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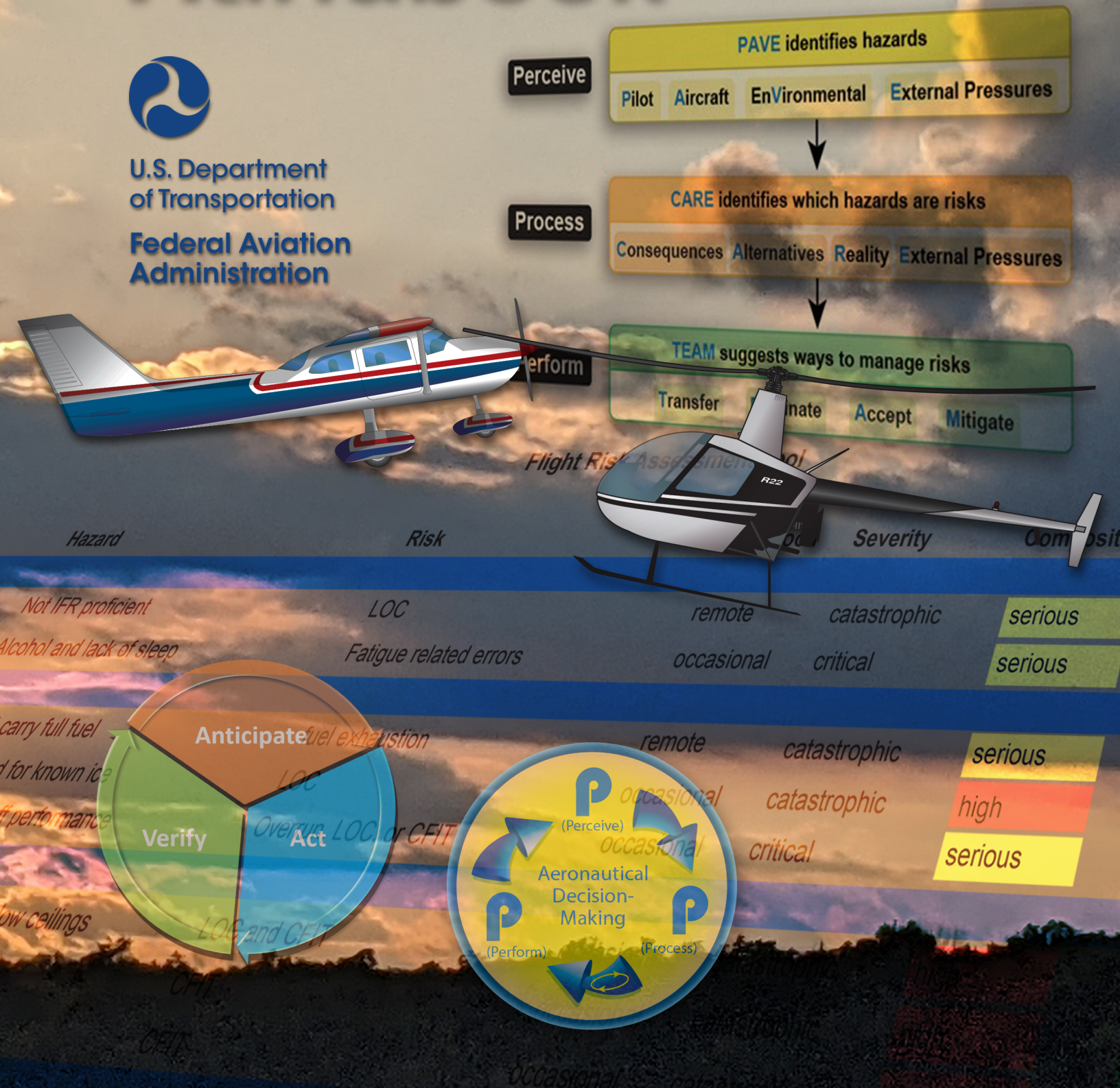
Risk Management Handbook

U.S. Department of Transportation
Federal Aviation Administration



Introduction

According to the National Transportation Safety Board (NTSB) statistics, in the last 20 years, approximately 85 percent of aviation accidents have been caused by "pilot error." Many of these accidents are the result of the tendency to focus flight training on the physical aspects of flying the aircraft by teaching the student pilot enough aeronautical knowledge and skill to pass the written and practical tests. In this scenario, risk management is ignored, which can potentially lead to fatal results. The certificated flight instructor (CFI) who integrates risk management into flight training teaches aspiring pilots how to proactively identify safety-related hazards pertaining to the flight and mitigating the associated risks of the identified hazards.

