase also includes the final approach to landing, after landing rollout, runway exit, and taxi to parking. Regarding your plan, make sure you have current wind information to help you with crosswind correction. Verify you are aligned with the correct runway or landing area and your heading matches the runway or landing direction. In the case of parallel runways or close-by similar airports, pay special attention to verifying your landing in the right spot. Verify aircraft configuration on final approach—landing gear should be extended and locked with a positive indication, flaps should be set for landing, mixture and propeller controls should be properly set—verbally verify aircraft configuration and ask for passenger confirmation. Ensure all before landing checklists are completed. Always be ready to go around or reject the landing. Ensure passengers are informed of the imminent landing and are briefed to have seatbelts fastened. Verify any automated systems and the autopilot are properly programmed. Normally, and if the system allows, the flight management system should have any missed approach or go-around procedure loaded and the autopilot ready to fly the procedure in the event of a missed approach, go around, or rejected landing. Regardless, be prepared to disengage the autopilot for landing and be alert for any out-of-trim conditions when you do disengage it.

After touchdown, concentrate on proper aircraft control and crosswind correction. Verify any aircraft configuration changes such as spoiler deployment and thrust reverser activation. Delay any other aircraft configuration changes, such as flap retraction and spoiler stowing, until the landing rollout is complete and you are clear of the runway. Making configuration changes during the landing rollout while your attention is elsewhere will increase the risk of making errors. It is normally best to stop the aircraft completely once clear of the runway to reconfigure the airplane for taxi and record and brief taxi instructions. While taxiing to the parking location, do not let complacency set in. Many incidents, accidents, and runway incursions can happen after landing as a result of complacency and reduced attention.

Personal Minimums

Pilots should understand the difference between what is “legal” in terms of the regulations and what is “smart” or “safe” in terms of pilot experience and proficiency. In Chapters 2 through 4, the idea of establishing or using personal minimums as a method of risk mitigation was established. In Chapter 5, it was explained how proficiency and discipline can affect error management. By establishing personal minimums, pilots can take a big step in managing risk. In the article, “Getting the Maximum from Personal Minimums,” (May/June 2006 FAA Aviation News), it discusses six steps for establishing personal minimums.

Step 1—Review Weather Flight Categories

Most people think of personal minimums primarily in terms of weather conditions, so begin with a quick review of weather category definitions. [Figure 7-6]

Category	Ceiling		Visibility
Visual Flight Rules VFR (green sky symbol)	Greater than 3,000 feet AGL	and	Greater than 5 miles
Marginal Visual Flight Rules MVFR (blue sky symbol)	1,000 to 3,000 feet AGL	and/or	3 to 5 miles
Instrument Flight Rules IFR (red sky symbol)	500 to below 1,000 feet AGL	and/or	1 mile to less than 3 miles
Low Instrument Flight Rules LIFR (magenta sky symbol)	below 500 feet AGL	and/or	less than 1 mile

Figure 7-6. Weather conditions in terms of flight category showing values for ceiling and visibility.

Step 2—Assess Experience and Comfort Level

At first glance, this part of the process might look a bit complicated. It might take a few minutes to review, record, and summarize your personal experience, but you should find the finished product is well worth your time.

First, think back through your flight training and complete the Certification Training, an Experience Summary table in *Figure 7-7*.

Certification, Training, and Experience Summary	
Certification Level	
Certificate level (e.g., private, commercial, ATP)	
Ratings (e.g., instrument, multiengine)	
Endorsements (e.g., complex, high performance, high altitude)	
Training Summary	
Flight review (e.g., certificate, rating, wings)	
Instrument Proficiency Check	
Time since checkout in airplane 1	
Time since checkout in airplane 2	
Time since checkout in airplane 3	
Variation in equipment (e.g., GPS navigators, autopilot)	
Experience	
Total flying time	
Years of flying experience	
Recent Experience (last 12 months)	
Hours	
Hours in this airplane (or identical model)	
Landings	
Night hours	
Night landings	
Hours flown in high density altitude	
Hours flown in mountainous terrain	
Crosswind landings	
IFR hours	
IMC hours (actual conditions)	
Approaches (actual or simulated)	

Figure 7-7. Certification, training, and experience summary.

Next, think through your recent flying experiences and make a note of the lowest weather conditions that you have comfortably experienced as a pilot in VFR and, if applicable, IFR conditions in the last six to twelve months. You might want to use the tables in *Figures 7-8 through 7-10* as guides for this assessment, but do not think that you need to fill in every square. You may not have, or even need, an entry for every category. Suppose that most of your flying takes place in a part of the country where clear skies and visibilities of 30 plus miles are normal. Your entry might specify the lowest VFR ceiling as 7,000, and the lowest visibility as 15 miles. You may have never experienced MVFR conditions at all, so you would leave those boxes blank.

For example, in a part of the country where normal summer flying often involves hazy conditions over relatively flat terrain, pilots who know the local terrain could regularly operate in hazy daytime MVFR

conditions (e.g., 2,500 and four miles), and would use the MVFR column to record these values.

Even in your home airspace, you might not consider flying down to VFR minimums at night, much less in the range of conditions defined as MVFR. For night VFR, anything less than a ceiling of at least 5,000 feet and a visibility of at least seven to eight miles might raise a red flag.

Figure 7-8 shows how your entries might look in the Experience & Comfort Level Assessment VFR & MVFR table. If you fly IFR, the next part of the exercise shown in Figure 7-9 is to record the lowest IFR conditions that you have comfortably, recently, and regularly experienced in your flying career. Again, be honest in your assessment. Although you may have successfully flown in low IFR (LIFR) conditions down to a 300-foot ceiling and $\frac{3}{4}$ -mile visibility, it does not mean you were “comfortable” in these conditions. Therefore, leave the LIFR boxes blank with entries for known “comfort level” in instrument meteorological conditions (IMC).

Experience and “Comfort Level” Assessment		
VFR & MVFR		
Weather Condition	VFR	MVFR
Ceiling	> 3,000	1,000–3,000
	Day	2,500
	Night	—
Visibility	> 5 miles	3–5 miles
	Day	4 miles
	Night	—

Figure 7-8. Experience and comfort level assessment for VFR and MVFR.

Experience and “Comfort Level” Assessment		
IFR & LIFR		
Weather Condition	IFR	LIFR
Ceiling	500–999	< 500
	Day	—
	Night	—
Visibility	1–3 miles	< 1 mile
	Day	—
	Night	—

Figure 7-9. Experience and comfort level assessment for IFR and LIFR.

If the entries are combined into a single table, the summary of your personal, known “comfort level” for VFR, MVFR, IFR, and LIFR weather conditions would appear as shown in Figure 7-10.

Experience and “Comfort Level” Assessment				
Combined VFR & IFR				
Weather Condition	VFR	MVFR	IFR	LIFR
Ceiling				
Day	2,500		800	
Night	5,000		999	
Visibility				
Day	4 miles		1 mile	
Night	8 miles		3 miles	

Figure 7-10. Experience and comfort level assessment for combined VFR and IFR.

Step 3—Consider Other Conditions

Ceiling and visibility are the most obvious conditions to consider in setting personal minimums, but it is also a good idea to have personal minimums for wind and turbulence. As with ceiling and visibility, the goal in this step is to record the most challenging wind conditions you have comfortably experienced in the last six to twelve months, not necessarily the most challenging wind conditions you have experienced. As shown in *Figure 7-11*, you can record these values for category and class, for specific make and model, or perhaps both.

Experience and “Comfort Level” Assessment			
Wind & Turbulence			
	SE	ME	Make/ Model
Turbulence			
Surface wind speed	10 knots	15 knots	
Surface wind gusts	5 knots	8 knots	
Crosswind component	7	7	

Figure 7-11. Experience and comfort level assessment for wind and turbulence.

In addition to winds, your “comfort level” inventory should also include factors related to aircraft performance. There are many variables, but start by completing the table with reference to the aircraft and terrain typical for the kind of flying you do most. [*Figure 7-12*] Remember that you want to establish a safety buffer, so be honest with yourself. If you have never operated to or from a runway shorter than 5,000 feet, the shortest runway box might say 5,000 feet. We will talk more about safe ways to extend personal minimums a bit later.

Experience and “Comfort Level” Assessment			
Performance Factors			
	SE	ME	Make/ Model
Performance			
Shortest runway	2,500	4,500	
Highest terrain	6,000	3,000	
Highest density altitude	3,000	3,000	

Figure 7-12. Experience and comfort level assessment for performance factors.

Step 4—Assemble and Evaluate

Now you have some useful numbers to use in establishing baseline personal minimums. Combining these numbers, the Baseline Personal Minimums table in *Figure 7-13* shows how the whole picture might look.

Baseline Personal Minimums					
Weather Condition		VFR	MVFR	IFR	LIFR
Ceiling					
	Day	2,500		800	
	Night	5,000		999	
Visibility					
	Day	4 miles		1 mile	
	Night	8 miles		3 miles	
		SE	ME	Make/Model	
Turbulence					
	Surface wind speed	10 knots	15 knots		
	Surface wind gusts	5 knots	8 knots		
	Crosswind component	7	7		
		SE	ME	Make/Model	
Performance					
	Shortest runway	2,500	4,500		
	Highest terrain	6,000	3,000		
	Highest density altitude	3,000	3,000		

Figure 7-13. *Baseline personal minimums.*

Step 5—Adjust for Specific Conditions

Any flight you make involves almost infinite combinations of pilot skill, experience, condition, and proficiency; aircraft equipment and performance; environmental conditions; and external influences. Both individually and in combination, these factors can compress the safety buffer provided by your baseline personal minimums. Consequently, you should develop a practical way to adjust your baseline personal minimums to accommodate specific conditions.

Note that the example adjustment factors are just that— examples to provide a basic starting point from which you can develop your own factors based on your experience, aircraft capabilities, and operation. If your flying experience is limited or if you do not fly very often, you might want to double these values. In addition, if your situation involves more than one special condition from the table above, you may want to add the adjustment factor for each one. For example, suppose you are planning a night cross-country flight to an unfamiliar airport, departing after a full workday. If you decide to make this trip, the table in *Figure 7-14* suggests that you should at least raise your baseline personal minimums by adding 1,000 feet to your ceiling value, one mile to visibility, and 1,000 feet to required runway length.

Example Situations and Additional Safety Margins	
Pilot	Illness, use of medication, stress, fatigue, lack of proficiency
Aircraft	Unfamiliar airplane, unfamiliar avionics or other equipment, inoperative equipment
enVironment	Unfamiliar airports, airspace, terrain, possible icing conditions, convective activity
External Pressures	Perceived time constraints, pressures from passengers, etc.
<p>Example additional safety margins from baseline personal minimums:</p> <ul style="list-style-type: none"> • Add 1,000 feet ceiling for VFR; add 200 feet to MDA/DA for IFR • Add 2 miles visibility for VFR; add 1/2 mile to minimum visibility for IFR • Add additional reserve fuel of 30 minutes for VFR or 45 minutes IFR • Add 500 feet to required runway length • Reduce maximum wind limitation by at least 5 knots 	

Figure 7-14. *Examples of baseline personal minimums.*

How about adjustments in the other direction? Some pilots fear that establishing personal minimums is a once-and-for-all exercise. With time and experience, though, you can modify personal minimums to match growing skill and judgment. When you have comfortably flown to your baseline personal minimums for several months, you may want to assess whether and how to safely lower your personal minimums. If, for instance, your personal minimums call for daytime visibility of at least five miles, and you have developed some solid experience flying in those conditions, you might consider lowering the visibility value to four miles for your next flight.

There are two important cautions:

1. Never adjust personal minimums to a lower value for a specific flight. The time to consider adjustments is when you are not under any pressure to fly, and when you have the time and objectivity to think honestly about your skill, performance, and comfort level during the last few flights. Changing personal minimums “on the fly” defeats the purpose of having them in the first place.
2. Keep all other variables constant. For example, if your goal is to lower your baseline personal minimums for visibility, do not try to lower the ceiling, wind, or other values at the same time. In addition, you never want to lower the baseline if there are special conditions (e.g., unfamiliar aircraft, pilot fatigue) present for this flight. You might find it helpful to talk through your newly established personal minimums with a qualified flight instructor.

Step 6—Stick to the Plan

Once you have done all the thinking required to establish baseline personal minimums, all you need to do next is stick to the plan. As most pilots know, that task is a lot harder than it sounds, especially when the flight is for a trip that you want to make, or when you are staring into the faces of your disappointed passengers. Here is where personal minimums can be an especially valuable tool. Professional pilots live by the numbers, and so should you. Pre-established personal minimums can make it a lot easier to make a smart no-go or divert decision rather than a vague sense of whether you can deal with the conditions that you are facing at any given time. In addition, a written set of personal minimums can also make it easier to explain tough decisions to passengers who are, after all, trusting their lives to your aeronautical skill and judgment.

Chapter Summary

General aviation pilots enjoy a level of responsibility and freedom unique in aviation. Unlike the air carrier, corporate, and military communities, most GA pilots are free to fly when and where they choose. They are unencumbered by the strict regulatory structure that governs many other flight operations. However, the GA pilot is not supported by a staff of dispatchers and meteorologists or governed by rigid operational guidelines designed to reduce risk. Pilots should not be lulled into a false sense of security simply because they comply with the regulations. Judgment and aeronautical decision-making serve as the bridge between regulatory compliance and safety. Deciding if or when to undertake any flight lies solely with the PIC. Effective single-

pilot resource management can help pilots organize and manage the resources available to them, in turn improving risk management and ADM abilities. Establishment of personal minimums allows for an objective assessment of a pilot's ability and proficiency in comparison to actual or predicted flight conditions.

A copy of the charts used in this chapter can be found in Appendix B, Risk Assessment Tools. Pilots are encouraged to make a copy of this appendix, complete applicable charts, and use them before each flight.

Introduction

Appendices A through D are designed to supplement the text material in the main body of this handbook. To take full advantage of the appendices, you should become familiar with at least the material in Chapters 1 through 4.

The information in these appendices is designed to cover a broad range of general operations under 14 CFR Part 91, ranging from recreational flights in simple airplanes to single-pilot operation of turbojets. Although risk management concepts are applicable multi-crew operations, those operations are governed by more sophisticated concepts and programs such as crew resource management (CRM), safety management systems (SMS), advanced qualification programs (AQP), and other regulatory requirements.

How to Use

Each appendix is designed to accomplish a specific purpose.

- **Appendix A, Risk Management Training:** Helps you integrate risk management tools and procedures into initial, recurrent, and specialized flight training. You should work with your flight instructors or other training providers to ensure that these risk management practices are included in your training, whether it is initial training, training for a higher rating, required currency events, or other training situations. For example, if you are already certificated and need a flight review or instrument proficiency check (IPC), you should request your instructor to provide a risk-based review or check. Instructors should refer to the *Aviation Instructors Handbook* (FAA-H-8083-9, latest edition), especially Chapter 10, to obtain guidance on how to provide risk management training.
- **Appendix B, Risk Management Tools:** Briefly reviews common risk assessment tools discussed in Chapters 1 through 4. These include both numerical and non-numerical flight risk assessment tools, as well as a summary of the models and checklists discussed in the main text, and the use of a risk assessment matrix. This section can be used as a reference as you review the cases and examples in Appendices C and D.
- **Appendix C, Risk Management Accident Case Studies:** Reviews several fatal accidents from a risk management perspective. Analyses of four separate accidents will cover a broad range of general aviation accidents in Part 91 operations, including recreational flying, single-pilot operation of advanced turbine-powered airplanes, and helicopter operations. Chapters 1 through 4 already include accident case study examples of a fifth category, a complex piston-engine airplane used for transportation. A “school” analysis of risk management aspects is provided for each accident.
- **Appendix D, Risk Management Exercises:** Considers four hypothetical scenarios involving the same four categories of general aviation outlined in Appendix C. Questions are posed that can guide you as you conduct your risk analysis like the case study in Chapters 2, 3, and 4 that covered a hypothetical flight of a piston-engine complex airplane used for transportation. A “school” solution is not provided for each example, as was done in Appendix C. Instead, we encourage you to conduct your own risk analysis because you may identify, assess, and mitigate the risks differently.

Using Appendices as a Workbook

You should consider these appendices as a bridge between the knowledge in this handbook and further risk management training you should obtain, such as an online risk management course. They can also serve as a supplement to initial, recurrent, and other training as described in Appendix A. The appendices should thus serve as a “workbook” that amplifies the text material and provides a real-world context to the concepts covered in this handbook.

Appendix A: Risk Management Training

Although the underlying principles of risk management are not complicated, applying them in an aviation environment will be more effective if you receive specific training for this purpose. This training can be provided by a certificated flight or ground instructor, by attending a live ground school or completing an online course, or from another source. Risk management training should be integrated into all initial, recurrent, and other training events.

Integrating Risk Management Training and Other Training Requirements

Risk management training is critical, but this training will be more effective when it is integrated with both the knowledge and skill requirements applicable to all grades of certificates and ratings. The Airman Certification Standards (ACS) prescribe the applicable knowledge, risk management, and skill requirements for all required tasks in the ACS.

A solid base of aeronautical knowledge is needed to effectively conduct risk management. For example, consider the case study presented in Chapters 2 through 4. The pilot of the Mooney needed to consider takeoff and departure risks when departing from either of the two airports in Durango, CO. To do so, the pilot needed a firm knowledge of density altitude concepts, aircraft performance analysis, and payload/range tradeoffs. As another example, the pilot would then need to have enough knowledge of aviation weather products to plan the route to California. He then applied this knowledge to conduct an effective risk analysis for the departure and the rest of the flight.

The knowledge and risk analysis proficiency the pilot in the case study exhibited still would not be effective unless the pilot had the necessary skills to execute the tasks needed to depart safely. For example, when departing from the smaller Durango airport, the pilot may have needed to execute a maximum performance takeoff and climb to ensure the Mooney could make a safe departure to the nearby larger Durango airport.

When considering when and how to obtain risk management training, pilots should be mindful of the need to reinforce and improve their knowledge and skills. In between major training events, such as flight reviews, pilots should seek to maintain their currency and proficiency. For example, you could maintain and expand your knowledge by completing on-line training for a broad base of topics, as well as for risk management. To maintain your physical stick-and-rudder proficiency, you may want to exceed the minimum currency requirements of Part 61 for events such as takeoffs and landings.

When and How to Obtain Risk Management Training

Risk management training should be integrated into all training events, from the first training activity to all subsequent training events. This should include not only initial flight training but advanced and recurrent training also. Your training will be most effective if it is scenario-based. That is, the training should be structured around a typical flight that you can expect to undertake in the “real world” and not just in the training environment. An effective scenario will have a specific “real world” purpose that will have consequences if it is not accomplished. For example, you may be planning to fly your family to an important family event, such as an anniversary.

Risk management training will also be more effective if it is integrated with other SRM skills such as automation management, task and workload management, and situational awareness. These higher-order thinking skills are crucial to operating safely in today’s aviation environment. As with risk management, training for these other SRM skills will be most effective if they are integrated with a realistic scenario.

Incorporating Risk Management Training into Flight Reviews, Proficiency Checks, and Other Evaluations

Risk management training and procedures should not be confined only to initial training events and practical tests. It should also be integrated into required currency events such as the flight review, instrument proficiency checks, and other evaluation activities. There is no prohibition against conducting training during evaluation events required by 14 CFR part 61. As with other events, most training received during these events should be scenario-based, as should the evaluation itself.

The scenario used for the training or evaluation component of flight reviews should replicate a typical purpose that the pilot flies for, whether it is for recreation, transportation, or another purpose. For example, if you frequently fly your aircraft with friends to nearby airports to dine at the local restaurant (i.e. the “100-dollar hamburger”) you might want your instructor to structure the risk management process around that activity. He may want you to identify the hazards and risks common to that activity, such as external pressures to complete the flight regardless of conditions so you do not disappoint your friends. The scenario you choose should also include an evaluation of your SRM skills, as well as training and evaluation that covers the applicable objectives and tasks in the appropriate ACS. The instrument proficiency check should also be based around a realistic scenario and not confined solely to individual tasks and maneuvers. For example, if a pilot is instrument-rated and uses a complex or high-performance airplane to travel regularly, an instrument proficiency check should be structured around a typical transportation flight and conducted on an instrument flight plan in the ATC system and, if possible, under actual IMC. Required tasks for the IPC contained in the instrument rating ACS should be integrated into the scenario where appropriate.

