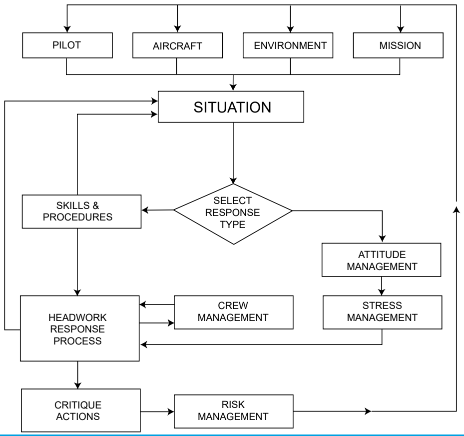
8 Risk Evaluation and Management

How do we decide if a particular flight is safe—acceptable risk—and will continue to remain within safe margins? We apply the concepts of sound Aeronautical Decision Making: *the ability to obtain all available, relevant information, evaluate alternate courses of action, then analyze and evaluate their risks, and determine the results*. Simple, huh! We've addressed impediments to sound Aeronautical Decision Making, looked at methods to recognize and correct hazardous behaviors, examined sound decision making, and developed personal minimums.

safe—Risk free; however, for practical (operational) purposes it can be interpreted as "acceptable risk."

The application of sound risk evaluation and management and a structured approach to decision making enhances safety. Risk evaluation and management is the process of identifying risks, assessing implications, deciding on a course of action, and evaluating the results. Risk evaluation and management can be divided into two phases, strategic and tactical. The initial part of flight planning—strategic—consists of a preflight evaluation of terrain, altitudes, and the environment. Although typically a preflight assessment, strategic planning and evaluation may be required enroute. It may be necessary to reevaluate, revise, or adopt a new strategic plan. Tactical planning consists of actions carried out with a limited or immediate goal. For example, the weather does not improve or deteriorates more rapidly than expected. As well as the weather, tactical evaluation includes fuel, aircraft equipment, and the pilot's physical and psychological condition. Tactical evaluation is a continuous process from the beginning to the end of the flight—no matter how simple or complex. Throughout this process we must be proactive in risk evaluation and management.

There is often some middle ground in the risk evaluation and management process. We can plan the flight in stages—strategic, landing short of our ultimate destination. We can "take a look" at the weather—tactical. Although, there are two caveats to this option. First, we must know when to abandon the plan. When it's not meant to be, it's not



meant to be! Second, we must have an alternate plan or two (PLAN B, PLAN C, PLAN D).

In 1991 the FAA published Advisory Circular 60-22 Aeronautical Decision Making. Like commercial operators, the publication addressed General Aviation. AC 60-22 proposed an ADM block diagram (callout). After examination, it didn't appear to be of much practical use. If it takes longer than the flight or you run out of fuel before completing the process, it's not of much operational value. I thought, "How do I plan a flight?"

Preparation

After the publication of AC 60-22 in 1991, I thought "How do I plan a flight and apply risk assessment and management strategies?" Refer to the "Risk Evaluation and Management" decision tree (block diagram) in Fig. 8-1. Strategic Planning begins with an analysis of three primary factors: Planning, Aircraft, and Pilot. The factors in Fig. 8-1 can be evaluated or reevaluated at any time or in any order prior to or during or the flight.