A key element of risk decision-making is determining if the risk is justified. The risks involved with flying are quite different from those experienced in daily activities. Managing these risks requires a conscious effort and established standards (or a maximum risk threshold). Pilots who practice effective risk management have predetermined personal minimums and have formed habit patterns and checklists to incorporate them.

If the procedures and techniques described in this handbook are taught and employed, pilots will have tools to identify potential hazards of a flight and successfully mitigate the risks associated with the identified hazards. The goal is to reduce the general aviation accident rate involving poor risk management. Pilots who make a habit of using risk management tools will find their flights considerably more enjoyable and less stressful for themselves and their passengers. In addition, some aircraft insurance companies reduce insurance rates after a pilot completes a formal risk management course.

This Risk Management Handbook makes available recommended tools for identifying hazards and assessing risk in order to conduct the safest flight possible with the least amount of risk. The appendices at the end of this handbook contain checklists and scenarios to aid in risk management consideration, flight planning, and training.

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Chapter 6: Threat and Error Management

Introduction

Pilots use risk management as described in earlier chapters to analyze the likelihood and potential severity of an incident or accident based on identified hazards. The process takes time, thought, and collection of information pertinent to the flight. However, once a planned operation begins, a pilot may encounter unforeseen hazards or threats. In addition, a pilot may respond inappropriately to a given condition, thus making an error. This chapter provides strategies pilots may use once flight begins.

Threats

Threats have the following characteristics:

- Threats occur outside the influence of the flight crew; they are not controlled by the pilot.
- Threats increase the operational complexity of a flight.
- Threats may appear suddenly, and may limit the time available for analysis.
- A threat requires effective management to contain risk within acceptable levels.

Some common threats include:

- Malfunction of aircraft systems, engines, flight controls, or automation.
- Various unforecast weather hazards.
- Collision hazards, including wildlife on airports and birds in the air.
- Unexpected sudden reductions in visibility.
- Closures of facilities, runways, or taxiways while en route.
- Unreported poor braking action or surface contamination.
- Malfunction of a radio navigation aid or service after takeoff.
- Unexpected ATC clearances, restrictions, or reroutes that may significantly increase workload.
- Controller errors, radio congestion, or communication failure.
- Cabin events.
- Undetected improper refueling or fuel contamination.

What is an Error?

Errors are deviations from intended or expected actions and result in a reduction in safety margins. They include both unintentional and intentional acts. They do not require the presence of a threat and can occur spontaneously. Errors may cause confusion and increase workload.

Causes of Errors

Errors may result from insufficient training and experience, inadequate flight planning or preparation, external pressures, and physiological and psychological effects.

Insufficient Training & Experience

A pilot who lacks training or experience regarding a given set of conditions may not be in a position to respond appropriately to a related sequence of events and the potential for an inappropriate decision or error increases. Organizations often provide training and supervised operating experience for this reason. General aviation pilots who are enthusiastic about meeting new challenges

may find themselves in an unfamiliar situation that may result in serious errors. Pilots seeking the thrill of an adventure should consider the potential danger from errors that may occur.

Inadequate Flight Planning or Preparation

Chapters 3, 4, and 5 of this handbook discuss risk analysis as an important step in the flight planning process. However, the pilot can only conduct a preflight risk analysis based on the information gathered before flight. Inadequate flight planning may leave a pilot in unanticipated conditions and can lead to errors. For example, a pilot dropped off a passenger at the Edward F. Knapp State airport (KMPV) in rural Vermont and expected to refuel for the return trip to White Plains, New York (KHPN). Upon arrival, fuel or other services were not available since it was the weekend. The pilot thought about waiting but decided to fly home after estimating the fuel would be sufficient. The pilot filed a flight plan in the air as visibility started to diminish after departure. Soon after, ATC required a hold as the destination airport had closed for snow removal. The entire region was becoming affected by a snowstorm, and the pilot was running low on fuel. Luckily, after explaining the situation to the controller, the pilot was able to divert to Bridgeport in Connecticut (KBDR), which was the last airport open in the area. Fortunately, the ceiling was just above minimums for the instrument approach, and the pilot was able to land the aircraft in a few inches of snow. Bridgeport closed shortly thereafter for snow removal.