Appendix B: Risk Assessment Tools

The risk management process will be much easier and more effective if you approach it using simple tools and checklists. These included flight risk assessment tools (FRAT), the risk assessment matrix discussed in Chapter 3, and models and checklists such as 3P, PAVE, CARE, and TEAM as discussed in Chapters 2 through 4.

Numerical-Based FRATs

The most common type of FRAT is based on a numerical scoring system. A variety of such FRATs have been created by various aviation organizations, including the FAA and its industry partners. For example, the General Aviation Joint Safety Committee (GAJSC) has developed a typical [numerical-based FRAT](#). This FRAT is constructed to cover the main risk areas included in the PAVE checklist. It does so by listing a finite number of risk elements in each of the four risk categories. Like most non-numerical FRATs, this tool assigns a score to each risk identified. The consolidated scores are totaled, and the user evaluates the total risk in terms of the aggregated score. If the score is below a certain level (green), then it is assumed the flight is below the unsafe risk threshold. If the total score is in the next higher category (yellow), then it implies caution and the user should either seek third-party counsel or take some other specified action. If the score is at the highest level (red), then the FRAT states that the flight should not depart.

A numerical based FRAT is easy to use and provides a framework for accomplishing risk management and analysis. Some aviation organizations have found this type of FRAT to be effective for their members. However, this type of FRAT has drawbacks that could prevent users from identifying, assessing, and mitigating all the risks that could apply to any given flight. Specifically, a numerical FRAT has the following drawbacks.

- They are limited to a fixed number of hazards/risks. If other hazards and risks exist, they may not be identified, assessed, and mitigated by the user.
- For a given flight, there may be only a single hazard, and hence the score is so low (green) that the FRAT indicates it is safe to depart. Yet, that single hazard may be such that the risk is high and could result in an accident unless mitigated.
- The score assigned to each risk is arbitrary and may not be proportional to the actual risk present for that hazard.

It is still possible for pilots to successfully use a numerical based FRAT. However, you should complete risk management training prior to using them and apply conservative margins in any analysis completed when using these FRATs.

Non-Numerical Objective-Based FRAT

A less common type of FRAT does not use a numerical scoring system. Rather, these objective-based FRATs provide a framework that requires the user to comprehensively identify, assess, and mitigate any potential hazard and its associated risk on a given flight.

The FRAT outline used in the case study in Chapters 2 through 4 is based on an objective-based FRAT developed by the National Business Aviation Association (NBAA). This FRAT was included in a risk management guide developed by the NBAA Safety Committee for single-pilot operation of light business aircraft. This type of FRAT requires the user to conduct more analysis than would be required for a numerical FRAT. However, it addresses all the disadvantages of a numerical-based FRAT that were previously cited. It is not based on a fixed list of hazards and requires the user to consider all hazards in the PAVE checklist. Each hazard and related risk identified must be assessed in terms of likelihood and severity to determine the overall risk level. For serious and high risks, this FRAT prompts the user to mitigate risk by reducing the likelihood or severity.

The NBAA [Risk Management Guide for Single-Pilot Light Business Aircraft](#) can be accessed and used independent of this handbook. The stand-alone [Flight Risk Assessment Tool Worksheet](#) that is part of the NBAA guide may also be accessed directly. The worksheet is replicated on the next two pages.

FLIGHT RISK ASSESSMENT TOOL WORKSHEET

Three step process: **IDENTIFY, ASSESS, MITIGATE.**
Conduct before departure and in flight.

STEP 1: IDENTIFY THE RISKS (Complete second column below)

RISK CATEGORY	HAZARD & RISK	LIKELIHOOD (Probability)	SEVERITY (Consequences)	OVERALL RISK LEVEL (Color)	MITIGATION/NEW RISK RED - MUST Mitigate YELLOW - SHOULD Mitigate GREEN - ACCEPT No Unnecessary Risk
PILOT					
Qualification / Currency / Proficiency					
Aeromedical / Human Factors					
AIRCRAFT					
Fuel / Range / Payload					
Equipage (Incl. Inoperative Equipment)					
Performance					
ENVIRONMENT					
Weather					
Airspace / ATC / Airports					
Terrain / Day vs. Night					
EXTERNAL PRESSURES					
Work-related and Personal					

Other Data:

STEP 2: ASSESS THE RISKS (Complete third, fourth and fifth columns on the worksheet using the descriptors in the matrix below)

RISK ASSESSMENT MATRIX				
Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	HIGH	HIGH	SERIOUS	MEDIUM
Occasional	HIGH	SERIOUS	MEDIUM	LOW
Remote	SERIOUS	MEDIUM	MEDIUM	LOW
Improbable	MEDIUM	MEDIUM	MEDIUM	LOW

Risk Likelihood Descriptors	Risk Severity Descriptors
Probable: An event will occur several times.	Catastrophic: Results in fatalities and / or total loss.
Occasional: An event will probably occur sometime.	Critical: Results in severe injury and / or major damage.
Remote: An event is unlikely to occur, but is possible.	Marginal: Results in minor injury and / or minor damage.
Improbable: An event is highly unlikely to occur.	Negligible: Results in less than minor injury and / or minor damage.

STEP 3: MITIGATE THE RISKS (Complete sixth column on worksheet. Specify new overall risk level after mitigation.)

- Risk mitigation strategy: Take actions to reduce likelihood and/or severity to lower levels for each identified risk in accordance with step two. Use this worksheet until risk management process becomes intuitive, or conditions remain complex.
- Mitigation guidelines for assessed risk:

RED (HIGH): Risk likelihood and/or severity **MUST** be reduced to lower levels before departure. If in flight, risk likelihood and/or severity **MUST** be reduced by taking appropriate divert or other actions.

YELLOW (SERIOUS): Risk likelihood and/or severity **SHOULD** be reduced to lower levels before departure. If in flight, risk likelihood and/or severity **SHOULD** be reduced by taking appropriate divert or other actions.

GREEN (MEDIUM): Flight can depart or continue, but risk severity and/or likelihood **SHOULD** be reduced whenever possible.

WHITE (LOW): Risks can usually be addressed by following checklists and complying with normal procedures.

Figure B-1. Non-Numerical Flight Risk Assessment Tool.

Risk Assessment Tools Identifying, Assessing, and Mitigating Risk

The tools in this section were discussed in Chapters 2 through 4. They are summarized in this appendix so that they

may be more easily accessed when reviewing the accident and case study examples in Appendices C and D.

Risk Identification Tools

The most accepted tool for identifying risk before a flight is the PAVE checklist. It can also be used inflight to update any changes in risk and identify new risks. It is most effective before a flight when it is used with a flight risk assessment tool, especially a non-numerical objective-based FRAT such as the one developed by the NBAA and illustrated in *Figure B-1*. Another tool to identify risk is the 3P model, illustrated in *Figure B-2*, in which the first “P” is for “perceive.” The 3P works best for in-flight use. The 3P model and PAVE checklist work well together conceptually, as shown in *Figure B-3*.



Figure B-2. 3P model

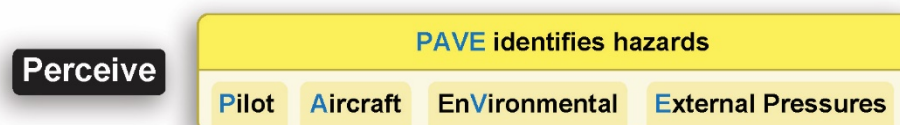


Figure B-3. Perceive using the PAVE checklist for risk identification.

Risk Assessment Tools

Once risks have been identified, they must be assessed in terms of likelihood (probability) and severity (consequences) to determine the overall level of risk for each hazard. The risk assessment matrix discussed in Chapter 3 and shown in *Figure B-4* is the most effective means of doing this before flight. The matrix and the steps required to use it are also described in the FRAT that is illustrated in *Figure B-1*.

RISK ASSESSMENT MATRIX				
Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	HIGH	HIGH	SERIOUS	MEDIUM
Occasional	HIGH	SERIOUS	MEDIUM	LOW
Remote	SERIOUS	MEDIUM	MEDIUM	LOW
Improbable	MEDIUM	MEDIUM	MEDIUM	LOW

Figure B-4. Risk assessment matrix.

Once in-flight, a more convenient means for assessing risk is the CARE checklist. Its use and place in the overall risk management model is illustrated in *Figure B-5*. Each element of the CARE checklist works in-flight to assess risks previously identified before a flight as well as new risks that appear after departure. The consequences component of the checklist is analogous to the overall risk level determined from assessing of risk “likelihood” and “severity” using the risk management matrix.

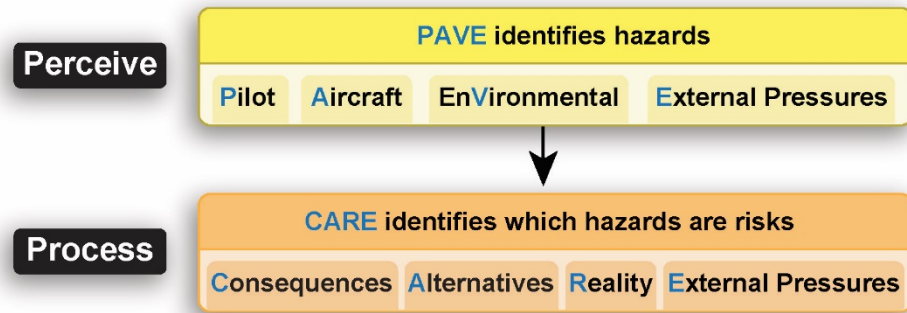


Figure B-5. *Process using the CARE checklist for risk assessment.*

Risk Mitigation Tools

The primary tool for risk mitigation before a flight is the TEAM checklist. This checklist is used by the FRAT illustrated in *Figure B-1*. This checklist is analogous to the perform step in the 3P model as well as the alternatives and reality components in the CARE checklist. All four of the tools described in this section work well in unison, as illustrated in *Figure B-6*.

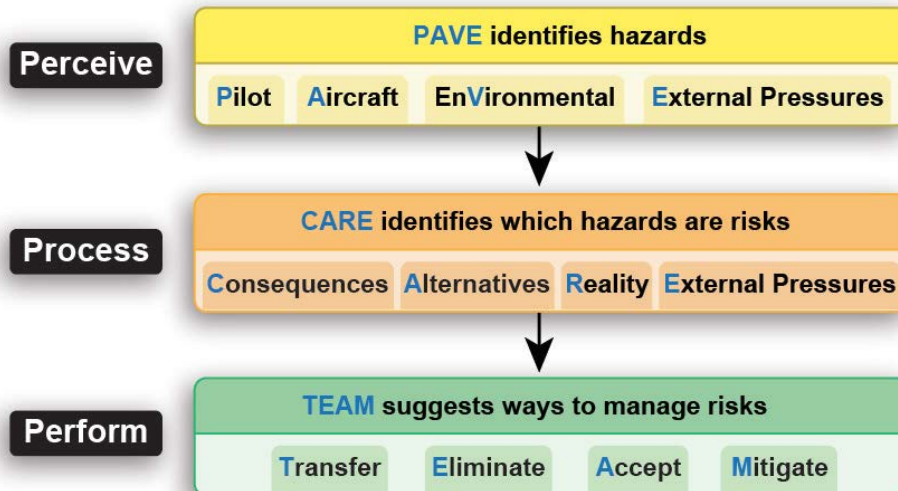


Figure B-6. *Perform using the TEAM checklist for risk mitigation.*

Appendix C: Risk Management Accident Case Studies

The accident profiles described below are actual accidents that are representative of fatal accidents occurring across a wide range of general aviation activities to the [NTSB Aviation Accident Database](#) for further study.

For each accident, a summary using the PAVE checklist outlines potential risk factors that may be part of the root cause of the accident. The analysis includes a suggested assessment of these risks, as well as potential mitigations. This analysis is necessarily abbreviated due to space limitations. You may want to expand on this analysis. For example, you may identify alternate or additional hazards and associated risks. You may also wish to assess and mitigate these risks differently, using the tools, models, and checklists outlined in Appendix B.

All the accident case studies outlined below involve single-pilot operations. Crewed operations will inevitably require a discussion of crew resource management (CRM) that is beyond the limited scope of CRM discussion in this handbook.

Accident Profile 1: Fatal Accident, Recreational Aviation, Not for Transportation

Type Aircraft: Cessna 172

Location: Veneta, OR (Crow-Mag airport, 33OR)

Date: 06/23/2012

NTSB Defining Event: Loss of lift

NTSB Case File No.: WPR12FA274

NTSB Probable Cause: The pilot's failure to maintain adequate airspeed and altitude to clear trees during the initial climb after takeoff.

NTSB Factual Summary Excerpts (edited): The pilot was carrying three passengers on a local scenic flight and the aircraft was only a few pounds under maximum gross weight. Visual meteorological conditions prevailed at departure. The 3,100-foot turf runway was wet with grass at least three inches high and there were 100-foot trees at the other end of the runway. The pilot operating handbook (POH) only provided takeoff performance data for departure over a 50-foot obstacle and indicated that about 1,700 feet would be required for takeoff from a hard-surface runway over a 50-foot obstacle under the takeoff weight and other conditions. However, the POH did not provide data for departure from a wet, turf runway, with uncut grass or for a 100-foot obstacle.

After departure, the aircraft could not clear the obstacle and descended into the trees. A cell phone video in the aircraft was later examined and the sound of the aircraft stall warning could be heard just before it collided with the trees. Witnesses reported seeing the aircraft descend into the trees. All four occupants died during the crash. An autopsy toxicology report indicated the presence of marijuana in the pilot's bloodstream, although the exact degree of pilot impairment from the level of this drug in his blood could not be determined. The investigators could not find any aircraft defects that would have prevented it from achieving full power on takeoff.

Risk Analysis: There are hazards and associated risks for all four of the categories of the PAVE checklist in this accident. However, environmental and aircraft performance hazards may have generated the highest risk levels that may be the root causes of this accident.

Risk Identification: The primary hazard in this accident is the 100-foot trees at the end of the runway, aggravated by the wet grass on the turf runway. These environmental factors, coupled with an aircraft hazard arising from takeoff and climb performance limitations, generated the risk that could be a root cause of the accident. There is a hazard associated with the pilot's performance being potentially affected by marijuana use. There is also a potential external pressure hazard and risk associated with pressure to please the passengers by completing the flight.

Risk Assessment: The risk severity generated by the collision potential with the trees is "catastrophic" because it resulted in loss of life. Given the environment and aircraft performance limitations that the pilot could have reasonably anticipated, the likelihood of the risk was at least "occasional," that is, it would probably occur sometime. Consulting the risk assessment matrix, the resulting risk is high (red) and requires mitigation to a lower level of likelihood and/or severity.

Risk Mitigation: Because the Cessna was already located at the turf airport, the risk severity generated by the trees will remain. However, the pilot could have greatly reduced the likelihood by flying the aircraft solo to the nearby Eugene, OR (EUG) airport to pick up the passengers [Figure C-1]. This single action addresses both the environmental and aircraft performance risks. This would also have reduced the external pressures.



Figure C-1. Chart excerpt.

Accident Profile 2: Fatal Accident, Turboprop-Powered, Transportation

Type Aircraft: Socata TBM 700

Location: Morristown, NJ

Date: 12/20/2011

NTSB Defining Event: Loss of control in flight

NTSB Case File No.: ERA12FA115

NTSB Probable Cause: The airplane's encounter with severe icing conditions that were characterized by high ice accretion rates and the pilot's failure to use his command authority to depart the icing conditions in an expeditious manner, which resulted in a loss of airplane control.

NTSB Factual Summary Excerpts (edited): The pilot departed Teterboro, NJ (TEB) on an IFR flight plan to Atlanta, GA (PDK). No evidence of a weather briefing was found, although the pilot may have obtained weather information from non-government sources. There was an AIRMET for moderate icing in northern New Jersey and westward from the freezing level (2,000 to 8,000 feet) to 20,000 feet. There were numerous pilot reports of moderate to severe icing and a Center Weather Advisory (CWA) had accordingly been issued, as depicted *Figure C-2*.

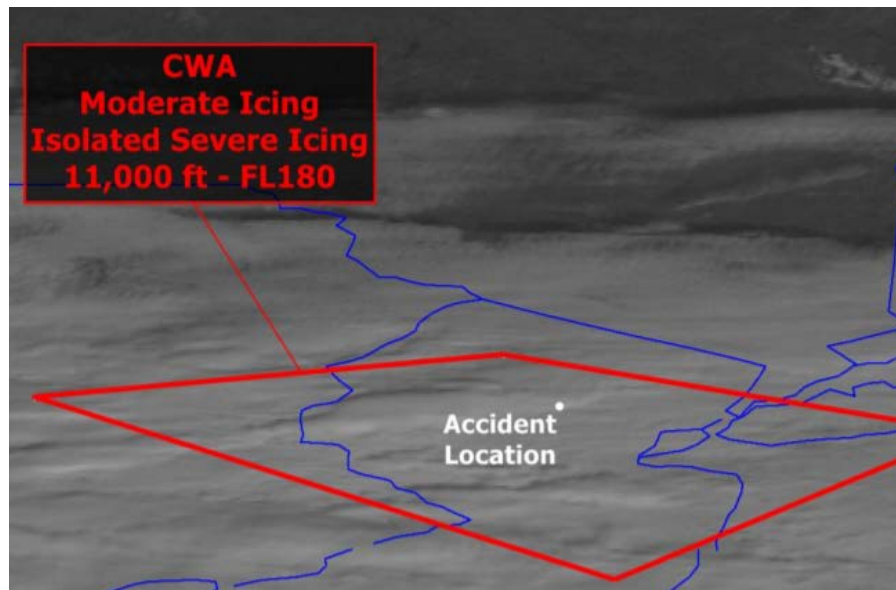


Figure C-2. CWA moderate to severe icing area.

The TBM pilot reported entering light icing at 16,800 feet and requested a higher altitude. There was a delay before air traffic control subsequently approved a climb to Flight Level 200. The radar track showed the TBM reached a peak altitude of 17,800 before beginning a rapid descent. The aircraft disintegrated during the descent and all five occupants perished. The TBM POH included a warning that the aircraft was not certificated for flight in severe icing.

Risk Analysis: This accident has potential root causes related to the hazards and associated risks of operating an aircraft in severe icing conditions when it is not certificated for such conditions. Thus, in the PAVE checklist, both aircraft and environmental hazards and associated risks come into play in this accident. The severity of this combined risk is catastrophic because it resulted in the loss of five lives. Given the severity of the icing, the length of time the aircraft was in it, and the caution in the TBM POH, the likelihood of the event was at least "occasional," meaning it would probably occur sometime. Thus, the overall risk level was high and required mitigation.

The pilot was qualified in the aircraft and had attended recurrent training recently. No other pilot risk factors were apparent. As with any transportation flight, there may have been external pressures to depart on time to reach their destination in Atlanta.

How could the TBM have mitigated the risk factors on this flight? One way may have been to file for 10,000 feet and maintained this altitude until exiting the severe icing area somewhere in southern New Jersey. This would have decreased fuel efficiency in the turboprop TBM, but it would not have taken much time to reach an area without icing and then requesting a climb to a more fuel-efficient altitude. It also might have been easier to obtain ATC clearance for an unrestricted climb through any remaining icing, the further the aircraft was from the New York and Philadelphia metro areas.

Accident Profile 3: Fatal Accident, Helicopter, Personal Flight

Type Aircraft: Robinson R44 II

Location: Panacea, FL

Date: 02/08/2014

NTSB Defining Event: Collision during takeoff/land

NTSB Case File No.: ERA14FA115

NTSB Probable Cause: The pilot's failure to maintain adequate clearance from trees during a takeoff at night. Contributing to the accident was the pilot's lack of recent night flight experience.

NTSB Factual Summary Excerpts (edited): The pilot and two passengers had flown from the Tallahassee, FL airport (TLH) to the nearby Wakulla County Airport (2J0), 24 NM from TLH. The Wakulla airport has a turf runway that is 2,590 feet long [Figure C-3]. The airport and the area around it were poorly lit. The purpose of the flight was to dine at the restaurant across the street. It was dusk when they arrived at 2J0.



Figure C-3. Turf runway.

After dinner, they returned to the helicopter for the return flight to TLH. After liftoff, the helicopter impacted 50-foot trees about 350 feet from the liftoff point. The pilot and one passenger suffered fatal injuries and the other passenger was severely injured. According to the NTSB report, the pilot may not have been aware of the proximity of the trees to the helicopter's takeoff point.