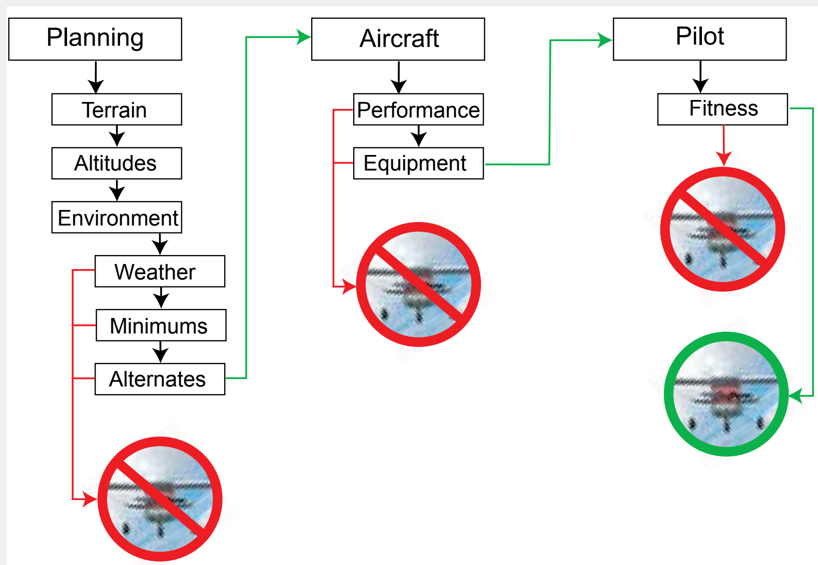


Fig. 8-1. *Risk assessment and management can be simple or complex depending on the mission.*

Planning is the "homework" part of the flight. It's incumbent upon the pilot—for every flight—to study terrain, altitude requirements, and the environment. The environment includes time of day, the weather, an evaluation of personal minimums, and alternatives. (Alternatives include, but are not limited to, alternate airports. We'll expand on this notion.) What if PLAN A doesn't pan out? From this evaluation we make an initial GO-NO GO decision.

Next, there's the aircraft. Does it have the required performance and equipment for the mission? Is the aircraft ready for cold or hot weather operations? Does the aircraft have ice protection or storm avoidance equipment? Is the aircraft a Technically Advance Airplane? The aircraft and its equipment directly affect personal minimums—which must be factored into the Planning stage. From this evaluation we make the next GO-NO GO decision.

The pilot and passengers are also a factor in the initial risk evaluation and management process. Warm and cool season flights present different environmental conditions. Are we properly dressed and equipped (survival gear) for the environment?

Caution

> If you can inspect an aircraft and not get dirty, you haven't done a thorough job! Wear slacks. Shoes should be flat–soled for safety and to insure proper flight control operation. Avoid loose fitting clothes or jewelry that could get caught on sharp edges in or around the aircraft.

It can get mighty uncomfortable on cold and windy days and normally temperature decreases with altitude. On most light, single engine aircraft cabin heat is typically obtained by routing outside air through a muffler shroud that surrounds the engine exhaust stacks. This raises the temperature of the air by about 20°C.

Case Study

> Consider a trip from Reno to Lovelock in Nevada. At 7500 ft the outside air temperature (OAT) was -18º C. The air entering the cabin was between 0° and 5°! Bring a windbreaker or jacket when conditions are warranted. At the Bakersfield, California FSS I was amazed to see students flying from the L.A. area over the Tehachapi Mountains wearing nothing more than tank tops, shorts, and shower shoes!

Are we flying over sparsely populated or mountainous terrain? Carry waterproof jackets, long pants, boots, and gloves. Do we have proper survival gear for a forced landing? Our survival might depend on being properly equipped for an emergency landing, possibly in below freezing conditions, and being able to survive until rescued. (An Alaskan bush pilot pointed out that we may have ONLY the gear on our person after a crash—think about it!)

Case Study

> Years ago, an airplane crashed in California's rugged Sierra Nevada mountains. This accident was subsequently made into the TV movie, I Alone Survived. The accident illustrates the hazards of flying over wilderness without proper clothing or survival equipment. There were two fatalities.

The flight was from the San Francisco Bay area to Death Valley in California. Both are relatively warm areas. The crash occurred on the crest of the Sierra Nevada mountains, at an elevation above 11,000 ft. They had no survival gear or proper clothing. The sole survivor had to walk many miles out of the mountains.

Pilots from normally warm climates must be especially aware of the hazards associated with a crash landing. Flying from warm, populated coastal areas and valleys to freezing, snow covered wilderness areas present significant hazards—beyond personal comfort.