Physiological Effects

Some of the items listed on the I'm Safe checklist (illness, medication, stress, alcohol, fatigue) have the potential to cause pilot errors. For example, it may become difficult or impossible for a stressed or fatigued pilot to focus on a situation or task. Not acting when necessary also constitutes an error.

Limitations affect human senses and perception. For example, when will a pilot see another aircraft on a collision course? The avoidance maneuver may depend not only on where the pilot is looking, but also on the pilot's individual sense of vision combined with all the visual signals received at the same time.

Psychological Effects

Psychological effects include stress, emotion, expectation bias, and the effects of personality.

Stress & Emotion

While pilots should self-evaluate for stress and emotion during preflight mitigation analysis, stress and emotion do sometimes affect a flight in progress. External pressures from outside sources including supervisors, family, and friends may bias a pilot to make an error in an effort to complete a flight as originally planned. What does the pilot actually think about before making a decision? Does the desire to complete a flight as planned influence or outweigh the need to reduce risk? Only the pilot knows the thought process that leads to a decision, but making safety other than the top priority may cause the pilot to err.

An emotional response could appear spontaneously and lead to an error at any time. After an emotional shock or an important life event, the pilot may not be able to concentrate on the current conditions. On the other hand, individuals may become relaxed during flight and may not be sufficiently alert to react to a threat or error. Occasionally, pilots overfly their destination because they have become completely relaxed. If here today, Aristotle would say that errors become more likely if the pilot is obsessed to the point of exclusion of all else or if the pilot is generally disinterested in the events at hand. Appropriate focus and concentration are the golden mean.

Expectation Bias

A pilot's erroneous assessment may persist even though it is wrong and despite available evidence to indicate the error. The term for this phenomenon is expectation bias. The NTSB has investigated numerous accidents and incidents that involved pilot errors resulting from expectation bias, particularly in night VMC when fewer cues aid in airport and runway identification. For example, in January 2014, a Boeing 737 landed at the wrong airport in Branson, Missouri, in night VMC. The flight crew expected that the visually identified airport and runway were the intended destination and did not reference flight deck displays to verify the airport and runway. As a result, the airplane landed on Runway 12 at M. Graham Clark Downtown Airport instead of Runway 14 at Branson Airport.

A general aviation pilot routinely flew to a specific airport with parallel runways. The airport had one runway closed by NOTAM for several months, but after some time, the runway closure was reversed. The NOTAM was no longer for 19R/1L, but for 19L/1R. Even after reading the NOTAM and listening to the ATIS broadcast, the pilot perceived it as it had been previously. An error occurred when the pilot initiated an approach to the closed runway.

When presented with conflicting information, some pilots will try to suppress that information if it does not fit in with the expectation rather than triggering an internal "uh-oh." The phenomenon, not to be confused with expectation bias, has the slightly different name "confirmation bias." The result of either, if uncorrected, may lead to an error. Either case results in the

pilot continuing with a plan despite clues indicating the situation is not as perceived. Fatigue tends to stop pilots from taking extra steps to verify perceived reality and contributes to expectation and confirmation bias susceptibility.

An incident at the San Francisco, California airport (KSFO) is another example involving expectation bias. The NTSB docket for this incident provides extensive information regarding expectation bias and is available here.

Expectation bias often occurs on the ground while taxiing. Pilots may expect a particular taxi route and perceive the clearance as expected rather than as given by ATC. Pilots familiar with a particular airport who routinely receive the same taxi clearance may be more susceptible to this error.

Pilots are often thought of as being calm and rational. Like all people, each pilot has a different personality. A normal ability to face reality, handle anxiety, and think rationally under pressure varies over a range. How a particular pilot reacts to a threat may depend on training and experience and may vary considerably. When a threat appears and calls for a decision, two hazardous attitudes may come into play. A pilot might react impulsively without due consideration or with resignation and not respond in a timely manner. Either extreme may increase workload and confusion and may not address a threat or error properly.

What is an Undesired Aircraft State?