The pilot had only one hour of night flight experience in the previous 11 months. He did not possess an instrument rating. Witnesses to the accident stated the area around the airport was dark or "very dark." The pilot was taking a disqualifying drug that can cause drowsiness, although the NTSB did not assert this as a factor in the accident.

The surviving passenger stated that the pilot was in a hurry to return home so he could spend time with his daughter and had he had been gone longer than planned.

Risk Analysis: At least three of the four risk categories in the PAVE checklist may be part of the root causes of this accident. The pilot had only minimal night currency for this flight. Aeromedical factors may have contributed to the pilot's perception of the environment, although the NTSB report did not cite the disqualifying drug as a factor in the accident.

External pressures may also have been a root cause of the accident. The pilot was in a hurry to return and this could have impaired his situational awareness of the airport environment and perhaps caused him to rush through the start-up and liftoff of the helicopter.

The airport environment and obstacle hazards contributed to the risk present at takeoff. The proximity of the 50-foot trees to the takeoff zone meant that a running takeoff by the helicopter would not provide safe clearance from the trees during climb out. A hovering takeoff and climb out might also have been hazardous. For example, the R-44 POH includes the following statement in the limitations section, "Orientation during night flight must be maintained by visual reference to ground objects illuminated solely by lights on the ground or adequate celestial illumination."

The collective risk severity level for this accident was catastrophic. The risk likelihood was at least occasional, producing a high overall risk level that must be mitigated. Avoiding nighttime operations at this airport could have been a key mitigation. Perhaps the pilot and his passengers could have planned for a late lunch or earlier dinner at the restaurant that would have had them departing at or before the 1820 sunset, rather than their actual departure time of 1945.

Accident Profile 4: Fatal Accident, Turbojet-Powered, Single-Pilot

Type Aircraft: Cessna 525C (Citation CJ4)

Location: Cleveland, OH

Date: 12/29/2016

NTSB Defining Event: Loss of control in flight

NTSB Case File No.: CEN17FA072

NTSB Probable Cause: Controlled flight into terrain due to pilot spatial disorientation. Contributing to the accident was pilot fatigue, mode confusion related to the status of the autopilot, and negative learning transfer due to flight guidance panel and attitude indicator differences from the pilot's previous experience.

NTSB Factual Summary Excerpts (edited): The pilot and five passengers had flown to the Burke Lakefront Airport (BKL) earlier to attend a sporting event. They arrived back at BKL around 2230 for the return flight to Columbus, Ohio. Although BKL was VFR, the ceiling was 2300 feet and the departure took place in full darkness. After takeoff, the single pilot lost control of the aircraft within two minutes. The radar track showed the aircraft climbing through its assigned altitude and then flying erratically before plunging into Lake Erie with a descent rate of about 6,000 feet per minute.

The pilot had been awake for 17 hours at takeoff. He had recently transitioned from the Cessna 510 to the Cessna 525 and completed both aircraft and simulator training in the Cessna 525, earning his single-pilot type rating only three weeks before the accident. According to his instructors, he had been taught to operate using the autopilot most of the time. He may have suffered from mode confusion regarding the configuration and status of the autopilot in the Cessna 525, as compared to the Cessna 510 he had recently flown and did not realize that the autopilot had not engaged. This could have generated a high workload and caused him to get behind the aircraft. He was also undoubtedly under external pressure to return to Columbus that evening.

Risk Analysis: It is likely that all four categories of risk generated by the PAVE checklist were present in this accident. The pilot may have been fatigued. In addition, he may not have had enough proficiency and experience in using the autopilot control configuration in the Cessna 525 and may still have unconsciously been applying procedures appropriate to his previous Cessna 510. The nighttime environment and departure over the lake created an IMC-like environment that required the pilot to monitor the flight instruments, yet he may have been distracted by the automation issues. It is likely that his expectation, and that of his passengers, was that they would routinely return to Columbus right after the sports event. Thus, they were unprepared to remain overnight in Cleveland.

Considering a combined assessment of all the risk factors present, the catastrophic consequences associated with this accident, when combined with at least occasional likelihood, created a high-risk level for loss of control that demanded mitigation before departure. In hindsight, having a second pilot for this flight may have reduced the likelihood of loss of control. Yet, it is not clear that the pilot had such a pilot, or a "mentor pilot" available, nor any indication that he used one regularly. Alternatively, remaining overnight in Cleveland would have provided needed rest for the pilot and allowed a departure during daylight, which also could have reduced the likelihood of loss of control.

Risk management proficiency is not the only single-pilot resource management (SRM) skill that was a factor in this accident. The pilot's situational awareness was likely reduced and as a result, he did not notice that the autopilot was not engaged. Poor task and workload management may have also been a factor, causing the pilot to be overwhelmed by task saturation. Poor automation management may have been the most critical skill deficiency that hampered the pilot's ability to maintain control of the aircraft. For single-pilot operation of this complex turbojet, mastery of the autopilot and other automation is essential to manage risk and ensure safe operation under all conditions.

Appendix D – Risk Management Exercises

This appendix includes four hypothetical scenarios that can be used to illustrate the complete cycle of risk management including risk identification, assessment, and mitigation. They represent the same four aircraft categories as Appendix C. However, unlike in Appendix C, the following case studies will not include a “school solution” risk analysis. Instead, you are invited to conduct your own risk analysis and identify, assess, and mitigate the risks that your own analysis reveals and perhaps vary the scenario to consider some “what-ifs.” In this situation, there are no right or wrong answers. Once you have identified and assessed hazards and associated risks, you may find numerous ways to mitigate high risks to lower levels of likelihood and severity.

You are invited to select the scenario that is closest to the type of flying you normally do. If you are a pilot-in-training, your flight or ground instructor should work with you to discuss the results of your risk analysis and provide feedback on your work. You should use the risk management tools that were summarized in Appendix B and follow the risk management process as discussed in Chapters 2 through 4. You may also want to consult supplemental materials such as aeronautical charts.

For each case study, you should answer the following questions after you complete your risk analysis.

1. What are the potential hazards you identified in the scenario?
2. What is the risk associated with each hazard?
3. What is the likelihood (probability) of each risk?
4. What is the severity (consequences) of each risk?
5. What is the overall risk level of each risk (red, yellow, green, low)?
6. How can you mitigate each risk by reducing the likelihood and severity?
7. What is the remaining level of risk after your mitigations? Are you prepared to assume these risks on behalf of yourself and your passengers?

Scenario 1: Recreational Aviation

It is a Thursday evening in late July. You are in the final stages of planning your annual flight to the EAA Airventure in Oshkosh, WI (OSH) in your Cessna 172. [Figure D-1] You are planning to fly direct, non-stop (390 NM) from your home airport of Chan Gurney Municipal (YKN) in Yankton, SD. This year you are bringing two friends who have never flown before in a small aircraft.



Figure D-1. Scenario 1 chart excerpt.

The AirVenture starts the following Monday and you have all planned to make the flight to OSH on Sunday. You and your friends have been anticipating this flight for months. As you ponder the weather prog charts for the next several days, you note that a large weather system will arrive in YKN from the west late Saturday night. It will generate a line of severe thunderstorms that move rapidly east and pass OSH late Sunday evening. Behind the front, there will be low ceilings of 300-500 feet and light to moderate rain. On Saturday, it will be good VFR in both YKN and OSH, with isolated thunderstorms enroute.

You are a private pilot with 300 hours. You have an instrument rating and, while legally current, you have not flown in actual or simulated instrument conditions in five months. Your 172 is also technically legal for IFR, although the number 2 radio is out for repair. The non-stop flight to OSH will take about 3:30 and you have 4:30 endurance with full fuel.

Scenario 2: Turboprop-Powered, Personal Transportation

You are the owner of a small specialized manufacturing firm, with production facilities in St. Petersburg, FL. You also have a facility in Pittsfield, MA, as well as a summer home nearby in the Berkshires. To facilitate efficient travel between these locations, you operate and own a Piper PA-46-500 (M500) single-engine turboprop, which you fly single-pilot.

It is now 10 am on a Friday in August after a hectic but successful week in Florida involving a new product launch. You have just finished a press conference and are ready to head north to enjoy the weekend at your summer home before meetings at your Pittsfield facility on Monday. You are planning on flying your PA-46 nonstop (984 NM) from St. Petersburg Clearwater (PIE) to the Pittsfield, MA airport (PSF) at FL270. [Figure D-2]

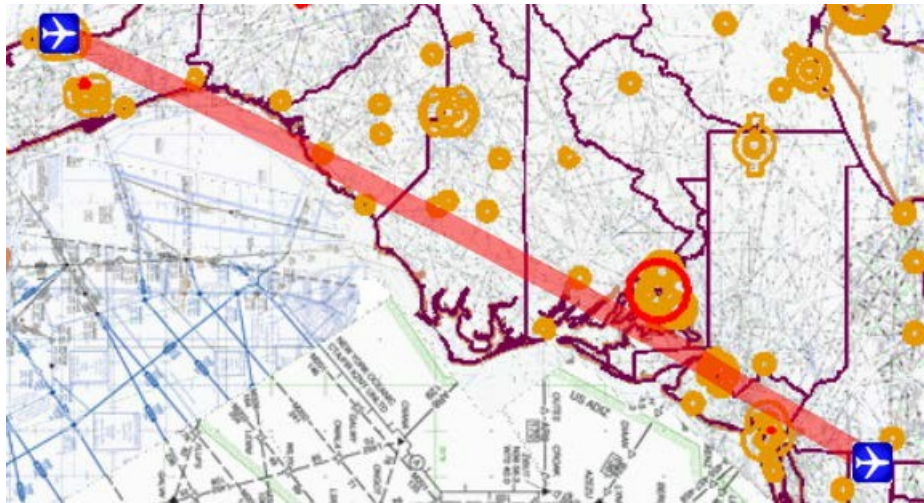


Figure D-2. Scenario 2 chart excerpt.

As your wife drives you to the airport for the 11 AM takeoff, you review your flight planning. The flight should take 3:45 and you have 4:45 of fuel. The weather is good at PSF and en route, with isolated to scattered air mass thunderstorms. You are a little concerned about air traffic in the Washington, DC, and New York metro areas, especially about the possibility of re-routing and being descended to a lower altitude where the PA-46 loses fuel efficiency. You are hoping to arrive at PSF at about 3 PM, so you and your wife can attend a cocktail party with your investors at 5 PM, before heading to a performance at the Tanglewood arts center at 7 PM.

Scenario 3: Helicopter, Business Transportation

You are the owner of a large wholesale business with multiple warehouses throughout the Los Angeles basin in California. All these facilities are within a mile of a general aviation airport. To travel between these locations and avoid the congested freeways, you own and pilot a Robinson R66 turbine-engine helicopter.

It is 6 AM Monday morning and you are planning a sweep through all four of your facilities. You plan to depart from your home near the Santa Monica Airport (SMO) and fly progressively to Van Nuys (VNY), San Gabriel Valley (EMT), Brackett Field (POC) in Pomona, and Fullerton (FUL). You will make the return flight to SMO in the early evening, to arrive just before sunset. Your direct route is plotted on the Figure D-3 chart excerpt.

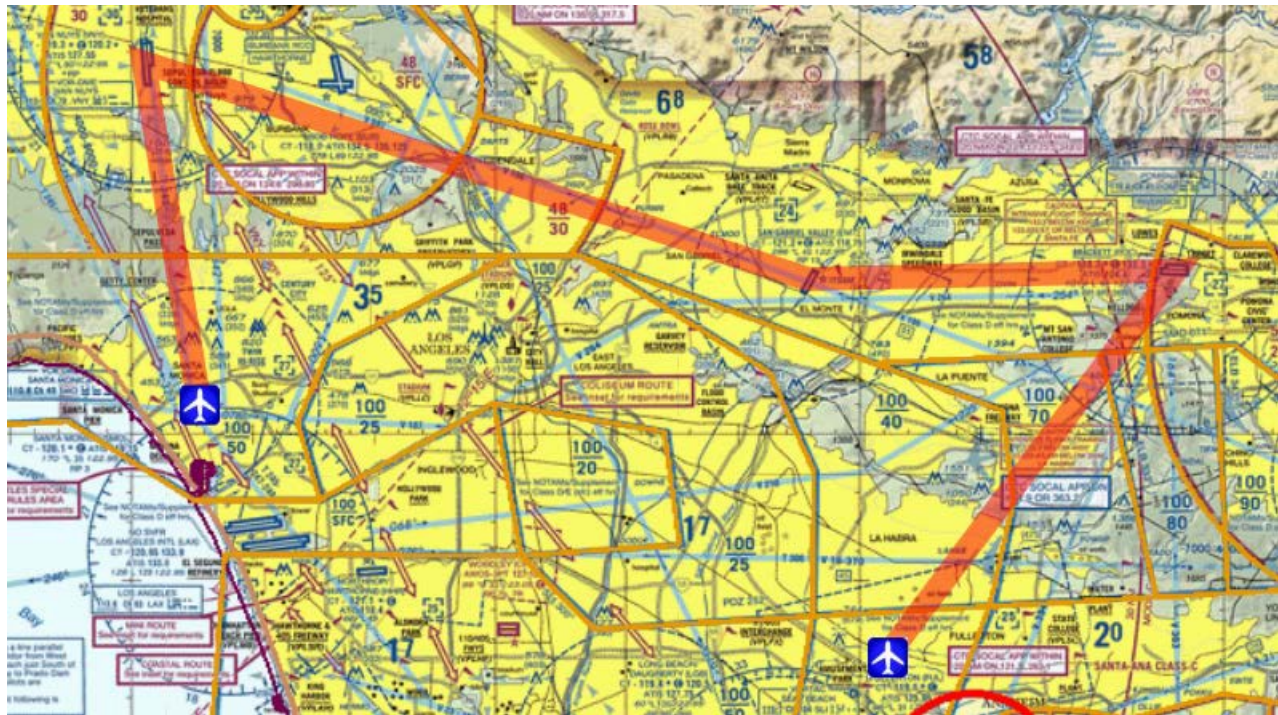


Figure D-3. Scenario 3 chart excerpt.

The weather throughout the basin is marginal VFR, with visibilities of 3-5 miles and ceilings varying from 1700 feet at FUL to 800 feet at POC. Clear skies are forecast after 2 PM. You have a helicopter instrument rating and the R66 has IFR instrumentation, but it is not approved for IFR flight. You are not instrument current. After departure from SMO, there is high terrain on the way to VNY, although you can divert to the east and perhaps fly through a pass in VMC to get to VNY.

Scenario 4: Turbojet-Powered, Single-Pilot, Business Transportation

You own a consulting firm with a nationwide clientele and are based in Springfield, IL (SPI). You fly an Eclipse 500 single pilot to reach your clients. You only recently purchased the aircraft and have just completed the mandatory “mentoring” following the type rating practical test. You have also committed to adding a 20 percent margin to takeoff and landing distances until you log 100 additional flight hours in the Eclipse.

You have a client in Turners Falls, MA who has an urgent need to meet with you tomorrow, Thursday, so you can evaluate some engineering plans and data. The client is located in an industrial park on the Turners Falls Airport (0B5). The 0B5 airport is 790 NM from SPI. You run the numbers in your flight planning software and determine that the flight will take about 2:15 and use 1,100 pounds of fuel at a cruise altitude of FL350, with full fuel of 1,700 pounds on board. The weather in Massachusetts is forecast to be marginal VFR tomorrow with ceilings of 1,200 feet and five miles visibility with cloud tops at around 8,000 feet.

You next consider the destination logistics and consult both the New York sectional chart and the associated chart supplement, as well as internet sources for fuel, airport services, rental cars, and hotels. [Figure D-4]

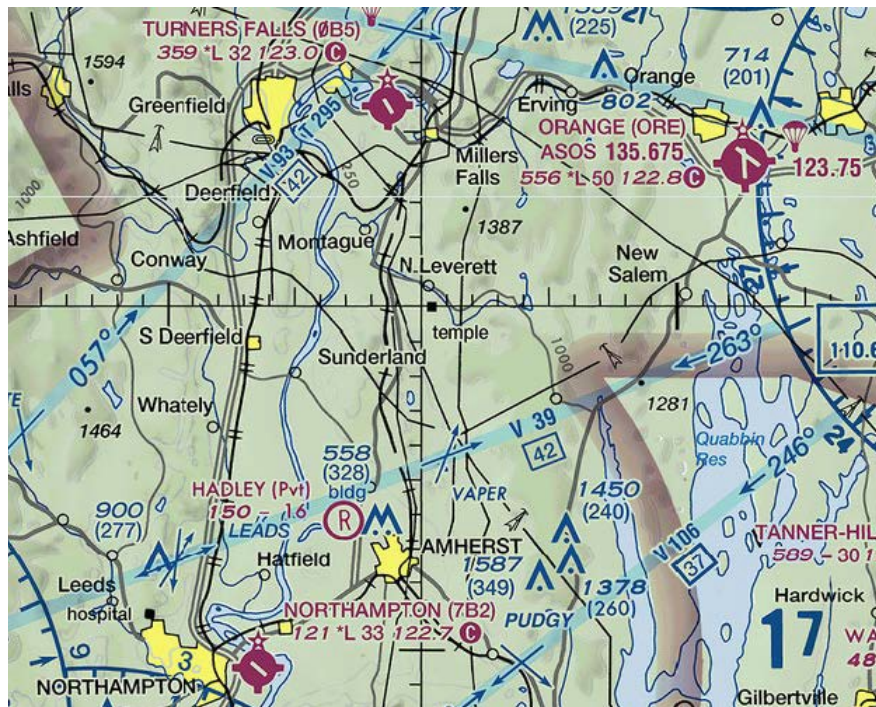


Figure D-4. Scenario 4 chart excerpt.

The runway at Turners Falls is 3,200 feet. Nearby airports Orange (ORE) and Northampton (7B2) have runways of 5,000 feet and 3,335 feet, respectively. Your calculated unfactored landing distance is 2,760 feet at your landing weight at Turners Falls with 600 pounds of fuel remaining. Your calculated unfactored takeoff distance is 2,600 feet at full fuel or 1900 feet with only 600 pounds of fuel.

After a further phone discussion with the client, you realize that you will need at least six hours of review time on site with her. If you depart SPI at 8 AM, you will arrive at 0B5 at about 11:30. You will likely not finish with the client until nearly 6 PM and not be able to return to SPI before 8 PM, assuming a non-stop flight. You have an important meeting back in Springfield on Friday.

You ponder the logistics issues. Turners Falls has no jet fuel, no rental cars, and only marginal hotel availability. Orange has jet fuel, but no rental cars, and no suitable lodging nearby. Northampton has no jet fuel but does have rental cars and numerous full-service hotels available. The nearest airport with all these services is in Westfield, MA (BAF, 9,000-foot runway) about 20 miles south of Northampton.

All three airports have RNAV (GPS) instrument approaches. Only circling minimums with a minimum descent altitude (MDA) of 1,121 feet above ground is available at Turners Falls. The minimums at Orange provide for vertical guidance through LPV minima of 328 feet. At Northampton, only lateral guidance (LNAV) is available with minima of 819 feet above the ground.

Risk Management Handbook (FAA-H-8083-2)

Glossary

Numbers & Symbols

14 CFR. See Title 14 of the Code of Federal Regulations.

3P. An acronym that represents the three components of the risk management cycle: perceive, process, perform.

5P. An acronym used by the single pilot to organize resources and information that impact hazard identification, risk assessment, and ADM. The five Ps are the plan, plane, pilot, passengers, and programming.

A

Acceptable risk. That part of identified risk that is allowed to persist without further engineering or management action. Making this decision is a difficult yet necessary responsibility for managing activity. This decision is made with full knowledge that it is the user who is exposed to this risk.

Aeronautical decision-making (ADM). A systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances.

C

CARE. An acronym that represents the four risk assessment elements: Consequences, Alternatives, Reality, and External pressures.

CAST/ICAO Common Taxonomy Team (CICTT). A group that developed common classifications and definitions for aviation accident and incident reporting.

Checklist. A tool that is used as a human factors aid in aviation safety. It is a systematic and sequential list of all operations that must be performed to accomplish a task properly.

Commercial Aviation Safety Team (CAST). An organization that aims to reduce commercial aviation fatality risk in the United States and promote new government and industry safety initiatives throughout the world.

Controlled flight into terrain (CFIT). An accident whereby an airworthy aircraft, under pilot control, inadvertently flies into terrain, an obstacle, or water.

CFR. See Title 14 of the Code of Federal Regulations.