Case Study

> The Navy has a major training facility at Lemoore, California in the San Joaquin Valley. They routinely fly to their gunnery and bomb ranges across the Sierras to northern Nevada. Sometimes pilots and crew get lax and wear their flight suits over their skivvies. To keep this from getting out of hand, occasionally, they helicopter these folks to about the 8000 ft elevation in the mountains for an overnighter—with only what they're wearing and on-hand survival gear.

It's relatively inexpensive to put together a first aid/survival kit and carry a non-breakable jug of water. This must include proper clothing for the terrain and climate. According to Murphy's Law the only time you'll ever need the equipment is when you haven't got it!

Winter over California's Sierra Nevada mountains.

One of several versions of the origin of "Murphy's Law" contends that its namesake—Captain Ed Murphy, an engineer at Edwards Air Force Base in 1949, frustrated with a transducer which was malfunctioning remarked: "If there was any way that something could go wrong, it would go wrong!"

The FAA has developed a—somewhat hokey, but none the less useful—physical and mental checklist (Fig. 8-2).

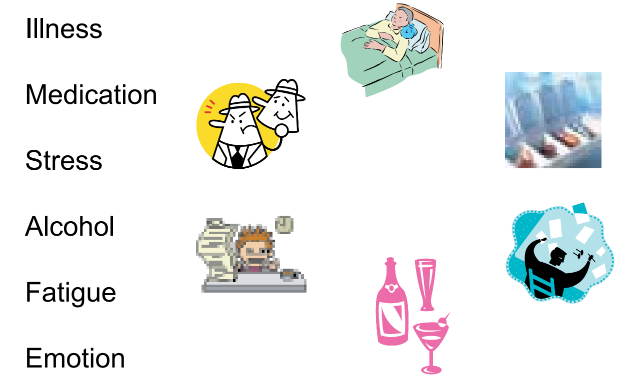


Fig. 8-2. *I'M SAFE. (I told you it was hokey.)*

Everyday illnesses can seriously degrade performance. Illness can produce distracting symptoms that impair judgment, memory, alertness, and the ability to make calculations. Even if symptoms appear to be under control with medication, the medication itself may impair performance. The safest rule is not to fly while suffering from any illness. If you have questions about a particular malady or remedy, consult your Aviation Medical Examiner.

Day-to-day living experiences affect our flying ability and safety. How? Well, get up at "oh-dark-thirty," go to work, put in a full day—trying to get out as much work as possible—drive to the airport and begin the preflight inspection. Think about it. We just drove to and from work; freeway, traffic, someone just cut you off and to say the least, we're perturbed. Now, continue with the flight.

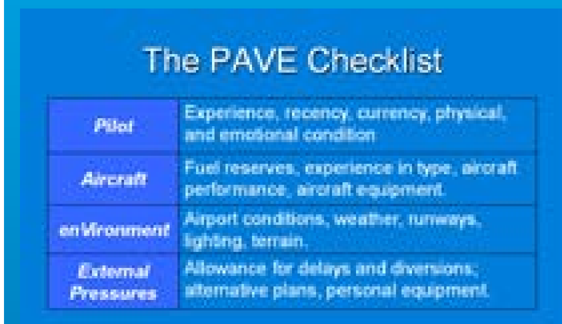
Minimum time between alcohol consumption and flying is specified in the regulations. However, as we've seen, minimum does not necessarily mean safe. Research indicates that as little as one ounce of liquor, one bottle of beer, or four ounces of wine can impair our flying skills. Alcohol also renders us much more susceptible to disorientation and hypoxia.

Fatigue is the tiredness felt after physical or mental strain, including muscular effort, immobility, heavy mental workload, strong emotional pressure, monotony, and lack of sleep. Fatigue can be described as either acute (short term—gone after a good night's sleep or perhaps a nap), or chronic (long term—those all niters preparing for final exams or partying). This is just one of many everyday living occurrences that cause fatigue. Fatigue can be minimized with proper rest and sleep, regular exercise, and proper nutrition (M&Ms, Coke—yes, the soft drink, coffee, and donuts don't count).