Flight crew error creates an undesired aircraft state described as:

- Incorrect aircraft position, speed, attitude, or configuration.
- An in-flight situation that causes pilot confusion and increased workload.
- Reduced safety margins and increased risk from threats or errors.

Defenses against Threats, Errors, and Undesired Aircraft States

When a pilot perceives a flight condition that requires attention, the pilot may know what to do immediately or may need time to process alternatives. The pilot may utilize several different strategies and defenses to manage risk while in the air.

Defenses Provided to the Pilot or Crew

A manufacturer, employer, or a flight school may provide defenses to pilots. Examples include checklists, operating limitations, minimum pilot qualifications, standard operating procedures, and insurance requirements. Regardless of the flight mission, some defenses will always be predetermined.

Checklists, Standard Operating Procedures, and Best Practices

Like the aircraft, its approved checklists are normally provided. The manufacturer's approved checklists, placards, and emergency procedures provide a basic defense against threats, errors, or undesired aircraft states. Many flight schools, flying clubs, and larger flight departments may develop checklists and standard operating procedures (SOPs) that enhance the procedures provided by the manufacturer. Many aircraft owners participate in type-specific owner organizations that develop and share best practices. A short video on developing a checklist that includes optional or aftermarket equipment is available here.

Utilizing a Second Pilot or Person

Even when flying a single-pilot aircraft, a pilot may choose to fly with a second pilot. The second pilot may be a flight instructor or another pilot who can perform some flight duties. The pilot can also assign specific duties to a passenger who can help monitor certain conditions or read a checklist. Pilots should consider how to use an additional person appropriately since a resource could also introduce threats.

External Resources

Flight service personnel are a valuable resource, especially for weather avoidance and flight plan changes. Air traffic control can assist pilots with traffic avoidance, weather avoidance, terrain avoidance, and navigation. However, ATC workload or

equipment limitations affect the amount of assistance they can provide. In larger operations, a dispatch or company operations center can normally coordinate all communications and assistance.

Defenses Provided by the Pilot or Crew

Certain pilot behaviors defend against threats and errors.

Clear Communication and Briefings

Whether operating as a single pilot or as part of a crew, clear and concise communication is the foundation for sharing information and conveying intentions. When communicating with ATC or during crew briefings, each pilot should agree on the plan of action, ask for clarification, and question any inconsistency.

Effective Situational Awareness

Situational awareness may include knowing:

- Aircraft position
- Flight Path
- Status of other aircraft in the area
- Status of the environment
- Human factors in play

Planning for What Comes Next

Situational awareness allows the pilot to plan for what will happen next and to stay ahead of the aircraft. A forward-looking plan also provides for early detection of any deviation from expectations.

Time Management

On the ground, the pilot has the option to stop the aircraft. Pilots can always resume taxi after addressing an issue. Once airborne, budgeting time, prioritizing tasks, or slowing aircraft speed may allow sufficient time to complete tasks without error. A pilot feeling rushed while being vectored for an approach can request a delay or a vector that gives more time for completing checklists or configuring the aircraft.

Teamwork

Pilots may normally communicate with Flight Service and ATC. Some operators also have dispatchers available who track and assist flights. These external contacts are part of a team and a resource that can provide in-flight assistance. However, in a critical situation during any flight, declaring an emergency results in additional assistance and priority handling.

When the flight involves more than one pilot, crew resource management principles should be used. Typically, this allows one pilot focus on flight path management while the second pilot monitors the flight and accomplishes other tasks. However, the pilots should communicate their reasoning, intentions, and actions to allow for discussion, agreement, and verification.

Automation Management

Managing automation can reduce workload and improve situational awareness if understood and used properly. Automation management will be discussed in greater detail in Chapter 7, Automation & Flight Path Management.

Flying Skills (The Last Resort)

Employing this defense becomes necessary after experiencing an undesired aircraft state that cannot be remedied with other defenses alone. Ability to take full control of the aircraft and return to safe flying parameters is of critical importance.

Pilots should always train, remain current, remain proficient, improve knowledge, employ risk management, and be ready to handle any situation that could occur. Effective risk management and threat and error management usually prevent occurrences of an undesired aircraft state that may require a pilot to rely solely on flying skills as a defense.