Crew resource management (CRM). The application of team management concepts in the flight deck environment. It was initially known as cockpit resource management, but as CRM programs evolved to include cabin crews, maintenance personnel, and others, the phrase “crew resource management” has been adopted. This includes single pilots, as in most general aviation aircraft. Pilots of small aircraft, as well as crews of larger aircraft, must make effective use of all available resources; human resources, hardware, and information. A current definition includes all groups routinely working with the flight deck crew who are involved in decisions required to operate a flight safely. These groups include, but are not limited to: pilots, dispatchers, cabin crewmembers, maintenance personnel, and air traffic controllers. CRM is one way of addressing the challenge of optimizing the human/ machine interface and accompanying interpersonal activities.

Currency. Meeting all established requirements.

E

Electronic flight bag (EFB). A portable or integrated device that allows the pilot to carry all necessary aeronautical, performance, weight and balance, and aircraft checklists in digital form and may allow remote manipulation of the avionics through wireless radio connections.

Emergency. An urgent condition or distress that requires immediate attention.

Error. Deviations from intended or expected actions that are caused by the flight crew that cause confusion, increase workload, absorb attention, reduce safety margins, increase risk, and may lead to undesired aircraft states.

External pressures. Influences external to the flight that create a sense of pressure for a pilot to complete a flight, often at the expense of safety.

F

Flight management system (FMS). A system normally integrated into a technically advanced aircraft that provides an efficient means of loading and programming horizontal and vertical flight path information that can be tracked by the autopilot or followed manually by the pilot using flight director and other guidance cues

Flight risk assessment tool (FRAT). A way to record and analyze identified hazards and risks. A FRAT can be numerical (scoring predetermined hazards) to measure risk or narrative (recording identified hazards, associate risk, and individual risk mitigations).

G

General aviation. All flights other than military and scheduled airline flights, both private and commercial.

General Aviation Joint Steering Committee (GAJSC). Team of FAA and general aviation community members formed to analyze general aviation accidents and create safety enhancements that can mitigate leading accident causes.

H

Hazard. A present condition, event, object, or circumstance that could lead to or contribute to an unplanned or undesired event such as an accident.

Human behavior. The product of factors that cause people to act in predictable ways.

Human factors. A multidisciplinary field devoted to optimizing human performance and reducing human error. It incorporates the methods and principles of the behavioral and social sciences, engineering, and physiology. It may be described as the applied science which studies people working together in concert with machines. Human factors involve variables that influence individual performance, as well as team or crew performance.

I

IMSAFE. An acronym that represents the six aeromedical risk areas: Illness, Medication, Stress, Alcohol, Fatigue, and Emotion.

Identified risk. The risk that has been determined through various analysis techniques. The first task of system safety is to identify, within practical limitations, all possible risks.

Instrument flight rules (IFR). Rules that govern the procedure for conducting flight in weather conditions below VFR weather minimums. The term IFR also is used to define weather conditions and the type of flight plan under which an aircraft is operating.

Instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from clouds, and ceiling less than the minimums specified for visual meteorological conditions, requiring operations to be conducted under IFR.

International Civil Aviation Organization (ICAO). An international body that sets aviation safety standards. Member states agree to formulate regulation to meet those standards.

J

Judgment. The mental process of recognizing and analyzing all pertinent information in a particular situation, a rational evaluation of alternative actions in response to it, and a timely decision on which action to take.

L

Loss of control inflight (LOC-I). An accident caused by the pilot not maintaining control of the airplane. Many LOC-I accidents are the result of stalls, spins, or accelerated maneuvers.

M

Mode annunciator. A display panel normally integrated into the primary flight display that shows the current status and operating functions of the autopilot or flight director.

Mode controller. The interface used by the pilot to select autopilot or flight director operating modes and to engage or disengage the autopilot system.

N

National Transportation Safety Board (NTSB). A United States Government independent organization responsible for investigations of accidents involving aviation, highways, waterways, pipelines, and railroads in the United States. The NTSB is charged by the Congress of the United States to investigate civil aviation accidents.

Notice to airmen (NOTAM). A notice filed with an aviation authority to alert aircraft pilots of any hazards en route or at a specific location. The authority in turn provides means of disseminating relevant NOTAMs to pilots.

P

PAVE. An acronym that represents the four identification areas for hazards and associated risks: Pilot, Aircraft, enVironment, and External pressures.

Personality. The embodiment of personal traits and characteristics of an individual that are set at a very early age and are extremely resistant to change.

Pilot report (PIREP). Report of meteorological phenomena encountered by aircraft.

Probable cause. The defining event that directly leads to an accident.

Proficiency. Possessing a high standard of competence or expertise.

Q

Qualification. Having the certificates, ratings, endorsements, or other designations required for the operation.

R

Residual risk. The remaining risk after system safety efforts have been fully employed. It is not necessarily the same as acceptable risk. Residual risk is the sum of acceptable risk and unidentified risk. This is the total risk passed on to the user.

Risk. The future impact of a hazard that is not eliminated or controlled.

Risk assessment. An approach to managing uncertainty. Risk assessment assigns a quantitative value to risk likelihood and risk severity.

Risk assessment matrix. A tool used to see the relationship between risk likelihood and risk severity to determine an overall level of risk, measured as low, medium, serious, or high.

Risk likelihood. The probability of encountering risk categorized as probable, occasional, remote, or improbable.

Risk management. The part of the decision-making process which relies on situational awareness, problem recognition, and good judgment to reduce risks associated with each flight.

Risk mitigation. The process of reducing risk likelihood and severity to lower levels

Risk severity. The magnitude of consequences of risk categorized as catastrophic, critical, marginal, or negligible.

Root cause. The underlying reason that leads the pilot or aircraft toward the probable cause of an accident.

S

Safety management system (SMS). The application of special technical and managerial skills to the systematic, forward-looking identification and control of hazards throughout the life cycle of a project, program, or activity.

Single-pilot resource management (SRM). The set of competencies that include situational awareness, communication skills, teamwork, task allocation, aeronautical decision making, risk management, controlled flight into terrain (CFIT) awareness, and automation management. SRM specifically refers to the management of all resources available to the single pilot. Resources are found both inside and outside the flight deck.

Situational awareness. Perception of variables in the environment, comprehension of their meaning, and projection of their status in the near future.

Stress. The body's response to demands placed upon it.

System component failure of the powerplant (SCF-PP). An accident caused by failure of an engine component that may lead to complete failure of the engine.

T

TEAM (or TEMA). An acronym that represents the four risk mitigation process steps: Transfer, Eliminate, Accept, and Mitigate (or Transfer, Eliminate, Mitigate, and Accept).

Technically advanced aircraft (TAA). Aircraft that have an advanced avionics system that includes a primary flight display (PFD) showing the six primary flight instruments, a multifunction display (MFD) that has a moving map showing aircraft position based on a global positioning system (GPS), and a two-axis autopilot capable of tracking heading and navigation guidance signals.

Threat. Hazards present in the environment or that are outside the influence of the flight crew that increase operational complexity and may lead to errors.

Threat and error management (TEM). A risk management methodology designed to anticipate and prevent threats from creating errors, trap errors before they cause undesired aircraft states, and mitigate undesired aircraft states to stop an incident or accident from occurring.

Total risk. The sum of identified and unidentified risks.

Title 14 of the Code of Federal Regulations (14 CFR). Includes what was formerly known as the Federal Aviation Regulations governing the operation of aircraft, airways, and airmen.

U

Unacceptable risk. The risk that cannot be tolerated by the managing activity. It is a subset of identified risk that must be eliminated or controlled.

Unidentified risk. Risk not yet identified. Some unidentified risks are subsequently identified when a mishap occurs. Some risk is never known.

Undesirable risk. A tolerable risk that must be prepared for and mitigated as best as possible.

V

Visual flight rules (VFR). Code of Federal Regulations that govern the procedures for conducting flight under visual conditions.

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling meeting or exceeding the minimums specified for VFR.

Risk Management Handbook Subgroup

Recommendation and Suggestions



Risk Management Handbook Subgroup: Final Recommendation

ACS Working Group – August 7, 2020

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Notes About the Recommended Handbook

- Chapter 1 through 4 are a complete rewrite of material in the current edition of the handbook.
- Chapter 5 is new material discussing threat and error management.
- Chapter 6 was meant to be focused on flight path management under both automated and manual flight. However, the subgroup's SME on the topic terminated his work on the project last March because of the COVID-19 pandemic. Chapter 6 instead is a significant rewrite of the current edition's chapter on automation.
- Chapter 7 is largely reused and updated content from current edition of the handbook with the notable exception being a complete rewrite of the section about SRM and the 5P check.

Open Comments and Recommendations

- The subgroup cannot understate the importance of this handbook in improving aviation safety. The subgroup recommends that this handbook be the sole source and primary reference for any content contained in it. Discussion about risk management, aeronautical decision-making, single pilot resource management, or any other topics should be removed from other handbooks and references. Readers of other handbooks and references should be directed to this handbook. A notable exception would be Chapter 10 of the Aviation Instructor's Handbook, which is specific to instructional risk management. That content should remain in that handbook.
- Chapter 6, Automation Management, has much greater potential than its currently recommended form. The subgroup recommends expansion of this chapter to focus on flight path management under both automated and manual flight based on the input of SMEs on the topic and perhaps other working groups.
- Chapter 7, ADM, SRM, and Personal Minimums, includes a complete rewrite of SRM and the 5P check. This material will no longer align with the same topics in other handbooks. The subgroup

recommends to the FAA that this new material be used elsewhere as a replacement to current material should it need to be duplicated in other handbooks and references.

- Barbara Adams of the FAA recommended addition of information about confirmation and expectation bias during taxi operations. Without specific content recommendations, the subgroup did not find it appropriate to add this material. However, the subgroup acknowledges its importance. After ARAC approval of our recommended revision to the RMH, the FAA should develop the material and add it to the handbook if and where appropriate.

Suggestions Prior to Final Publication/Distribution

- Reference to the National Business Aviation Association (NBAA) is made a couple of times in the handbook. Several graphics concerning flight risk assessment tools were developed based on materials freely available on their website. Bob Wright of Wright Aviation Solutions assisted the NBAA with those materials and was also one of our subgroups SMEs. The subgroup recommends that the NBAA have an opportunity to review the handbook before publication.
- There are several hyperlinks in the handbook. The FAA should consider how to properly format these in a consistent manner through this handbook and others. The FAA should also come up with a plan for checking for and updating broken hyperlinks, as many web page URLs periodically change.
- The subgroup recommends inclusion of a cover page, references section, and index in the final document, consistent with other FAA handbooks. References and footnotes in Chapter 5 should be moved to the references section to be included with references for the rest of the handbook.
- The current draft does not represent the final layout or formatting. Those items will be addressed through the FAA's work of finalizing and publishing the handbook.

Powered-Lift Instrument Instructor

Airman Certification Standards



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**Completion
Standards**

- A. Pass the appropriate knowledge test(s).
- B. Pass the practical test. The applicant should:
 - 1. Demonstrate instructional proficiency in the Tasks;
 - 2. Facilitate the learning of subject material;
 - 3. *Simultaneously* demonstrate, teach, and explain the maneuvers;
 - 4. Teach practical risk management skills associated with the Tasks;
 - 5. Identify, assess, and mitigate risks associated with instruction;
 - 6. Promote professionalism;
 - 7. Recognize, analyze, and correct common learner errors.
 - 8. Meet the standards of the knowledge, risk management, and skill elements assessed by the evaluator.

**Instructional
Proficiency**

This section contains Areas of Operation and Tasks for the Instrument Instructor - Powered-Lift practical test.

The instructor applicant demonstrates instructional proficiency. Instructional proficiency includes the ability to explain the knowledge elements of each selected Task, demonstrate and *simultaneously* explain the skills associated with each Task, and manage the risks associated with flight instruction. See appendix 6 for more information about risk management for the instructor.

The instructor applicant also demonstrates the ability to describe, analyze, and correct common errors associated with Tasks imported from foundational ACS document(s). When the evaluator assumes the role of a pilot in training, the instructor applicant should point out any errors and provide appropriate instruction unless the evaluator waives such instruction. The applicant should use appropriate judgment in deciding whether to take over control from the evaluator. Whether an applicant demonstrates and teaches a Task or corrects errors, the evaluator judges the effectiveness of the instruction and determines if the instruction given during the training scenario would bring about the desired learning.

Unless otherwise indicated, the evaluator assesses at least one knowledge element, one risk element, and all skill elements for each selected Task.

I. Fundamentals of Instructing

Tasks E, F, and at least one other Task

Area of Operation I. *The evaluation of teaching skills (i.e., FOI, Section 1) is part of the entire instrument flight instructor practical test (ground and flight). The evaluator's plan-of-action does not necessarily have a specific "portion" that is devoted to FOI. FOI Tasks may be covered throughout the practical test by way of scenario-based evaluation.*

If there is concern about the applicant's ability to apply SBT, the evaluator can direct the applicant to prepare the AOO IV, Preflight Lesson on a Maneuver To Be Performed in Flight as if it were a real lesson under a specific scenario. In addition, the evaluator may evaluate the lesson as a flight maneuver lesson in order to evaluate how the applicant teaches on the ground, briefs the flight, and conducts the training.

Note

FOI Tasks:

- A. Human Behavior and Effective Communication
- B. Learning Process
- C. Teaching Process and Methods
- D. Assessment
- E. Instructor Responsibilities and Professionalism
- F. Risk Management and the Aeronautical Decision-Making Process

II. Technical Subject Areas

Task A. Logbook Entries Related to Instrument Instruction

Note	<i>The evaluator selects Tasks A, C, and at least one other Task from PI.II, Technical Subject Areas.</i>
References	<i>14 CFR parts 61, 68; ACs 60-28, 68-1; FAA-H-8083-2, FAA-H-8083-15, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with requirements of logbook entries related to instrument instruction as they relate to safety of flight and applies that knowledge when delivering ground instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.II.A.K1	Required logbook entries for instruction given.
PI.II.A.K2	Other required pilot logbook endorsements.
PI.II.A.K3	Required endorsement of a pilot logbook for the satisfactory completion of an instrument proficiency check.
PI.II.A.K4	Required flight instructor records.
PI.II.A.K5	Flight instructor renewal and reinstatement requirements.
Risk Management	<i>The applicant demonstrates instructional knowledge by teaching how to identify, explain, and manage risk arising from:</i>
PI.II.A.R1	Endorsements without appropriate limitations or expiration dates.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.II.A.S1	Describe or prepare logbook entries/endorsements required for at least two of the events specified in the elements or sub-elements of K1 through K5.

II. Technical Subject Areas

Task B. Aircraft Systems Related to IFR Operations

Note	<i>The evaluator selects Tasks A, C, and at least one other Task from PI.II, Technical Subject Areas.</i>
References	<i>14 CFR parts 61, 91, 97; AC 91-74; FAA-H-8083-2, FAA-H-8083-15, FAA-H-8083-33; POH/RFM</i>
Objective	<i>To determine that the applicant understands the elements associated with anti-icing and de-icing as they relate to safety of flight and applies that knowledge when delivering ground instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.II.B.K1	General operational characteristics and limitations of applicable anti-icing/deicing and weather detection equipment, including:
Note	<i>The evaluator selects at least one sub-element from K1a through K1g.</i>
PI.II.B.K1a	a. Airframe
PI.II.B.K1b	b. Thrust/lift device
PI.II.B.K1c	c. Air intake
PI.II.B.K1d	d. Fuel system
PI.II.B.K1e	e. Pitot-static system
PI.II.B.K1f	f. Radar/lightning detection system
PI.II.B.K1g	g. Other inflight weather systems
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.II.B.R1	Recognition and detection of system malfunctions or failures.
PI.II.B.R2	Exceeding the aircraft systems capabilities.
Skills	<i>The applicant demonstrates the ability to:</i>
PI.II.B.S1	Teach at least one of the sub-elements from K1a through K1g.

II. Technical Subject Areas

Task C. Aircraft Flight Instruments and Navigation Equipment

Note	<i>The evaluator selects Tasks A, C, and at least one other Task from PI.II, Technical Subject Areas.</i>
References	<i>14 CFR parts 61, 91; AC 90-100, 90-105, 90-107, 91-78; AIM; FAA-H-8083-15, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with managing instruments appropriate for an IFR flight as they relate to safety of flight and applies that knowledge when delivering ground instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.II.C.K1	Operation of the aircraft's applicable flight instrument system(s), including:
PI.II.C.K1a	a. Pitot-static instrument system: altimeter, airspeed indicator, vertical speed indicator
PI.II.C.K1b	b. Gyroscopic/electric/vacuum instrument system: attitude indicator, heading indicator, turn-and-slip indicator/turn coordinator
PI.II.C.K1c	c. Electrical systems, electronic flight instrument displays (primary flight display (PFD) and multi-function display (MFD))
PI.II.C.K1d	d. Magnetic compass
PI.II.C.K2	Capabilities and uses of electronic flight bags (EFB).
PI.II.C.K3	Operation of the aircraft's applicable navigation system(s), including:
PI.II.C.K3a	a. VOR, DME, ILS, marker beacon receiver/indicators
PI.II.C.K3b	b. RNAV, GPS, Wide Area Augmentation System (WAAS), FMS, autopilot
PI.II.C.K4	Transponder and Automatic Dependent Surveillance - Broadcast (ADS-B).
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.II.C.R1	Managing and monitoring automated systems.
PI.II.C.R2	Difference between approved and non-approved navigation devices.
PI.II.C.R3	Common failure modes of flight and navigation instruments.
PI.II.C.R4	Limitations of electronic flight bags.
PI.II.C.R5	Ensuring currency and coverage of navigation databases.
Skills	<i>The applicant demonstrates the ability to:</i>
PI.II.C.S1	Teach at least one of the elements or sub-elements listed in K1 through K4.

II. Technical Subject Areas

Task D. Human Factors

Note	<i>The evaluator selects Tasks A, C, and at least one other Task from PI.II, Technical Subject Areas.</i>
References	<i>AIM; FAA-H-8083-2, FAA-H-8083-9, FAA-H-8083-25</i>
Objective	<i>To determine that the applicant understands the elements associated with personal health, flight physiology, aeromedical, and human factors as they relate to safety of flight and applies that knowledge when delivering ground instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.II.D.K1	The symptoms (as applicable), recognition, causes, effects, and corrective actions associated with aeromedical and physiological issues, including:
PI.II.D.K1a	a. Hypoxia
PI.II.D.K1b	b. Hyperventilation
PI.II.D.K1c	c. Middle ear and sinus problems
PI.II.D.K1d	d. Spatial disorientation
PI.II.D.K1e	e. Motion sickness
PI.II.D.K1f	f. Carbon monoxide poisoning
PI.II.D.K1g	g. Stress
PI.II.D.K1h	h. Fatigue
PI.II.D.K1i	i. Dehydration and nutrition
PI.II.D.K1j	j. Hypothermia
PI.II.D.K1k	k. Optical illusions
PI.II.D.K1l	l. Dissolved nitrogen in the bloodstream after scuba dives
PI.II.D.K2	Regulations regarding use of alcohol and drugs.
PI.II.D.K3	Effects of alcohol, drugs, and over-the-counter medications.
PI.II.D.K4	Aeronautical Decision-Making (ADM).
Risk Management	<i>The applicant demonstrates instructional knowledge by teaching how to identify, explain, and manage risk arising from:</i>
PI.II.D.R1	Aeromedical and physiological issues.
PI.II.D.R2	Hazardous attitudes.
PI.II.D.R3	Distractions, improper task management, loss of situational awareness, or disorientation.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.II.D.S1	Associate the symptoms (as applicable), recognition, causes, effects, and corrective actions with at least three of the conditions listed in K1a through K1l.
PI.II.D.S2	Perform self-assessment, including fitness for flight and personal minimums.

III. Preflight Procedures

Task A. Flight Instrument Check

Note	<i>The evaluator selects all Tasks from PI.III, Preflight Procedures.</i>
References	<i>14 CFR part 91; AC 91.21-1; FAA-H-8083-2, FAA-H-8083-15, FAA-H-8083-25, FAA-H-8083-33; POH/RFM</i>
Objective	<i>To determine that the applicant understands the elements associated with conducting a preflight check on the aircraft's instruments necessary for an IFR flight as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.III.A.K1	Purpose of performing a flight instrument check and how to detect possible defects.
PI.III.A.K2	IFR airworthiness, including aircraft inspection requirements and required equipment for IFR flight (and use of minimum equipment list (MEL), if applicable).
PI.III.A.K3	Required procedures, documentation, and limitations of flying with inoperative equipment.
PI.III.A.K4	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.III.A.R1	Operating with inoperative equipment.
PI.III.A.R2	Operating with outdated navigation publications or databases.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.III.A.S1	Perform preflight inspection by following the checklist appropriate to the aircraft and determine that the aircraft is in a condition for safe instrument flight.
PI.III.A.S2	Identify, describe, and correct errors, as applicable.