Emotions, upset by events like a serious argument, death, separation or divorce, loss of a job, and financial problems, also affect our ability to fly safely. If you experience an emotionally upsetting event, you should not fly until you have given yourself adequate time to recover.

Our involvement in all health aspects of flying continues until the day we retire our certificate. Pilots are prohibited from flying with any known medical condition that does not meet the standards of their medical certification. Depending on source "E" represents Emotion or Eating. "Eating: Have I eaten enough proper foods lately?" Both are important. (As a good FAA employee naturally, I feel very strongly "both ways.")

From this evaluation of the "human element" we make a: GO-NO GO decision.



The PAVE Checklist

Pilot	Experience, recency, currency, physical, and emotional condition
Aircraft	Fuel reserves, experience in type, aircraft performance, aircraft equipment
enVironment	Airport conditions, weather, runways, lighting, terrain.
External Pressures	Allowance for delays and diversions, alternative plans, personal equipment.

The FAA's ADM efforts continued in 2009 with FAA-H-8083-2 *Risk Management Handbook*. This publication included the "PAVE Checklist" to help pilots identify risks during flight planning (callout). PAVE was a significant improvement over the AC 60-22 block diagram and like the "Risk Evaluation and Management" decision tree Fig. 8-1.

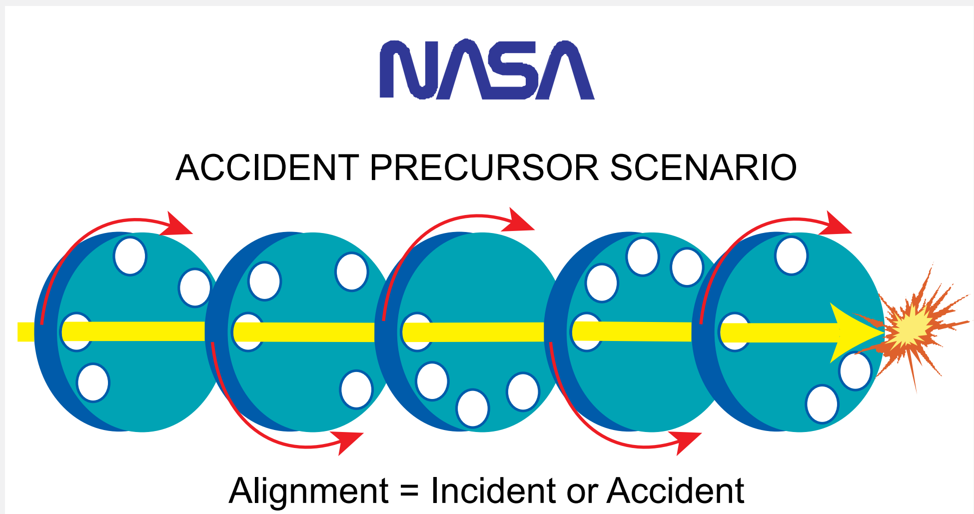
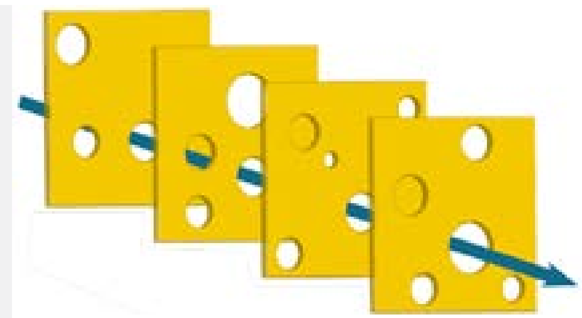
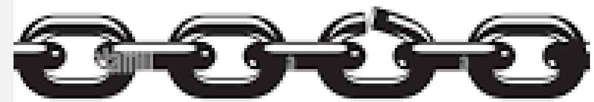


Fig. 8-3. *Precursors might be physical incapacity, poor judgment, aircraft deficiency, failure of the ATC system, or the weather.*

Evaluating the Risk

The National Aeronautics and Space Administration (NASA) has developed "precursors" that precede, and indicate or suggest that an incident or accident will occur. Precursors are illustrated in Fig. 8-3. Each "wheel" represents one precursor. It might be physical incapacity, poor judgment, aircraft deficiency, failure of the ATC system, the weather, or other factors which in themselves would not create an incident or accident, but when taken together lead to disaster. (Sometimes referred to as the "Swiss cheese model" where holes in the cheese line up which result in an incident or accident or "chain of events" where the breaking of any one link would have prevented the incident of accident.)