Proficiency

A pilot who remains proficient is better prepared to defend against threats, errors, and undesired aircraft states. This can be depicted in the context of a Swiss cheese model. Each piece of Swiss cheese is a component of the defense against threats, errors, and undesired aircraft states. [*Figure 6-1*] Each of the holes in the cheese is a weakness in those defenses. A greater level of proficiency reduces the likelihood the holes will align.

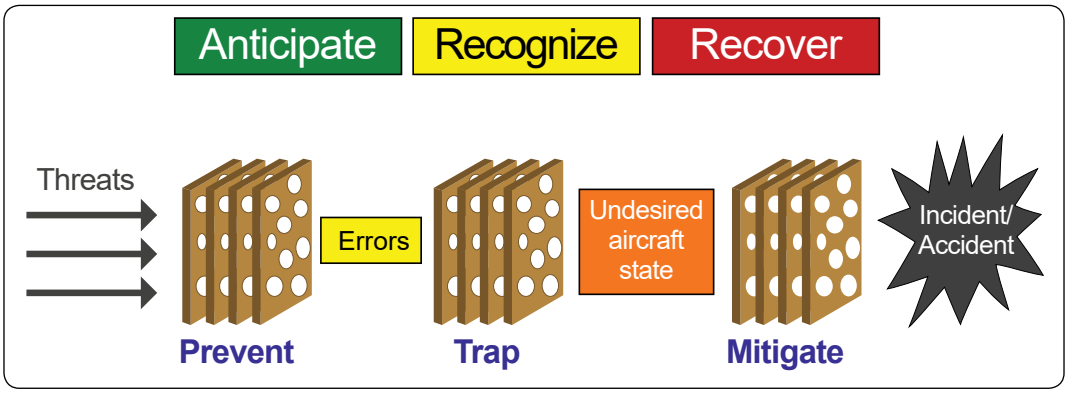

Figure 6-1. *The Swiss cheese model.*

Discipline

Discipline stems from good training and 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 hazardous attitudes and operational pitfalls, as shown in *Figure 6-2*. In general, a disciplined pilot will always do the right thing. Just like proficiency, discipline will lessen the likelihood that a threat or error will find a path through the pilot defenses.

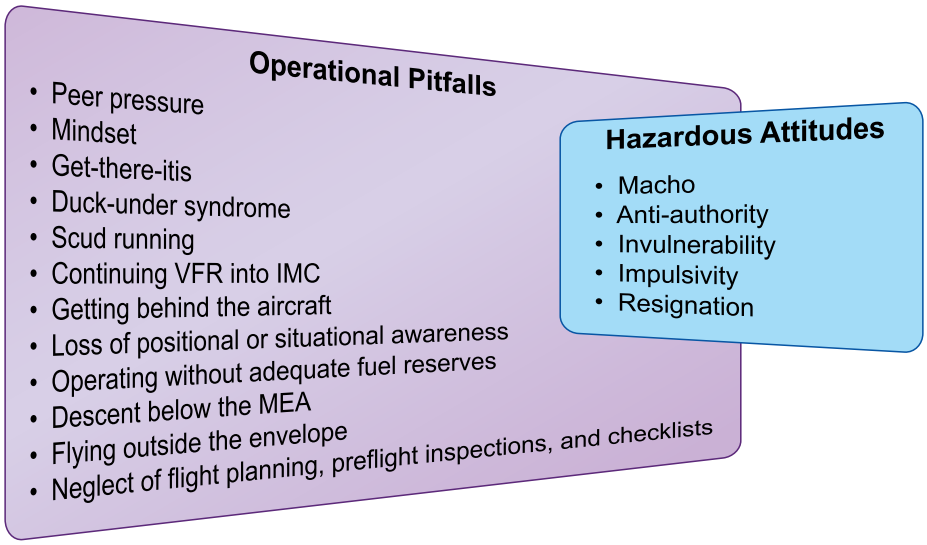

Figure 6-2. *Operational Pitfalls and Hazardous Attitudes.*

Chapter Summary

Defenses against threats and errors are either provided to the pilot or provided by the pilot. Pilots should perceive threats and errors and respond appropriately. The response may require the use of an appropriate checklist or may require more complex decision-making. A trained, proficient, and disciplined pilot uses appropriate threat and error management strategies to prevent or recover from an undesired aircraft state.