III. Preflight Procedures

Task B. Weather Information

Note	<i>The evaluator selects all Tasks from PI.III, Preflight Procedures.</i>
References	<i>14 CFR part 91; AC 00-6, 00-45; AIM; FAA-H-8083-25, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with obtaining, understanding, and applying weather information for a flight under IFR as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.III.B.K1	Acceptable sources of weather data for flight planning purposes.
PI.III.B.K2	Weather products and resources utilized for preflight planning, current and forecast weather for departure, en route operations, and arrival phases of flight.
PI.III.B.K3	Meteorology applicable to the departure, en route, alternate, and destination for flights conducted under IFR in Instrument Meteorological Conditions (IMC), including expected climate and hazardous conditions such as:
PI.III.B.K3a	a. Atmospheric composition and stability
PI.III.B.K3b	b. Wind (e.g., crosswind, tailwind, windshear, mountain wave, etc.)
PI.III.B.K3c	c. Temperature
PI.III.B.K3d	d. Moisture/precipitation
PI.III.B.K3e	e. Weather system formation, including air masses and fronts
PI.III.B.K3f	f. Clouds
PI.III.B.K3g	g. Turbulence
PI.III.B.K3h	h. Thunderstorms and microbursts
PI.III.B.K3i	i. Icing and freezing level information
PI.III.B.K3j	j. Fog
PI.III.B.K3k	k. Frost
PI.III.B.K4	Flight deck displays of digital weather and aeronautical information.
Risk Management	<i>The applicant demonstrates instructional knowledge by teaching how to identify, explain, and manage risk arising from:</i>
PI.III.B.R1	Factors involved in making the go/no-go and continue/divert decisions, including:
PI.III.B.R1a	a. Circumstances that would make diversion prudent
PI.III.B.R1b	b. Personal weather minimums
PI.III.B.R1c	c. Hazardous weather conditions, including known or forecast icing or turbulence aloft
PI.III.B.R2	Limitations of:
PI.III.B.R2a	a. Onboard weather equipment
PI.III.B.R2b	b. Aviation weather reports and forecasts
PI.III.B.R2c	c. Inflight weather resources
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.III.B.S1	Use available aviation weather resources to obtain an adequate weather briefing.
PI.III.B.S2	Discuss the implications of at least three of the conditions listed in K3a through K3k, using actual weather or weather conditions provided by the evaluator.

PI.III.B.S3	Correlate weather information to make a competent go/no-go decision.
PI.III.B.S4	Determine whether an alternate airport is required, and, if required, whether the selected alternate airport meets regulatory requirements.

III. Preflight Procedures

Task C. Cross-Country Flight Planning

Note	<i>The evaluator selects all Tasks from PI.III, Preflight Procedures.</i>
References	<i>14 CFR part 91; AIM; Chart Supplements; FAA-H-8083-2, FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-25, FAA-H-8083-33; NOTAMs; VFR Navigation Charts</i>
Objective	<i>To determine that the applicant understands the elements associated with planning an IFR cross-country and filing an IFR flight plan as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.III.C.K1	Route planning, including consideration of the available navigational facilities, special use airspace, preferred routes, and alternate airports/heliports/landing sites as applicable to the aircraft provided for the practical test.
PI.III.C.K2	Altitude selection accounting for terrain and obstacles, glide/autorotative distance of aircraft, IFR cruising altitudes, effect of wind, and oxygen requirements.
PI.III.C.K3	Calculating:
PI.III.C.K3a	a. Time, climb and descent rates, course, distance, heading, true airspeed, and groundspeed
PI.III.C.K3b	b. Estimated time of arrival, including conversion to universal coordinated time (UTC)
PI.III.C.K3c	c. Fuel requirements
PI.III.C.K4	Elements of an IFR flight plan.
PI.III.C.K5	Procedures for activating and closing an IFR flight plan in controlled and uncontrolled airspace.
Risk Management	<i>The applicant demonstrates instructional knowledge by teaching how to identify, explain, and manage risk arising from:</i>
PI.III.C.R1	Pilot(s).
PI.III.C.R2	Aircraft.
PI.III.C.R3	Environment (e.g., weather, icing, airports/heliports/helipads/landing areas, airspace, terrain, obstacles).
PI.III.C.R4	External pressures.
PI.III.C.R5	Limitations of air traffic control (ATC) services.
PI.III.C.R6	Limitations of electronic planning applications and programs.
PI.III.C.R7	Improper fuel planning.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.III.C.S1	Prepare, present, and explain a cross-country flight plan assigned by the evaluator, including a risk analysis based on real-time weather that includes calculating time en route and fuel, considering factors such as power settings, operating altitude, wind, fuel reserve requirements, and weight and balance requirements.
PI.III.C.S2	Recalculate fuel reserves.
PI.III.C.S3	Create an IFR flight plan and file if needed.
PI.III.C.S4	Interpret departure, arrival, en route, and approach procedures with reference to appropriate and current charts.
PI.III.C.S5	Recognize airframe icing and demonstrate knowledge of the adverse effects of airframe icing during pre-takeoff, takeoff, cruise, and landing phases of flight as well as the corrective actions.

PI.III.C.S6

Apply pertinent information from appropriate and current aeronautical charts, Charts Supplement; NOTAMs relative to airport runway and taxiway or heliport closures; and other flight publications.

IV. Preflight Lesson on a Maneuver to be Performed in Flight

Task A. Maneuver Lesson

References FAA-H-8083-9, FAA-H-8083-25, FAA-H-8083-33; POH/AFM

Objective To determine that the applicant understands the elements associated with a maneuver Task selected from PI.VI, Flight by Reference to Instruments through PI.IX, Emergency Operations and applies that knowledge when delivering ground instruction. Previously developed lesson plans from the instructor applicant's library may be used.

Note The selected maneuver may also be evaluated during flight, but it does not replace the requirement for the pre-flight lesson.

Knowledge The applicant demonstrates instructional knowledge by describing and explaining:

PI.IV.A.K1 Purpose of the maneuver.

PI.IV.A.K2 Elements of the maneuver and the associated common errors.

PI.IV.A.K3 Desired outcome(s), including completion standards.

Risk Management The applicant demonstrates instructional knowledge by teaching how to identify, explain, and manage risk arising from:

PI.IV.A.R1 Selected maneuver Task.

Skills The applicant demonstrates the ability to:

PI.IV.A.S1 Deliver instruction on the selected maneuver using a lesson plan, teaching methods, and teaching aids, as appropriate, that incorporate K1 through K3.

V. Air Traffic Control Clearances and Procedures

Task A. Compliance with Air Traffic Control Clearances

Notes	<i>The evaluator selects both Tasks from PI.V, Air Traffic Control Clearances and Procedures.</i>
	<i>See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.</i>
References	<i>14 CFR parts 61, 91; AIM; FAA-H-8083-15, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with ATC clearances and procedures as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates an understanding of:</i>
PI.V.A.K1	Elements and procedures related to ATC clearances and pilot/controller responsibilities for departure, en route, and arrival phases of flight, including clearance void times.
PI.V.A.K2	Pilot-in-Command (PIC) emergency authority.
PI.V.A.K3	Lost communication procedures.
PI.V.A.K4	Procedures for flights outside of ATC coverage.
PI.V.A.K5	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.V.A.R1	Less than full understanding of an ATC clearance.
PI.V.A.R2	Inappropriate, incomplete, or incorrect ATC clearances.
PI.V.A.R3	ATC clearances incompatible with aircraft performance and navigation capability.
PI.V.A.R4	Aircraft with similar call signs.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.V.A.S1	Copy, read back, interpret, and comply with simulated and actual ATC clearances in a timely manner using standard phraseology as provided in the Aeronautical Information Manual.
PI.V.A.S2	Set communication frequencies, navigation systems (identifying when appropriate), and transponder codes in compliance with the ATC clearance.
PI.V.A.S3	Use the current and appropriate paper or electronic navigation publications.
PI.V.A.S4	Intercept all courses, radials, and bearings appropriate to the procedure, route, or clearance in a timely manner.
PI.V.A.S5	Maintain the applicable airspeed ± 10 knots, headings $\pm 10^\circ$, altitude ± 100 feet; track a course, radial, or bearing within $\frac{3}{4}$ -scale deflection of the course deviation indicator (CDI).
PI.V.A.S6	Use SRM/CRM.
PI.V.A.S7	Perform the appropriate aircraft checklist items relative to the phase of flight.
PI.V.A.S8	Identify, describe, and correct errors, as applicable.

V. Air Traffic Control Clearances and Procedures

Task B. Holding Procedures

Note	<i>The evaluator selects both Tasks from PI.V, Air Traffic Control Clearances and Procedures.</i>
References	<i>14 CFR parts 61, 91; AIM; FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with holding procedures as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.V.B.K1	Elements related to holding procedures, including reporting criteria, appropriate speeds, aircraft configuration, and recommended entry procedures for published and non-published holding patterns.
PI.V.B.K2	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.V.B.R1	Recalculating fuel reserves if assigned an unanticipated expected further clearance (EFC) time.
PI.V.B.R2	Scenarios and circumstances that could result in minimum fuel or the need to declare an emergency.
PI.V.B.R3	Scenarios that could lead to holding, including deteriorating weather at the planned destination.
PI.V.B.R4	Improper holding entry and improper wind correction while holding.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.V.B.S1	Explain and use an entry procedure that ensures the aircraft remains within the holding pattern airspace for a standard, nonstandard, published, or non-published holding pattern.
PI.V.B.S2	Establish the holding airspeed and configuration appropriate for the altitude or aircraft when 3 minutes or less from, but prior to arriving at, the holding fix and set appropriate power as needed for fuel conservation.
PI.V.B.S3	Recognize arrival at the holding fix and promptly initiate entry into the holding pattern.
PI.V.B.S4	Maintain airspeed ± 10 knots, altitude ± 100 feet, selected headings within $\pm 10^\circ$, and track a selected course, radial, or bearing within $\frac{3}{4}$ -scale deflection of the course deviation indicator (CDI).
PI.V.B.S5	Use proper wind correction procedures to maintain the desired pattern and to arrive over the fix as close as possible to a specified time and maintain pattern leg lengths when specified.
PI.V.B.S6	Monitor the position of the aircraft in relation to the desired flightpath during holding.
PI.V.B.S7	Comply with ATC reporting requirements and restrictions associated with the holding pattern.
PI.V.B.S8	Use SRM/CRM.
PI.V.B.S9	Identify, describe, and correct errors, as applicable.

VI. Flight by Reference to Instruments

Task A. Instrument Flight

Note	<i>The evaluator selects both Tasks from PI.VI, Flight by Reference to Instruments.</i>
References	<i>14 CFR part 61; FAA-H-8083-2, FAA-H-8083-15, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with performing basic flight maneuvers solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.VI.A.K1	Elements related to attitude instrument flying during straight-and-level flight, climbs, turns, descents, and configuration changes while conducting various instrument flight procedures.
PI.VI.A.K2	Interpretation, operation, and limitations of pitch, bank, and power instruments.
PI.VI.A.K3	Normal and abnormal instrument indications and operations.
PI.VI.A.K4	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VI.A.R1	Situations that can affect physiology and degrade instrument cross-check.
PI.VI.A.R2	Spatial disorientation and optical illusions.
PI.VI.A.R3	Flying an unfamiliar aircraft, or operating with unfamiliar flight display systems and avionics.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VI.A.S1	Maintain altitude ± 100 feet during level flight, selected headings $\pm 10^\circ$, airspeed ± 10 knots, and bank angles $\pm 5^\circ$ during turns.
PI.VI.A.S2	Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.
PI.VI.A.S3	Identify, describe, and correct errors, as applicable.

VI. Flight by Reference to Instruments

Task B. Recovery from Unusual Flight Attitudes

Note	<i>The evaluator selects both Tasks from PI.VI, Flight by Reference to Instruments.</i>
References	<i>14 CFR part 61; FAA-H-8083-15, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with recovering from unusual flight attitudes solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction while using a view-limiting device.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.VI.B.K1	Procedures for recovery from unusual attitudes in flight.
PI.VI.B.K2	Upset prevention, including unusual attitude in flight causal factors, physiological factors, system and equipment failures, and environmental factors.
PI.VI.B.K3	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VI.B.R1	Situations that could lead to loss of control or unusual attitudes in flight (e.g., stress, task saturation, inadequate instrument scan, and distractions).
PI.VI.B.R2	Startle response and following an incorrect or abrupt recovery procedure.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VI.B.S1	Use proper instrument cross-check and interpretation to identify an unusual attitude in flight (including both nose-high and nose-low), and apply the appropriate pitch, bank, power, and configuration changes in the correct sequence to return to a stabilized level flight attitude.
PI.VI.B.S2	Identify, describe, and correct errors, as applicable.

VII. Navigation Systems

Task A. Intercepting and Tracking Navigational Systems and Arcs

Note	<i>The evaluator selects both Tasks from PI.VII, Navigation Systems.</i>
References	<i>14 CFR parts 61, 91, 97; AIM; FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-33; POH/RFM</i>
Objective	<i>To determine that the applicant understands the elements associated with intercepting and tracking navigation aids and arcs solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.VII.A.K1	Ground-based navigation (orientation, course determination, equipment, tests and regulations), including procedures for intercepting and tracking courses and arcs.
PI.VII.A.K2	Satellite-based navigation (orientation, course determination, equipment, tests and regulations, interference, appropriate use of databases, Receiver Autonomous Integrity Monitoring (RAIM), and Wide Area Augmentation System (WAAS)), including procedures for intercepting and tracking courses and arcs.
PI.VII.A.K3	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VII.A.R1	Management and monitoring of automated navigation and autoflight systems.
PI.VII.A.R2	Distractions, improper task management, loss of situational awareness, or disorientation.
PI.VII.A.R3	Limitations of the navigation system in use.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VII.A.S1	Tune and identify the navigational facility or program the navigation system and verify system accuracy as appropriate for the equipment installed in the aircraft.
PI.VII.A.S2	Determine aircraft position relative to the navigational facility or waypoint.
PI.VII.A.S3	Set and orient to the course to be intercepted.
PI.VII.A.S4	Intercept the specified course at appropriate angle, inbound to or outbound from a navigational facility or waypoint.
PI.VII.A.S5	Maintain airspeed ± 10 knots, altitude ± 100 feet, and selected headings $\pm 10^\circ$.
PI.VII.A.S6	Apply proper correction to maintain a course, allowing no more than $\frac{3}{4}$ -scale deflection of the course deviation indicator (CDI). If a distance measuring equipment (DME) arc is selected, maintain that arc ± 1 nautical mile.
PI.VII.A.S7	Recognize navigational system or facility failure, and when required, report the failure to ATC.
PI.VII.A.S8	Monitor position, track wind drift, and maintain situational awareness.
PI.VII.A.S9	Properly use the autopilot, if installed, to intercept courses.
PI.VII.A.S10	Identify, describe, and correct errors, as applicable.

VII. Navigation Systems

Task B. Departure, En Route, and Arrival Operations

Notes	<i>The evaluator selects both Tasks from PI.VII, Navigation Systems.</i>
	<i>See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.</i>
References	<i>14 CFR parts 61, 91, 97; ACs 90-100, 90-105, 91-74; AIM; FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-33; POH/RFM</i>
Objective	<i>To determine that the applicant understands the elements associated with IFR departure, en route, and arrival operations solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates an understanding of:</i>
PI.VII.B.K1	Departure procedures.
PI.VII.B.K2	En route procedures.
PI.VII.B.K3	Arrival procedures.
PI.VII.B.K4	Pilot/controller responsibilities, communication procedures, and ATC services available to pilots.
PI.VII.B.K5	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VII.B.R1	Miscommunication with ATC or deviating from clearances and published procedures.
PI.VII.B.R2	Recognition of limitations of traffic avoidance equipment.
PI.VII.B.R3	Using see-and-avoid techniques when and where possible.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VII.B.S1	Select, identify (as necessary) and use the appropriate communication and navigation facilities associated with the proposed flight.
PI.VII.B.S2	Configure the aircraft and perform the appropriate checklist items relative to the phase of flight.
PI.VII.B.S3	Use the current and appropriate paper or electronic navigation publications.
PI.VII.B.S4	Establish two-way communications with the proper controlling agency, use proper phraseology and comply, in a timely manner, with all ATC instructions and airspace restrictions as well as exhibit adequate knowledge of communication failure procedures.
PI.VII.B.S5	Intercept all courses, radials, and bearings appropriate to the procedure, route, or clearance in a timely manner.
PI.VII.B.S6	Comply with all applicable charted procedures.
PI.VII.B.S7	Maintain airspeed ± 10 knots, altitude ± 100 feet, and selected headings $\pm 10^\circ$, and apply proper correction to maintain a course allowing no more than $\frac{1}{4}$ -scale deflection of the course deviation indicator (CDI).
PI.VII.B.S8	Update/interpret weather in flight.
PI.VII.B.S9	Explain and use flight deck displays of digital weather and aeronautical information, as applicable.
PI.VII.B.S10	Use SRM/CRM.
PI.VII.B.S11	Identify, describe, and correct errors, as applicable.

VIII. Instrument Approach Procedures

Task A. Nonprecision Approach

Note	<i>The evaluator selects Tasks A and B to be combined with Task C or D from PI.VIII, Instrument Approach Procedures. At least one nonprecision approach procedure will be accomplished without the use of the primary flight instruments under simulated instrument conditions.</i>
Note	<i>See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.</i>
References	<i>14 CFR parts 61, 91; AC 120-108; AIM; FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-33; TPP</i>
Objective	<i>To determine that the applicant understands the elements associated with performing nonprecision approach procedures solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction while using a view-limiting device.</i>
Knowledge	<i>The applicant demonstrates an understanding of:</i>
PI.VIII.A.K1	Procedures and limitations associated with a nonprecision approach.
PI.VIII.A.K2	Navigation system indications and annunciations expected during a nonprecision approach.
PI.VIII.A.K3	Advisory vertical guidance.
PI.VIII.A.K4	Copter Point-in-Space (PinS) approaches.
PI.VIII.A.K5	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VIII.A.R1	Descending below the minimum descent altitude (MDA) without proper visual references.
PI.VIII.A.R2	Deteriorating weather conditions on approach.
PI.VIII.A.R3	An unstable approach, including excessive descent rates.
PI.VIII.A.R4	Aircraft configuration during an approach and missed approach.
PI.VIII.A.R5	Management and monitoring of automated navigation and autoflight systems.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VIII.A.S1	Accomplish the nonprecision instrument approaches selected by the evaluator.
PI.VIII.A.S2	Establish two-way communications with ATC appropriate for the phase of flight or approach segment, and use proper communication phraseology.
PI.VIII.A.S3	Select, tune, identify, and confirm the operational status of navigation equipment to be used for the approach.
PI.VIII.A.S4	Comply with all clearances issued by ATC or the evaluator.
PI.VIII.A.S5	Recognize if any flight instrumentation is inaccurate or inoperative, and take appropriate action.
PI.VIII.A.S6	Advise ATC or the evaluator if unable to comply with a clearance.
PI.VIII.A.S7	Establish the appropriate aircraft configuration and airspeed considering turbulence and windshear, and complete the checklist items appropriate to the phase of the flight.
PI.VIII.A.S8	Maintain altitude ± 100 feet, selected heading $\pm 10^\circ$, airspeed ± 10 knots, prior to beginning the final approach segment.
PI.VIII.A.S9	Apply adjustments to the published MDA and visibility criteria for the aircraft approach category, as appropriate, for factors that include NOTAMs, or inoperative aircraft, navigation equipment, or visual aids associated with the landing environment, etc.
PI.VIII.A.S10	Establish a stabilized descent to the appropriate altitude.

PI.VIII.A.S11	For the final approach segment, maintain no more than ¾ scale CDI deflection, airspeed ±10 knots, and altitude, if applicable, above MDA +100/-0 feet (to the VDP or MAP).
PI.VIII.A.S12	Execute the missed approach procedure if the required visual references for the intended runway/heliport/landing point are not distinctly visible and identifiable at the appropriate point or altitude for the approach profile.
PI.VIII.A.S13	Execute a landing from a straight-in or circling approach as applicable to the aircraft and scenario as instructed by ATC or the evaluator.
PI.VIII.A.S14	Monitor position, track wind drift, and maintain situational awareness.
PI.VIII.A.S15	Identify, describe, and correct errors, as applicable.

VIII. Instrument Approach Procedures

Task B. Precision Approach

Note	<i>The evaluator selects Tasks A and B to be combined with Task C or D from PI.VIII, Instrument Approach Procedures. At least one nonprecision approach procedure will be accomplished without the use of the primary flight instruments under simulated instrument conditions.</i>
Note	<i>See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.</i>
References	<i>14 CFR parts 61, 91; AC 90-105, 90-107; AIM; FAA-H-8083-15, FAA-H-8083-16, FAA-H-8083-33; TPP</i>
Objective	<i>To determine that the applicant understands the elements associated with performing precision approach procedures solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates an understanding of:</i>
PI.VIII.B.K1	Procedures and limitations associated with a precision approach, including determining required descent rates and adjusting minimums in the case of inoperative equipment.
PI.VIII.B.K2	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VIII.B.R1	Initiating the missed approach below Decision Altitude (DA)/Decision Height (DH) if the required visual references are not visible.
PI.VIII.B.R2	Deteriorating weather conditions on approach.
PI.VIII.B.R3	An unstable approach, including excessive descent rates.
PI.VIII.B.R4	Aircraft configuration during an approach and missed approach.
PI.VIII.B.R5	Management and monitoring of automated navigation and autoflight systems.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VIII.B.S1	Accomplish the precision instrument approach(es) selected by the evaluator.
PI.VIII.B.S2	Establish two-way communications with ATC appropriate for the phase of flight or approach segment, and use proper communication phraseology.
PI.VIII.B.S3	Select, tune, identify, and confirm the operational status of navigation equipment to be used for the approach.
PI.VIII.B.S4	Comply with all clearances issued by ATC or the evaluator.
PI.VIII.B.S5	Recognize if any flight instrumentation is inaccurate or inoperative, and take appropriate action.
PI.VIII.B.S6	Advise ATC or the evaluator if unable to comply with a clearance.
PI.VIII.B.S7	Establish the appropriate aircraft configuration and airspeed considering turbulence and windshear, and complete the checklist items appropriate to the phase of the flight.
PI.VIII.B.S8	Maintain altitude ± 100 feet, selected heading $\pm 10^\circ$, airspeed ± 10 knots, prior to beginning the final approach segment.
PI.VIII.B.S9	Apply adjustments to the published DA/DH and visibility criteria for the aircraft approach category, as appropriate, for factors that include NOTAMs, inoperative aircraft, navigation equipment, or visual aids associated with the landing environment, etc.
PI.VIII.B.S10	Establish a predetermined rate of descent at the point where vertical guidance begins, which approximates that required for the aircraft to follow the vertical guidance.
PI.VIII.B.S11	Maintain a stabilized final approach from the Final Approach Fix (FAF) to DA/DH allowing no more than $\frac{3}{4}$ -scale deflection of either the vertical or lateral guidance indications and maintain the desired airspeed ± 10 knots.

PI.VIII.B.S12	Immediately initiate the missed approach procedure when at the DA/DH, and the required visual references for the runway are not unmistakably visible and identifiable.
PI.VIII.B.S13	Transition to a landing approach only when the aircraft is in a position from which a descent to a landing on the runway can be made at a normal rate of descent using normal maneuvers.
PI.VIII.B.S14	Maintain a stabilized visual flight path from the DA/DH to the runway aiming point where an appropriate landing may be accomplished within the touchdown zone.
PI.VIII.B.S15	Monitor position, track wind drift, and maintain situational awareness.
PI.VIII.B.S16	Identify, describe, and correct errors, as applicable.

VIII. Instrument Approach Procedures

Task C. Missed Approach

Note	<i>The evaluator selects Tasks A and B to be combined with Task C or D from PI.VIII, Instrument Approach Procedures. At least one nonprecision approach procedure will be accomplished without the use of the primary flight instruments under simulated instrument conditions.</i>
References	<i>14 CFR parts 61, 91; AIM; FAA-H-8083-15, FAA-H-8083-33; TPP</i>
Objective	<i>To determine that the applicant understands the elements associated with performing a missed approach procedure solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.VIII.C.K1	Elements related to missed approach procedures and limitations associated with standard instrument approaches, including while using a flight management system (FMS) and/or autopilot, if equipped.
PI.VIII.C.K2	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VIII.C.R1	Deviating from prescribed procedures.
PI.VIII.C.R2	Holding, diverting, or electing to fly the approach again.
PI.VIII.C.R3	Aircraft configuration during an approach and missed approach.
PI.VIII.C.R4	Factors that might lead to executing a missed approach procedure before the missed approach point or to a go-around below the decision altitude (DA)/decision height (DH) or minimum descent altitude (MDA).
PI.VIII.C.R5	Management and monitoring of automated navigation and autoflight systems.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VIII.C.S1	Initiate the missed approach promptly by applying power and configuring the aircraft to establish and maintain a climbing profile in accordance with the manufacturer's recommendations.
PI.VIII.C.S2	Report to ATC upon beginning the missed approach procedure.
PI.VIII.C.S3	Comply with the published or alternate missed approach procedure.
PI.VIII.C.S4	Advise ATC or the evaluator if unable to comply with a clearance, restriction, or climb gradient.
PI.VIII.C.S5	Follow the recommended checklist items appropriate to the missed approach/go-around procedure.
PI.VIII.C.S6	Request, if appropriate, ATC clearance to the alternate airport, clearance limit, or as directed by the evaluator.
PI.VIII.C.S7	Maintain the recommended airspeed ± 10 knots; heading, course, or bearing $\pm 10^\circ$; and altitude(s) ± 100 feet during the missed approach procedure.
PI.VIII.C.S8	Monitor position and track to help navigate the missed approach.
PI.VIII.C.S9	Use SRM/CRM.
PI.VIII.C.S10	Identify, describe, and correct errors, as applicable.

VIII. Instrument Approach Procedures

Task D. Landing from an Instrument Approach

Note	<i>The evaluator selects Tasks A and B to be combined with Task C or D from PI.VIII, Instrument Approach Procedures. At least one nonprecision approach procedure will be accomplished without the use of the primary flight instruments under simulated instrument conditions.</i>
References	<i>14 CFR parts 61, 91; AIM; FAA-H-8083-15, FAA-H-8083-33</i>
Objective	<i>To determine that the applicant understands the elements associated with performing procedures for a landing from an instrument approach as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.VIII.D.K1	Elements related to the pilot's responsibilities, and the environmental, operational, and meteorological factors that affect a decision to land.
PI.VIII.D.K2	Landing site signs, markings and lighting, including approach lighting systems.
PI.VIII.D.K3	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.VIII.D.R1	Attempting to land from an unstable approach.
PI.VIII.D.R2	Flying below the glidepath.
PI.VIII.D.R3	Transitioning from instrument to visual references for landing.
PI.VIII.D.R4	Aircraft configuration for landing.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.VIII.D.S1	Transition at the DA/DH, MDA, or visual descent point VDP to a visual flight condition, allowing for safe visual maneuvering and an appropriate landing.
PI.VIII.D.S2	Adhere to all ATC or evaluator advisories, such as NOTAMs, windshear, wake turbulence, runway surface, braking conditions, and other operational considerations.
PI.VIII.D.S3	Complete the appropriate checklist(s).
PI.VIII.D.S4	Maintain positive aircraft control throughout the landing maneuver.
PI.VIII.D.S5	Use SRM/CRM.
PI.VIII.D.S6	Identify, describe, and correct errors, as applicable.

IX. Emergency Operations

Task A. Loss of Communications

Note *The evaluator selects Task D and at least one other Task from PI.IX, Emergency Operations. If the practical test is conducted in a multiengine aircraft, the evaluator selects Task B or C.*

References *14 CFR parts 61, 91; AIM*

Objective *To determine that the applicant understands the elements associated with loss of communications while operating solely by reference to instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.*

Knowledge *The applicant demonstrates instructional knowledge by describing and explaining:*

PI.IX.A.K1 Procedures to follow in the event of lost communication during various phases of flight during VMC and IMC.

PI.IX.A.K2 Common errors related to this Task and their appropriate remedies.

Risk Management *The applicant identifies, explains, and manages risk associated with:*

PI.IX.A.R1 Possible reasons for loss of communication.

PI.IX.A.R2 Deviation from procedures for lost communications.

Skills *The applicant demonstrates and teaches how to:*

PI.IX.A.S1 Recognize loss of communication.

PI.IX.A.S2 Perform actions to re-establish communication.

PI.IX.A.S3 Determine whether to continue to flight plan destination or deviate.

PI.IX.A.S4 Determine appropriate time to begin an approach.

PI.IX.A.S5 Use SRM/CRM.

PI.IX.A.S6 Identify, describe, and correct errors, as applicable.

IX. Emergency Operations

Task B. One Engine Inoperative during Straight-and-Level Flight and Turns (Multiengine Aircraft Only)

Note *The evaluator selects Task D and at least one other Task from PI.IX, Emergency Operations. If the practical test is conducted in a multiengine aircraft, the evaluator selects Task B or C.*

References *14 CFR part 61; FAA-H-8083-15, FAA-H-8083-33*

Objective *To determine that the applicant understands the elements associated with flight solely by reference to instruments with one engine inoperative as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.*

Knowledge *The applicant demonstrates instructional knowledge by describing and explaining:*

PI.IX.B.K1 Procedures used if engine failure occurs during straight-and-level flight and turns while on instruments.

PI.IX.B.K2 Common errors related to this Task and their appropriate remedies.

Risk Management *The applicant identifies, explains, and manages risk associated with:*

PI.IX.B.R1 Identification of the inoperative engine.

PI.IX.B.R2 Inability to climb or maintain altitude with an inoperative engine.

PI.IX.B.R3 Low altitude maneuvering, including stall, spin, or CFIT.

PI.IX.B.R4 Distractions, improper task management, loss of situational awareness, or disorientation.

PI.IX.B.R5 Fuel management during single-engine operation.

Skills *The applicant demonstrates and teaches how to:*

PI.IX.B.S1 Promptly recognize an engine failure and maintain positive aircraft control.

PI.IX.B.S2 Establish the best engine-inoperative aircraft configuration, speed, and trim.

PI.IX.B.S3 Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.

PI.IX.B.S4 Verify the prescribed checklist procedures normally used for securing the inoperative engine.

PI.IX.B.S5 Attempt to determine and resolve the reason for the engine failure.

PI.IX.B.S6 Monitor engine functions and make necessary adjustments.

PI.IX.B.S7 Maintain the specified altitude ± 100 feet or minimum sink rate if applicable, airspeed ± 10 knots, and the specified heading $\pm 10^\circ$.

PI.IX.B.S8 Assess the aircraft's performance capability and decide an appropriate action to ensure a safe landing.

PI.IX.B.S9 Maintain control and fly within the aircraft's one engine inoperative (OIE) operating limitations.

PI.IX.B.S10 Use SRM/CRM.

PI.IX.B.S11 Identify, describe, and correct errors, as applicable.

IX. Emergency Operations

Task C. Approach and Landing with an Inoperative Engine (Multiengine Aircraft Only)

Notes	<i>The evaluator selects Task D and at least one other Task from PI.IX, Emergency Operations. If the practical test is conducted in a multiengine aircraft, the evaluator selects Task B or C.</i>
	<i>See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations for information related to this Task.</i>
References	<i>14 CFR parts 61, 91; FAA-H-8083-15, FAA-H-8083-33; TPP</i>
Objective	<i>To determine that the applicant understands the elements associated with executing a published instrument approach solely by reference to instruments with one engine inoperative as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.</i>
Knowledge	<i>The applicant demonstrates an understanding of:</i>
PI.IX.C.K1	Instrument approach procedures with one engine inoperative.
PI.IX.C.K2	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.IX.C.R1	Plan for engine failure during approach.
PI.IX.C.R2	Distractions, improper task management, loss of situational awareness, or disorientation.
PI.IX.C.R3	Single-engine performance.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.IX.C.S1	Promptly recognize an engine failure and maintain positive aircraft control.
PI.IX.C.S2	Confirm the correct aircraft configuration.
PI.IX.C.S3	Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.
PI.IX.C.S4	Follow the manufacturer's recommended emergency procedures.
PI.IX.C.S5	Monitor the operating engine and affected aircraft systems and maintain within limitations.
PI.IX.C.S6	Request and follow an actual or a simulated ATC clearance for an instrument approach.
PI.IX.C.S7	Maintain altitude ± 100 feet, airspeed ± 10 knots, and selected heading $\pm 10^\circ$.
PI.IX.C.S8	Establish a rate of descent that ensures arrival at the MDA or DA/DH with the aircraft in a position from which a descent to a landing site can be made.
PI.IX.C.S9	On final approach segment, maintain vertical (as applicable) and lateral guidance within $\frac{3}{4}$ -scale deflection.
PI.IX.C.S10	Comply with the published criteria for the aircraft approach category.
PI.IX.C.S11	Terminate the approach as directed by ATC or the evaluator.
PI.IX.C.S12	Complete the appropriate checklist(s).
PI.IX.C.S13	Use SRM/CRM.
PI.IX.C.S14	Identify, describe, and correct errors, as applicable.

IX. Emergency Operations

Task D. Approach with Loss of Primary Flight Instrument Indicators

Note	<i>The evaluator selects Task D and at least one other Task from PI.IX, Emergency Operations. If the practical test is conducted in a multiengine aircraft, the evaluator selects Task B or C.</i>
References	<i>14 CFR parts 61, 91; FAA-H-8083-15, FAA-H-8083-33; TPP</i>
Objective	<i>To determine that the applicant understands the elements associated with performing an approach solely by reference to instruments with the loss of primary flight control instruments as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction while using a view-limiting device.</i>
Knowledge	<i>The applicant demonstrates instructional knowledge by describing and explaining:</i>
PI.IX.D.K1	Indications that primary flight instruments are inaccurate or inoperative and the need to advise ATC or the evaluator.
PI.IX.D.K2	Failure modes of primary instruments and how to correct or minimize the effect of their loss.
PI.IX.D.K3	Common errors related to this Task and their appropriate remedies.
Risk Management	<i>The applicant identifies, explains, and manages risk associated with:</i>
PI.IX.D.R1	Use of secondary flight displays when primary displays have failed.
PI.IX.D.R2	Maintaining aircraft control.
PI.IX.D.R3	Distractions, improper task management, loss of situational awareness, or disorientation.
Skills	<i>The applicant demonstrates and teaches how to:</i>
PI.IX.D.S1	Advise ATC or the evaluator if unable to comply with a clearance.
PI.IX.D.S2	Complete a nonprecision instrument approach without the use of the primary flight instruments using the skill elements of the nonprecision approach Task (see Area of Operation VI, Task A).
PI.IX.D.S3	Use SRM/CRM.
PI.IX.D.S4	Identify, describe, and correct errors, as applicable.

X. Postflight Procedures

Task A. After Landing Taxiing, Parking, and Securing

References 14 CFR parts 61, 91; FAA-H-8083-33; POH/RFM

Objective To determine that the applicant understands the elements associated with after landing, parking, and securing procedures as they relate to safety of flight and applies that knowledge when delivering ground or instrument flight instruction.

Knowledge The applicant demonstrates instructional knowledge by describing and explaining:

PI.X.A.K1 Aircraft shutdown, securing, and postflight inspection.

PI.X.A.K2 Documenting in-flight/postflight discrepancies.

PI.X.A.K3 Low visibility taxiing.

PI.X.A.K4 Common errors related to this Task and their appropriate remedies.

Risk Management The applicant identifies, explains, and manages risk associated with:

PI.X.A.R1 Inappropriate activities and distractions.

PI.X.A.R2 Confirmation or expectation bias as related to taxi instructions.

PI.X.A.R3 Collision hazards, including aircraft, obstacles, persons, terrain, vehicles, vessels, wildlife, and wires.

PI.X.A.R4 Airport/heliport/helipad/landing area specific security procedures.

PI.X.A.R5 Disembarking passengers.

Skills The applicant demonstrates and teaches how to:

PI.X.A.S1 Demonstrate taxiway/runway incursion avoidance procedures.

PI.X.A.S2 Park in an appropriate area considering the safety of nearby persons and property.

PI.X.A.S3 Complete the appropriate checklist(s).

PI.X.A.S4 Conduct a postflight inspection.

PI.X.A.S5 Document discrepancies and servicing requirements, if any.

PI.X.A.S6 Secure the aircraft.

PI.X.A.S7 Identify, describe, and correct errors, as applicable.

Private Pilot – Airship

Airman Certification Standards



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I. Preflight Preparation

Task A. Certificates and Documents

References 14 CFR parts 43, 61, 91; Airship Pilot Manual; FAA-H-8083-25

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with certificates and documents.

Knowledge The applicant demonstrates understanding of:

PR.I.A.K1 Pilot certificate privileges and limitations.

PR.I.A.K2 Medical certificate class and duration.

PR.I.A.K3 Pilot logbook or flight record required entries.

PR.I.A.K4 Locating and explaining:

PR.I.A.K4a a. Airworthiness and registration certificates

PR.I.A.K4b b. Operating limitations, placards, instrument markings, handbooks, and manuals

PR.I.A.K4c c. Weight and lift data, including the equipment list

PR.I.A.K4d d. Airworthiness directives and compliance records, maintenance/inspection requirements and appropriate records

Risk Management The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:

PR.I.A.R1 Failure to determine and document that the aircraft is in an airworthy condition.

Skills The applicant demonstrates the ability to:

PR.I.A.S1 Locate aircraft airworthiness and registration documents.

PR.I.A.S2 Determine the aircraft is airworthy in the scenario given by the evaluator.

I. Preflight Preparation

Task B. Weather Information

References	AC 00-6, AC 00-45; AIM; FAA-H-8083-25
Objective	To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with the elements related to weather information for a flight.
Knowledge	The applicant demonstrates understanding of:
PR.I.B.K1	Obtaining and analyzing weather reports and forecasts from various sources of data (e.g., National Weather Service and Flight Service) for flight planning purposes with emphasis on:
PR.I.B.K1a	a. PIREPs
PR.I.B.K1b	b. SIGMETs and AIRMETs
PR.I.B.K1c	c. Windshear reports
PR.I.B.K2	Explaining various atmospheric conditions and their effect on airship flight, including:
PR.I.B.K2a	a. Atmospheric influence
PR.I.B.K2b	b. Atmospheric stability
PR.I.B.K2c	c. Pressure and temperature changes
PR.I.B.K2d	d. Terrain effect on winds
PR.I.B.K2e	e. Cloud formations, including their impact on the potential for superheat
PR.I.B.K2f	f. Temperature inversion
PR.I.B.K2g	g. Calm winds versus a light, steady breeze on takeoff control
Risk Management	The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:
PR.I.B.R1	Failure to develop strategies that could allow the flight to be conducted safely.
PR.I.B.R2	Dynamic weather affecting flight.
PR.I.B.R3	Limitations of aviation weather reports and forecasts.
PR.I.B.R4	Failure to identify weather conditions that may create risk for the planned flight (e.g., wind speeds, ceilings, visibility, temperature, dew point, temperature inversion).
PR.I.B.R5	Failure to establish personal weather minimums based on the parameters of the flight (e.g. wind speeds, ceilings, visibility, temperature, dew point) and failure to determine when existing conditions do not meet established personal minimums.
Skills	The applicant demonstrates the ability to:
PR.I.B.S1	Use available aviation weather resources and other weather resources to obtain an adequate weather briefing.
PR.I.B.S2	Identify the conditions for superheat and manage the situation appropriately.
PR.I.B.S3	Identify (or describe) a temperature inversion and hazards associated with temperature inversions.
PR.I.B.S4	Make a competent risk mitigation decision based on available weather information.

I. Preflight Preparation

Task C. Cross-Country Flight Planning

References AIM; Chart Supplements; FAA-H-8083-25; NOTAM(s); Sectional Charts

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with cross-country flight planning.

Knowledge The applicant demonstrates understanding of:

- | | |
|------------|--|
| PR.I.C.K1 | Elements related to cross-country flight planning by presenting and explaining a preplanned VFR cross-country flight of maximum duration, appropriate to the airship used for the flight test, as previously assigned by the evaluator. The final flight plan includes real-time weather to the first fuel stop, with maximum allowable passenger and baggage loads. |
| PR.I.C.K2 | Use of appropriate, current paper aeronautical charts, or electronic flight bag. |
| PR.I.C.K3 | Plotting a course for the intended route of flight considering route of flight terrain and service ceiling. |
| PR.I.C.K4 | Airspace. |
| PR.I.C.K5 | Hazards associated with obstructions. |
| PR.I.C.K6 | Selecting alternate airports with consideration for the ability of the crew to get there and gain access. |
| PR.I.C.K7 | Selecting easily identifiable en route checkpoints. |
| PR.I.C.K8 | Selecting the most favorable altitudes, considering weather conditions and equipment capabilities. |
| PR.I.C.K9 | Computing headings, flight time, and fuel requirements. |
| PR.I.C.K10 | Effect of wind in mountainous terrain, including Venturi effect. |
| PR.I.C.K11 | Selecting appropriate navigation systems/facilities and communication frequencies. |
| PR.I.C.K12 | Required coordination with ground crew to meet the airship for landing. |
| PR.I.C.K13 | Considering availability of facilities and ground crew at destination. |
| PR.I.C.K14 | Extracting and applying pertinent information from NOTAMs, the Airport/Facility Directory, and other flight publications. |
| PR.I.C.K15 | Completing a navigation log and simulating the filing of a VFR flight plan. |

Risk Management The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:

- | | |
|-----------|--|
| PR.I.C.R1 | Failure to coordinate adequately with ground crew when there are high winds at the landing site. |
| PR.I.C.R2 | Failure to use current aeronautical charts. |
| PR.I.C.R3 | Failure to identify suitable areas for landing. |

Skills The applicant demonstrates the ability to:

- | | |
|-----------|---|
| PR.I.C.S1 | Prepare, present, and explain a flight plan including a risk analysis based on real-time weather. |
| PR.I.C.S2 | Use proper fuel management. |
| PR.I.C.S3 | Coordinate properly with ground crew. |

I. Preflight Preparation

Task D. National Airspace System

References 14 CFR part 91; Aeronautical Charts; AIM

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with the National Airspace System.

Knowledge The applicant demonstrates understanding of:

PR.I.D.K1 Basic VFR weather minimums for all classes of airspace.

PR.I.D.K2 Airspace classes, their boundaries, pilot certification and equipment requirements for the following:

PR.I.D.K2a a. Class A

PR.I.D.K2b b. Class B

PR.I.D.K2c c. Class C

PR.I.D.K2d d. Class D

PR.I.D.K2e e. Class E

PR.I.D.K2f f. Class G

PR.I.D.K3 Special use airspace.

PR.I.D.K4 Temporary flight restrictions.

Risk Management The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:

PR.I.D.R1 Failure to recognize various classes of airspace and their boundaries.

PR.I.D.R2 Lack of compliance with the requirements of controlled airspace and special use airspace.

Skills The applicant demonstrates the ability to:

PR.I.D.S1 Determine the requirements for basic VFR weather minimums and flying in particular classes of airspace.

PR.I.D.S2 Properly identify airspace and operate accordingly.

I. Preflight Preparation

Task E. Performance and Limitations

References *Airship Pilot Manual; FAA-H-8083-25*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with operational characteristics and the adverse effects of exceeding limitations and failure to operate an airship safely within the parameters of its performance limitations per the flight manual.*

Knowledge *The applicant demonstrates understanding of:*

- | | |
|------------|--|
| PR.I.E.K1 | Computing operating weight, maximum load, and trim conditions. |
| PR.I.E.K2 | Determining airship performance with the following considerations and their effects in mind: |
| PR.I.E.K2a | a. Weight limitations |
| PR.I.E.K2b | b. Static and dynamic lift capability |
| PR.I.E.K2c | c. Effect of superheat on ballonet(s) and percent of fullness |
| PR.I.E.K2d | d. Effect of gas purity and superheat on lift |
| PR.I.E.K2e | e. Temperature and humidity changes on performance and lift |
| PR.I.E.K2f | f. Temperature inversion on climbs and descents |
| PR.I.E.K2g | g. Leaks in ballonet(s) and envelope |
| PR.I.E.K2h | h. Average ballonet volume with respect to total envelope volume and service ceiling |
| PR.I.E.K2i | i. Loss of gross lift when above pressure height |
| PR.I.E.K2j | j. Relationship of ballonet fullness to pressure height |
| PR.I.E.K2k | k. Maximum rate of climb and descent limitations based on management of the air system |

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

- | | |
|-----------|---|
| PR.I.E.R1 | Exceeding performance limitations. |
| PR.I.E.R2 | Limitations in flight performance as a result of improper loading and trim. |

Skills *The applicant demonstrates the ability to:*

- | | |
|-----------|--|
| PR.I.E.S1 | Complete the load sheet for a given scenario provided by the evaluator. |
| PR.I.E.S2 | Use the aircraft manufacturer's approved performance charts, tables, and data. |

I. Preflight Preparation

Task F. Operation of Systems

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with operation of the systems of the airship provided for flight test.*

Note *Evaluator assesses the applicant's knowledge of K1 and at least three other knowledge elements from this Task.*

Knowledge *The applicant demonstrates understanding of:*

- | | |
|------------|---|
| PR.I.F.K1 | Air system. |
| PR.I.F.K2 | Surface control systems. |
| PR.I.F.K3 | Flight instruments and associated controls. |
| PR.I.F.K4 | Engines and engine vectoring system, if applicable. |
| PR.I.F.K5 | Propellers. |
| PR.I.F.K6 | Fuel and oil system. |
| PR.I.F.K7 | Environmental system. |
| PR.I.F.K8 | Avionics and auxiliary equipment. |
| PR.I.F.K9 | Any system unique to the airship flown. |
| PR.I.F.K10 | Ground support equipment. |

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

- | | |
|-----------|--|
| PR.I.F.R1 | Air system. |
| PR.I.F.R2 | Failure to identify a system malfunction or failure. |
| PR.I.F.R3 | Failure to take appropriate action for emergency procedures. |
| PR.I.F.R4 | Failure to recognize outside environmental factors and their effect on the system, including inadequate fuel pressure. |

Skills *The applicant demonstrates the ability to:*

- | | |
|-----------|---|
| PR.I.F.S1 | Explain and operate aircraft systems. |
| PR.I.F.S2 | Use checklist procedures. |
| PR.I.F.S3 | Use immediate action for emergency procedures, as applicable. |

I. Preflight Preparation

Task G. Human Factors

References AIM; FAA-H-8083-25

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with personal health and aeromedical and human factors as they relate to safety of flight and the crew.

Knowledge The applicant demonstrates understanding of:

PR.I.G.K1 Symptoms, recognition, causes, effects, and corrective actions associated with aeromedical issues, including:

Note If K1 is selected, the evaluator assesses the applicant's knowledge of at least three sub-elements.

PR.I.G.K1a a. Hypoxia

PR.I.G.K1b b. Hyperventilation

PR.I.G.K1c c. Middle ear and sinus problems

PR.I.G.K1d d. Spatial disorientation

PR.I.G.K1e e. Stress

PR.I.G.K1f f. Fatigue

PR.I.G.K1g g. Dehydration

PR.I.G.K1h h. Motion sickness

PR.I.G.K1i i. Carbon monoxide poisoning

PR.I.G.K2 Effects of alcohol, drugs, and over-the-counter medications, and associated regulations.

PR.I.G.K3 Effects of excess nitrogen absorption during scuba dives upon a pilot and/or passenger in flight.

Risk Management The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:

PR.I.G.R1 Effects of hazardous attitudes on aeronautical decision-making.

PR.I.G.R2 External and internal pressures on the pilot.

PR.I.G.R3 Failure to detect and manage threats and errors associated with human factors.

PR.I.G.R4 Distractions.

Skills The applicant demonstrates the ability to:

PR.I.G.S1 Perform a self-assessment, including whether the pilot is physically and emotionally fit for flight.

PR.I.G.S2 Show sound risk management in a scenario given by the evaluator.

PR.I.G.S3 Establish personal minimums.

II. Preflight Procedures

Task A. Preflight Inspection

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with element of preflight inspection.*

Knowledge *The applicant demonstrates understanding of:*

PR.II.A.K1 Elements related to visual inspection, including which items to inspect, the reasons for checking each item, and how to detect possible defects.

PR.II.A.K2 Inspection of the envelope for deficiencies, including rips, tears, and bullet holes, by inspecting the envelope internally from a dark area.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.II.A.R1 Failure to identify system malfunction or system failure.

PR.II.A.R2 Failure to make proper use of an appropriate checklist.

PR.II.A.R3 Distractions, especially from spectators, during preflight inspection.

PR.II.A.R4 Failure to determine lack of airworthiness in a scenario given by the evaluator.

Skills *The applicant demonstrates the ability to:*

PR.II.A.S1 Inspect the airship with reference to the checklist.

PR.II.A.S2 Verify the airship is in condition for safe flight.

II. Preflight Procedures

Task B. Flight Deck Management

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with flight deck management procedures.*

Knowledge *The applicant demonstrates understanding of:*

- | | |
|------------|---|
| PR.II.B.K1 | Ensuring all loose items in the flight deck and passenger area are secured. |
| PR.II.B.K2 | Briefing passengers on the use of safety belts and emergency procedures. |
| PR.II.B.K3 | Organizing essential material and equipment in a logical, efficient flow pattern. |
| PR.II.B.K4 | Maintaining orderly records reflecting progress of the flight, as appropriate. |
| PR.II.B.K5 | Utilizing all appropriate checklists. |
| PR.II.B.K6 | Operation of the air system. |

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

- | | |
|------------|---|
| PR.II.B.R1 | Improper use of systems and equipment, including the use of the air system. |
| PR.II.B.R2 | Flying with unresolved discrepancies. |

Skills *The applicant demonstrates the ability to:*

- | | |
|------------|---|
| PR.II.B.S1 | Properly operate the air system. |
| PR.II.B.S2 | Secure all items in the flight deck. |
| PR.II.B.S3 | Conduct an appropriate pre-takeoff briefing, including identifying the PIC, use of safety belts, harnesses, doors, sterile flight deck, and emergency procedures. |
| PR.II.B.S4 | Complete the appropriate checklist. |

II. Preflight Procedures

Task C. Engine Starting

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with elements of engine starting.*

Knowledge *The applicant demonstrates understanding of:*

PR.II.C.K1 Use of an external power source and starting under various atmospheric conditions as appropriate.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.II.C.R1 Failure to adhere to the checklist.

PR.II.C.R2 Failure to consider propeller safety.

PR.II.C.R3 Failure to maintain situational awareness, including consideration for crew safety.

Skills *The applicant demonstrates the ability to:*

PR.II.C.S1 Observe safety precautions related to starting, considering open hangars, other aircraft, and the safety of nearby persons and property.

PR.II.C.S2 Accomplish the correct starting procedure including proper adjustment of engine controls.

PR.II.C.S3 Complete the appropriate checklist.

II. Preflight Procedures

Task D. Unmasting, Ground Handling, and Positioning for Takeoff

References *Airship Pilot Manual; FAA-H-8083-25*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with unmasting, ground handling, and positioning for takeoff.*

Knowledge *The applicant demonstrates understanding of:*

- | | |
|------------|---|
| PR.II.D.K1 | Determining the appropriate number of required crew members and establishing communication with the crew. |
| PR.II.D.K2 | How to interface with the crew when positioning the aircraft. |
| PR.II.D.K3 | Effects of weather and how the management of the engines assists the crew. |
| PR.II.D.K4 | Completing the load sheet and establishing proper trim before unmasting. |
| PR.II.D.K5 | Considerations for positioning the aircraft for takeoff. |

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

- | | |
|------------|--|
| PR.II.D.R1 | Unmasting when out of trim. |
| PR.II.D.R2 | Failure to establish communications with the crew. |
| PR.II.D.R3 | Repositioning the airship for takeoff. |

Skills *The applicant demonstrates the ability to:*

- | | |
|------------|---|
| PR.II.D.S1 | Brief ground crew and coordinate hand signals and voice commands. |
| PR.II.D.S2 | Recognize undesirable airship movement and take appropriate action. |
| PR.II.D.S3 | Prevent airship from riding up on the mast. |
| PR.II.D.S4 | Ensure proper envelope pressure and trim before coming off the mast. |
| PR.II.D.S5 | Use ground crew and airship controls properly to move away from the mast and into position for takeoff while maintaining alertness for wind shifts. |
| PR.II.D.S6 | Divide attention inside and outside the flight deck to avoid an inadvertent takeoff after coming off the mast. |
| PR.II.D.S7 | Complete the appropriate checklist. |

II. Preflight Procedures

Task E. Before-Takeoff Check

References	<i>Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with the conduct of the before-takeoff check.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.II.E.K1	Elements related to the before-takeoff check.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.II.E.R1	Possibility of injury to crewmembers during takeoff and landing.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.II.E.S1	Ensure that engine temperatures and pressures are suitable for run-up and takeoff.
PR.II.E.S2	Review takeoff performance, wind direction and speed, expected takeoff distance, emergency procedures, and the departure procedure.
PR.II.E.S3	Ensure that the takeoff path is clear of obstacles.
PR.II.E.S4	Assure no conflict with traffic prior to takeoff.
PR.II.E.S5	Complete the appropriate checklist.

II. Preflight Procedures

Task F. Ground Weigh-Off

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with the conduct of a ground weigh-off.*

Knowledge *The applicant demonstrates understanding of:*

- | | |
|------------|---|
| PR.II.F.K1 | Importance of knowing buoyancy status and balance status before takeoff and how to determine it. |
| PR.II.F.K2 | Factors involved in the decision to place ballast such as how weather affects superheat in flight, fuel burn, and the target time to be at equilibrium (EQ) based on the purpose of the flight. |
| PR.II.F.K3 | Importance of being at EQ over sporting events to minimize noise and noise changes to avoid distracting the players. |
| PR.II.F.K4 | Communication required with the crew chief during weigh-off. |

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

- | | |
|------------|--|
| PR.II.F.R1 | Placement of ballast and the changing weight and buoyancy during the flight. |
| PR.II.F.R2 | Purpose of the flight and the pressures imposed on the crew by it. |

Skills *The applicant demonstrates the ability to:*

- | | |
|------------|---|
| PR.II.F.S1 | Position the airship properly to avoid hazards. |
| PR.II.F.S2 | Divide attention inside and outside the flight deck. |
| PR.II.F.S3 | Accomplish the before-takeoff check and confirm the airship is at the desired buoyancy and in trim and in safe operating condition. |
| PR.II.F.S4 | Prevent fore- and-aft surge and maintain zero inclination and heading into the wind. |
| PR.II.F.S5 | Determine buoyancy and trim status with neutral elevators, make a timely decision about the ballast to be carried, and communicate effectively with the crew chief. |
| PR.II.F.S6 | Complete the appropriate checklist. |

III. Airport Operations

Task A. Communications and Light Signals

References	<i>Airship Pilot Manual</i>
Objective	<i>To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with normal and emergency radio communications and ATC light signals to conduct safe airport operations.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.III.A.K1	How to obtain appropriate radio frequencies.
PR.III.A.K2	Proper radio communication procedures and ATC phraseology.
PR.III.A.K3	ATC light signal recognition.
PR.III.A.K4	Importance of good communications with the ground crew.
PR.III.A.K5	Appropriate use of transponders/ADS-B.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.III.A.R1	Poor communication.
PR.III.A.R2	Failure to recognize and declare an emergency.
PR.III.A.R3	Loss of communications with the ground crew.
PR.III.A.R4	Confirmation or expectation bias.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.III.A.S1	Select appropriate frequencies.
PR.III.A.S2	Transmit using phraseology and procedures as specified in the AIM.
PR.III.A.S3	Acknowledge radio communications and comply with instructions.

III. Airport Operations

Task B. Traffic Patterns

References 14 CFR part 91; AIM; Airship Pilot Manual; FAA-H-8083-25

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with traffic patterns.

Knowledge The applicant demonstrates understanding of:

PR.III.B.K1 Operations at controlled and uncontrolled airports, runway incursion and collision avoidance, wake turbulence avoidance, thermals, windshear, and temperature inversions.

PR.III.B.K2 Avoiding interference with the traffic pattern.

PR.III.B.K3 Coordinating with the ground crew.

Risk Management The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:

PR.III.B.R1 Operation of the crew at a landing area.

PR.III.B.R2 Operating in the vicinity of other aircraft.

PR.III.B.R3 Collision hazards, including aircraft, obstacles, persons, terrain, vehicles, vessels, wildlife, and wires.

PR.III.B.R4 Temperature inversions.

Skills The applicant demonstrates the ability to:

PR.III.B.S1 Coordinate with ground crew.

PR.III.B.S2 Avoid interference with the traffic pattern procedures.

PR.III.B.S3 Maintain proper spacing from other traffic.

PR.III.B.S4 Correct for wind drift to maintain the proper ground track.

PR.III.B.S5 Maintain orientation with the runway or landing area to be used.

PR.III.B.S6 Establish a final approach at an appropriate distance from the runway or landing area.

PR.III.B.S7 Maintain airspeed for the current static condition of the airship.

PR.III.B.S8 Complete the appropriate checklist.

III. Airport Operations

Task C. Airport and Runway Markings and Lighting

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with airport and runway markings and lighting.*

Knowledge *The applicant demonstrates understanding of:*

PR.III.C.K1 Elements related to airport and runway markings and lighting.

PR.III.C.K2 How to use knowledge of airport and runway markings and lighting to position the airship properly and communicate its position.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.III.C.R1 Inability to identify and communicate position on an airport using language others will understand.

Skills *The applicant demonstrates the ability to:*

PR.III.C.S1 Identify and interpret airport, runway, and taxiway markings.

PR.III.C.S2 Identify and communicate airship position with reference to airport, runway, and taxiway markings and lighting.

IV. Takeoffs, Landings, and Go-Arounds

Task A. Up-Ship Takeoff

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with performing an up-ship takeoff.*

Knowledge *The applicant demonstrates understanding of:*

PR.IV.A.K1 Elements related to performing an up-ship takeoff.

PR.IV.A.K2 Determining heaviness limitations and weather conditions under which an up-ship takeoff may be made.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.IV.A.R1 Attempting an up-ship takeoff with the airship out of trim.

PR.IV.A.R2 Attempting an up-ship takeoff with the airship that is too heavy.

PR.IV.A.R3 Attempting an up-ship takeoff with insufficient crew.

Skills *The applicant demonstrates the ability to:*

PR.IV.A.S1 Ensure that sufficient ground crew are available in order to obtain adequate upward velocity.

PR.IV.A.S2 Remain within the takeoff heaviness limits.

PR.IV.A.S3 Use proper and timely hand signals and voice commands with ground crew.

PR.IV.A.S4 Apply up elevator pressure as ground crew lifts airship and transition to a nose-up attitude keeping tail clear of the ground.

PR.IV.A.S5 Apply power as the airship nears the top of its upward thrust.

PR.IV.A.S6 Prevent the tail from striking the ground.

PR.IV.A.S7 Increase airspeed sufficiently to carry the load dynamically.

PR.IV.A.S8 Complete the appropriate checklist.

IV. Takeoffs, Landings, and Go-Arounds

Task B. Wheel Takeoff

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with performing a wheel takeoff.*

Knowledge *The applicant demonstrates understanding of:*

PR.IV.B.K1 Elements related to a wheel takeoff, including performing a wheel takeoff under various degrees of heaviness, including maximum heavy conditions.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.IV.B.R1 Obstacles, obstructions, and power lines avoidance.

PR.IV.B.R2 Takeoff from an unsuitable surface area.

PR.IV.B.R3 Unfavorable wind direction.

Skills *The applicant demonstrates the ability to:*

PR.IV.B.S1 Determine the approximate takeoff roll and ensure that the area is clear and sufficient, considering wind conditions and field surface.

PR.IV.B.S2 Position the airship to utilize the maximum available takeoff area and maintain trim.

PR.IV.B.S3 Use the proper hand signals and voice commands with the ground crew.

PR.IV.B.S4 Apply power slowly and in a timely manner.

PR.IV.B.S5 Use vectors properly, if applicable.

PR.IV.B.S6 Attain sufficient airspeed to carry the load dynamically while on the wheel.

PR.IV.B.S7 Use elevators to assist the airship in lifting dynamically.

PR.IV.B.S8 Maintain directional control and the proper inclination to keep the tail off the ground.

PR.IV.B.S9 Complete the appropriate checklist.

IV. Takeoffs, Landings, and Go-Arounds

Task C. Approach and Landing

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with performing an approach and landing.*

Knowledge *The applicant demonstrates understanding of:*

PR.IV.C.K1 Elements related to performing an approach and landing, including in light and heavy airships.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.IV.C.R1 Failure to recognize and respond to wave-off signals.

PR.IV.C.R2 Attempting an approach without knowing the static condition of the airship.

PR.IV.C.R3 Attempting an approach at improper speed.

Skills *The applicant demonstrates the ability to:*

PR.IV.C.S1 Accomplish static weigh-off prior to commencing the approach.

PR.IV.C.S2 Adjust trim, as necessary, for landing, considering weight and condition of air.

PR.IV.C.S3 Manage the air system properly.

PR.IV.C.S4 Coordinate flight and power controls, as necessary.

PR.IV.C.S5 Coordinate with the ground crew.

PR.IV.C.S6 Make a smooth and gradual approach, maintaining direction and angle of descent.

PR.IV.C.S7 Recognize and adhere to wave-off signals.

PR.IV.C.S8 Land at a speed appropriate for approaching the ground crew.

PR.IV.C.S9 Reverse thrust, if applicable.

PR.IV.C.S10 Complete the appropriate checklist.

IV. Takeoffs, Landings, and Go-Arounds

Task D. Go-Around

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with performing a go-around.*

Knowledge *The applicant demonstrates understanding of:*

PR.IV.D.K1 Elements related to performing a go-around.

PR.IV.D.K2 Determining conditions that may require a go-around.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.IV.D.R1 Failure to recognize an improper static weight.

PR.IV.D.R2 Failure to recognize in a timely manner conditions that may require a go-around.

Skills *The applicant demonstrates the ability to:*

PR.IV.D.S1 Make a timely decision to discontinue the approach to landing.

PR.IV.D.S2 Use correct procedures for a light or heavy airship, as appropriate.

PR.IV.D.S3 Coordinate use of power and flight controls to effect a smooth transition to a climb attitude.

PR.IV.D.S4 Manage the air system during a go-around.

PR.IV.D.S5 Complete the appropriate checklist.

V. Performance Maneuvers

Task A. Straight-and-Level Flight

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with straight-and-level flight.*

Knowledge *The applicant demonstrates understanding of:*

PR.V.A.K1 Elements related to straight-and-level flight.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.V.A.R1 Lack of awareness and management of the air system.

Skills *The applicant demonstrates the ability to:*

PR.V.A.S1 Properly manage the air system.

PR.V.A.S2 Adjust and maintain static trim.

PR.V.A.S3 Maintain the specified altitude, ± 200 feet (60 meters) and the specified heading, $\pm 20^\circ$.

V. Performance Maneuvers

Task B. Ascents and Descents

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with ascents and descents.*

Knowledge *The applicant demonstrates understanding of:*

PR.V.B.K1 Elements related to ascents and descents, including limitations.

PR.V.B.K2 Effects of a temperature inversion and how to manage the airship if a temperature inversion is encountered.

PR.V.B.K3 Elements of proper pressure control.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.V.B.R1 Thermals.

PR.V.B.R2 Temperature inversions.

Skills *The applicant demonstrates the ability to:*

PR.V.B.S1 Ascend and descend while keeping the envelope pressure within operating limits.

PR.V.B.S2 Control rates of ascent and descent, ± 300 feet (90 meters) per minute.

V. Performance Maneuvers

Task C. Level Turns

References	<i>Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with level altitude turns.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.V.C.K1	Elements related to level turns.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.V.C.R1	Failure to maintain airship control and orientation.
PR.V.C.R2	Collision hazards, including other aircraft and terrain.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.V.C.S1	Enter and maintain level turns with appropriate control application.
PR.V.C.S2	Maintain the specified altitude, ± 200 feet (60 meters) and stop turn on the assigned heading, $\pm 20^\circ$.

V. Performance Maneuvers

Task D. Inflight Weigh-Off

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with inflight weigh-off.*

Knowledge *The applicant demonstrates understanding of:*

PR.V.D.K1 Elements related to an informative inflight weigh-off.

PR.V.D.K2 Benefits of performing an inflight weigh-off.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.V.D.R1 Failure to determine static trim and buoyancy accurately for approach to landing.

Skills *The applicant demonstrates the ability to:*

PR.V.D.S1 Steer the airship into the wind in level flight at a minimum altitude of at least 500 feet (150 meters) AGL.

PR.V.D.S2 Reduce the power to the specified airspeed and stabilize the airship.

PR.V.D.S3 Manage the air system during a weigh-off.

PR.V.D.S4 Determine if the airship is being affected by updrafts or downdrafts.

PR.V.D.S5 Neutralize the elevator and rudder controls.

PR.V.D.S6 Observe the attitude of the airship and pressure differential in the ballonets.

PR.V.D.S7 Determine trim and static condition.

PR.V.D.S8 Adjust trim properly.

V. Performance Maneuvers

Task E. Air System Management

References	<i>Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with air system management.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.V.E.K1	Elements related to pressure control.
PR.V.E.K2	Elements related to static trim.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.V.E.R1	Failure to maintain proper pressure, including overpressure and underpressure.
PR.V.E.R2	Failure to maintain trim.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.V.E.S1	Control the pressure as recommended by the manufacturer to a predetermined valve(s) setting.
PR.V.E.S2	Operate the pressure system.
PR.V.E.S3	Maintain a constant altitude, ± 200 feet (60 meters).
PR.V.E.S4	Establish static trim for various weight conditions.

VI. Ground Reference Maneuvers

Task A. Rectangular Course

References *Airship Pilot Manual; FAA-H-8083-3*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with flying a rectangular course.*

Knowledge *The applicant demonstrates understanding of:*

PR.VI.A.K1 Elements related to flying a rectangular course.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.VI.A.R1 Failure to correct for wind and maintain a proper course.

PR.VI.A.R2 Collision hazards, including aircraft, terrain, obstacles, and wires.

Skills *The applicant demonstrates the ability to:*

PR.VI.A.S1 Select a suitable altitude and ground reference.

PR.VI.A.S2 Plan the maneuver in order to enter at a specified altitude at an appropriate distance from the selected reference.

PR.VI.A.S3 Apply adequate wind drift correction during straight and turning flight to maintain an appropriate ground track around the rectangular reference area.

PR.VI.A.S4 Divide attention between airship control and the ground track.

PR.VI.A.S5 Maintain altitude, ± 200 feet (60 meters).

VI. Ground Reference Maneuvers

Task B. Turns Around a Point

References *Airship Pilot Manual; FAA-H-8083-3*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with turns around a point.*

Knowledge *The applicant demonstrates understanding of:*

PR.VI.B.K1 Elements related to turns around a point.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.VI.B.R1 Failure to correct for wind and maintain the desired track.

PR.VI.B.R2 Collision hazards, including aircraft, terrain, obstacles, and wires.

Skills *The applicant demonstrates the ability to:*

PR.VI.B.S1 Select the ground reference point.

PR.VI.B.S2 Plan the maneuver in order to enter at 600 to 1,000 feet (180 to 300 meters) AGL at an appropriate distance from the reference point.

PR.VI.B.S3 Apply adequate wind drift correction to track a constant radius circle around the selected reference point.

PR.VI.B.S4 Divide attention between airship control and the ground track and maintain flight.

PR.VI.B.S5 Maintain altitude, ± 200 feet (60 meters).

VII. Navigation

Task A. Pilotage and Dead Reckoning

References *FAA-H-8083-3, FAA-H-8083-25*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with pilotage and dead reckoning.*

Knowledge *The applicant demonstrates understanding of:*

PR.VII.A.K1 Elements related to pilotage and dead reckoning.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.VII.A.R1 Collision hazards, including aircraft, terrain, obstacles, and wires.

PR.VII.A.R2 Distractions, improper task management, loss of situational awareness, or disorientation.

Skills *The applicant demonstrates the ability to:*

PR.VII.A.S1 Follow the preplanned course solely by visual reference to landmarks.

PR.VII.A.S2 Identify landmarks by relating the surface features to chart symbols.

PR.VII.A.S3 Navigate by means of precomputed headings, groundspeed, and elapsed time.

PR.VII.A.S4 Make a reasonable estimate of heading, groundspeed, arrival time, and fuel consumption to the destination.

PR.VII.A.S5 Correct for and record the differences between preflight fuel, groundspeed, and heading calculations and those determined en route.

PR.VII.A.S6 Verify the airship's position within 3 nautical miles of the flight planned route at all times.

PR.VII.A.S7 Arrive at the en route checkpoints or destination within 5 minutes of the ETA.

PR.VII.A.S8 Maintain the appropriate altitude, ± 200 feet (60 meters) and established heading, $\pm 20^\circ$.

PR.VII.A.S9 Complete all appropriate checklists.

VII. Navigation

Task B. Navigation Systems and Radar Services

References AIM; FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with navigation systems and radar services.

Knowledge The applicant demonstrates understanding of:

PR.VII.B.K1 Elements related to navigation systems and radar services.

Risk Management The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:

PR.VII.B.R1 Failure to manage the navigation system properly.

PR.VII.B.R2 Distractions, improper task management, loss of situational awareness, or disorientation.

PR.VII.B.R3 Limitations of the navigation system in use.

PR.VII.B.R4 Loss of navigation signal.

Skills The applicant demonstrates the ability to:

PR.VII.B.S1 Use an airborne electronic navigation system.

PR.VII.B.S2 Determine the airship's position using the navigation system.

PR.VII.B.S3 Intercept and track a given course, radial, or bearing, as appropriate.

PR.VII.B.S4 Recognize and describe the indication of station or waypoint passage, if appropriate.

PR.VII.B.S5 Recognize signal loss or interference and take appropriate action, if applicable.

PR.VII.B.S6 Use proper communication procedures when utilizing radar services, if available.

PR.VII.B.S7 Maintain altitude, ± 200 feet (60 meters).

VII. Navigation

Task C. Diversion

References	<i>AIM; Airship Pilot Manual; FAA-H-8083-2, FAA-H-8083-25; Navigation Charts</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with diversion.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.VII.C.K1	Elements related to diversion.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.VII.C.R1	Collision hazards, including aircraft, terrain, obstacles, and wires.
PR.VII.C.R2	Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.
PR.VII.C.R3	Failure to make a timely decision to divert.
PR.VII.C.R4	Failure to select an appropriate landing site.
PR.VII.C.R5	Failure to utilize all available resources (e.g., ground crew, automation, ATC, and flight deck planning aids).
PR.VII.C.R6	Failure to select a route the ground crew can follow and manage the ground crew properly.
PR.VII.C.R7	Pressures related to meeting a schedule or event.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.VII.C.S1	Manage ground crew in the event of a diversion.
PR.VII.C.S2	Select an appropriate alternate landing site and route the ground crew can follow.
PR.VII.C.S3	Divert promptly toward the alternate landing site.
PR.VII.C.S4	Make a reasonable estimate of heading, groundspeed, arrival time, and fuel consumption to the alternate landing site.
PR.VII.C.S5	Maintain the appropriate altitude, ± 200 feet (60 meters) and established heading, $\pm 20^\circ$.

VII. Navigation

Task D. Lost Procedures

References	<i>AIM; Airship Pilot Manual; FAA-H-8083-2, FAA-H-8083-25; Navigation Charts</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with lost procedures.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.VII.D.K1	Elements related to lost procedures.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.VII.D.R1	Collision hazards, including aircraft, terrain, obstacles, and wires.
PR.VII.D.R2	Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.
PR.VII.D.R3	Failure to record times over waypoints.
PR.VII.D.R4	Failure to seek assistance or declare an emergency in a deteriorating situation.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.VII.D.S1	Select the best course of action when given a lost situation.
PR.VII.D.S2	Maintain the original or an appropriate heading and climbs, if necessary.
PR.VII.D.S3	Identify the nearest prominent landmarks.
PR.VII.D.S4	Use aviation charts, road maps (as appropriate), navigation systems/facilities, or contact an ATC facility for assistance.
PR.VII.D.S5	Use the ground crew as a resource.

VIII. Emergency Procedures

Task A. Engine Fire

References *Airship Pilot Manual; FAA-H-8083-2, FAA-H-8083-3*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with managing an engine fire.*

Note *The evaluator should not simulate this Task in a manner that may jeopardize safe flight or result in possible damage to the airship.*

Knowledge *The applicant demonstrates understanding of:*

- PR.VIII.A.K1 Procedures used to manage an engine fire, including:
 - PR.VIII.A.K1a a. Completing memory items in the proper sequence and completing the checklist
 - PR.VIII.A.K1b b. Shutting down the affected engine using the checklist
 - PR.VIII.A.K1c c. Preparing to land at the earliest opportunity

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

- PR.VIII.A.R1 Failure to consider altitude, wind, terrain, and obstructions.
- PR.VIII.A.R2 Collision hazards, including aircraft, terrain, obstacles, and wires.
- PR.VIII.A.R3 Failure to manage the air system properly.
- PR.VIII.A.R4 Failure to utilize and manage ground crew properly.
- PR.VIII.A.R5 Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.

Skills *The applicant demonstrates the ability to:*

- PR.VIII.A.S1 Simulate direction of the ground crew to provide assistance during the simulated emergency.
- PR.VIII.A.S2 Complete the appropriate checklists and procedures for an engine fire in a simulated emergency scenario provided by the evaluator.

VIII. Emergency Procedures

Task B. Envelope Emergencies

References	<i>Airship Flight Manual; Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge and risk management associated with envelope emergencies.</i>
Note	<i>The evaluator is not required to have the applicant demonstrate this Task inflight.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.VIII.B.K1	Effects of a puncture or rip in the gas envelope or a ballonnet.
PR.VIII.B.K2	Effects of an excessive helium loss.
PR.VIII.B.K3	Effects of rain/icing on the envelope.
PR.VIII.B.K4	Emergency valve operations.
PR.VIII.B.K5	Emergency air-to-helium operations.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.VIII.B.R1	Envelope emergencies.
PR.VIII.B.R2	Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.
PR.VIII.B.R3	Failure to complete the appropriate checklist, if applicable.
Skills	<i>Intentionally left blank.</i>

VIII. Emergency Procedures

Task C. Free Ballooning

References	<i>Airship Flight Manual; Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with free ballooning.</i>
Note	<i>The evaluator should not simulate this Task in a manner that may jeopardize safe flight or result in possible damage to the airship.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.VIII.C.K1	Elements related to free ballooning.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.VIII.C.R1	Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.
PR.VIII.C.R2	Failure to use the appropriate checklist for multiple engine failures.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.VIII.C.S1	Manage the air system.
PR.VIII.C.S2	Manage the crew.
PR.VIII.C.S3	Assess airship static condition and determine ballast needs.
PR.VIII.C.S4	Establish equilibrium in a timely manner.
PR.VIII.C.S5	Turn off all nonessential electrical equipment.
PR.VIII.C.S6	Determine cause of engine failure and attempt restart.
PR.VIII.C.S7	Select suitable landing site and establish communications with the crew.
PR.VIII.C.S8	Use minimum helium valving and ballast dumping during descent.
PR.VIII.C.S9	Secure loose equipment.
PR.VIII.C.S10	Complete the appropriate checklist, if available.

VIII. Emergency Procedures

Task D. Ditching and Emergency Landing

References	<i>Airship Flight Manual; Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with ditching and emergency landing.</i>
Note	<i>The evaluator should not simulate this Task in a manner that may jeopardize safe flight or result in possible damage to the airship.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.VIII.D.K1	Elements related to ditching and emergency landing.
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.VIII.D.R1	Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.
PR.VIII.D.R2	Failure to complete the appropriate checklist, if applicable.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.VIII.D.S1	Manage the air system.
PR.VIII.D.S2	Manage the crew.
PR.VIII.D.S3	Simulate jettisoning ballast, considering potential fire hazard when dumping fuel.
PR.VIII.D.S4	Instruct passengers in safety procedures.
PR.VIII.D.S5	Ensure life jackets are on correctly, if ditching.
PR.VIII.D.S6	Secure loose equipment.
PR.VIII.D.S7	Simulate securing all systems to minimize chance of fire or other damage.
PR.VIII.D.S8	Complete the appropriate checklist.

VIII. Emergency Procedures

Task E. System and Equipment Malfunction

References	<i>Airship Flight Manual; Airship Pilot Manual</i>
Objective	<i>To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with system and equipment malfunction.</i>
Note	<i>The evaluator should not simulate this Task in a manner that may jeopardize safe flight or result in possible damage to the airship.</i>
Knowledge	<i>The applicant demonstrates understanding of:</i>
PR.VIII.E.K1	Elements related to systems and equipment malfunctions appropriate to the airship used for the practical test.
PR.VIII.E.K2	Appropriate action for simulated emergencies, such as:
PR.VIII.E.K2a	a. Air system malfunction
PR.VIII.E.K2b	b. Control system/actuator malfunction
PR.VIII.E.K2c	c. Fuel starvation
PR.VIII.E.K2d	d. Electrical system malfunction
PR.VIII.E.K2e	e. Propeller malfunction
PR.VIII.E.K2f	f. Pressure system malfunction
PR.VIII.E.K2g	g. Engine or nacelle fire
PR.VIII.E.K2h	h. APU fire, if applicable
Risk Management	<i>The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:</i>
PR.VIII.E.R1	Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.
PR.VIII.E.R2	Failure to complete the appropriate checklist, if applicable.
Skills	<i>The applicant demonstrates the ability to:</i>
PR.VIII.E.S1	Describe the appropriate action for simulated emergencies specified by the evaluator for at least three of the sub-elements listed in K2a through K2h.
PR.VIII.E.S2	Complete the appropriate checklist.

IX. Postflight Procedures

Task A. Masting

References *Airship Pilot Manual*

Objective *To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with masting.*

Knowledge *The applicant demonstrates understanding of:*

PR.IX.A.K1 Elements related to masting.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.IX.A.R1 Masting.

PR.IX.A.R2 Distractions, loss of situational awareness, incorrect airport surface approach and landing, or improper task management.

PR.IX.A.R3 Failure to complete the appropriate checklist, if applicable.

Skills *The applicant demonstrates the ability to:*

PR.IX.A.S1 Maintain coordination with crew chief through use of proper hand signals and voice commands.

PR.IX.A.S2 Remain in control of airspeed and position the airship properly.

PR.IX.A.S3 Coordinate use of power and flight controls.

PR.IX.A.S4 Ensure the airship is properly trimmed and ballasted when approaching the mast.

PR.IX.A.S5 Complete the appropriate checklist.

IX. Postflight Procedures

Task B. Post-Masting

References *Airship Pilot Manual*

Objective To determine the applicant exhibits satisfactory knowledge, risk management, and skills associated with post-masting.

Knowledge *The applicant demonstrates understanding of:*

PR.IX.B.K1 Elements related to post-masting appropriate to the airship used for the practical test.

PR.IX.B.K2 Effects of weather on post-masting.

Risk Management *The applicant demonstrates the ability to identify, assess, and mitigate risks associated with:*

PR.IX.B.R1 Post-masting.

PR.IX.B.R2 Failure to consider weather conditions when the airship is on the mast.

PR.IX.B.R3 Failure to complete the appropriate checklist, if applicable.

Skills *The applicant demonstrates the ability to:*

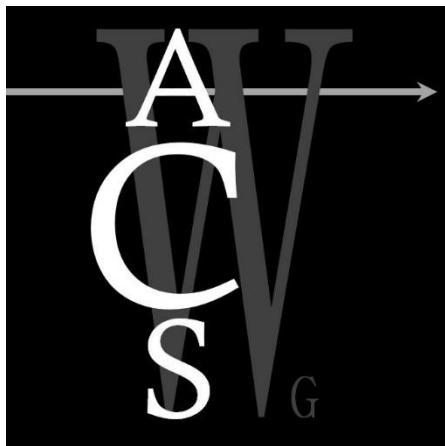
PR.IX.B.S1 Use proper engine shutdown procedures.

PR.IX.B.S2 Comply with equipment requirements for maintaining envelope pressure.

PR.IX.B.S3 Ensure mast security relative to weather conditions.

PR.IX.B.S4 Put ballast on the airship before passengers disembark.

PR.IX.B.S5 Complete the appropriate checklist.



Aviation Rulemaking Advisory Committee
Airman Certification System Working Group
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