Strategic and Tactical Decision Making

Assessing and managing risk can be as easy as my friend John in his Kit Fox looking at an afternoon flight in the pattern; or, as complex as one of NASA's International Space Station missions. Let's start with John's decision to "commit aviation." John will apply the Commercial pilot personal minimums described in Fig. 7-5 and the other Factors Affecting Personal Minimums in the Fig. 7-8 matrix.

Strategic

Planning: Airport elevation 397 ft, runway 25L 2699 ft; pattern altitude 1400 ft; the environment—clear, cool, winds calm, alternate: runway 25R. DECISION GO.

Aircraft: Performance of the Kit Fox OK; airplane equipped for flight in Class D airspace. DECISION GO.

Pilot: Fit for flight. DECISION GO!

Tactical

John will keep a close eye on the winds. If sustained winds, gusts, or crosswinds approach personnel minimums he'll terminate the flight.

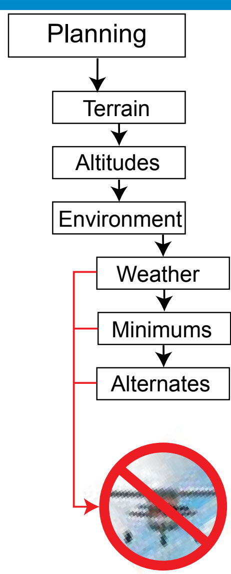
It can be this simple.

Don't worry. We're not going to evaluate a NASA International Space Station mission. Instead let's look at the following flight.

We were flying from Oklahoma City to Palm Springs, California. The flight from Oklahoma City to Amarillo, Texas was uneventful. The next leg was from Amarillo to Albuquerque, New Mexico. The Strategic Plan was to fly direct, via Tucumcari, New Mexico. The weather was good through Tucumcari but deteriorated west of Tucumcari into Albuquerque—the result of upslope clouds and fog. Passing Tucumcari I checked with Flight Watch and received the bad news. The weather ahead was MVFR to IFR.

With deteriorating weather ahead, I decided to go IFR—*I Follow Roads*. With little in way of landmarks, low ceilings and visibilities, the safest option was to follow Interstate 40—tactical. The terrain and clouds began to merge about 20 miles west of Santa Rosa. It was afternoon and we had been flying for about four hours. With night approaching, poor weather, and fatigue, a factor, the only “acceptable risk” option was to retreat and land at Santa Rosa.

Hal Marx (USMC retired), the Santa Rosa airport manager, fueled our airplane and gave us a lift into town, where we remained overnight. The next day was about the same and we remained another night. We had been trying to get to Albuquerque for two days without success. The following morning wasn’t much better, but forecast to improve—where have we heard that before?



Strategic

Planning: Refer to Fig. 8-4. Santa Rosa (red circle) has a field elevation of 4782 ft. Along I-40 the high plateau of eastern New Mexico rises to over 7000 ft, with the pass through the Sandia Mountains to Albuquerque at about the same elevation. The terrain is slightly lower to the north and south, but still over 6000 ft. Because of the mountains IFR Minimum Enroute Altitudes (MEA) vary from about 10,000 to 12,000 ft. Minimum VFR altitudes range from 6500 to 8500 ft.

Environment: Upslope continued to be the culprit. MVFR to IFR ceilings, generally good visibility, relatively high tops, freezing level at about 10,000 ft, conditions forecast to slowly improve during the day. When evaluating risk: Flying toward or into improving weather is better than flying toward or into deteriorating conditions.

With my training and experience I normally apply the Commercial pilot personal

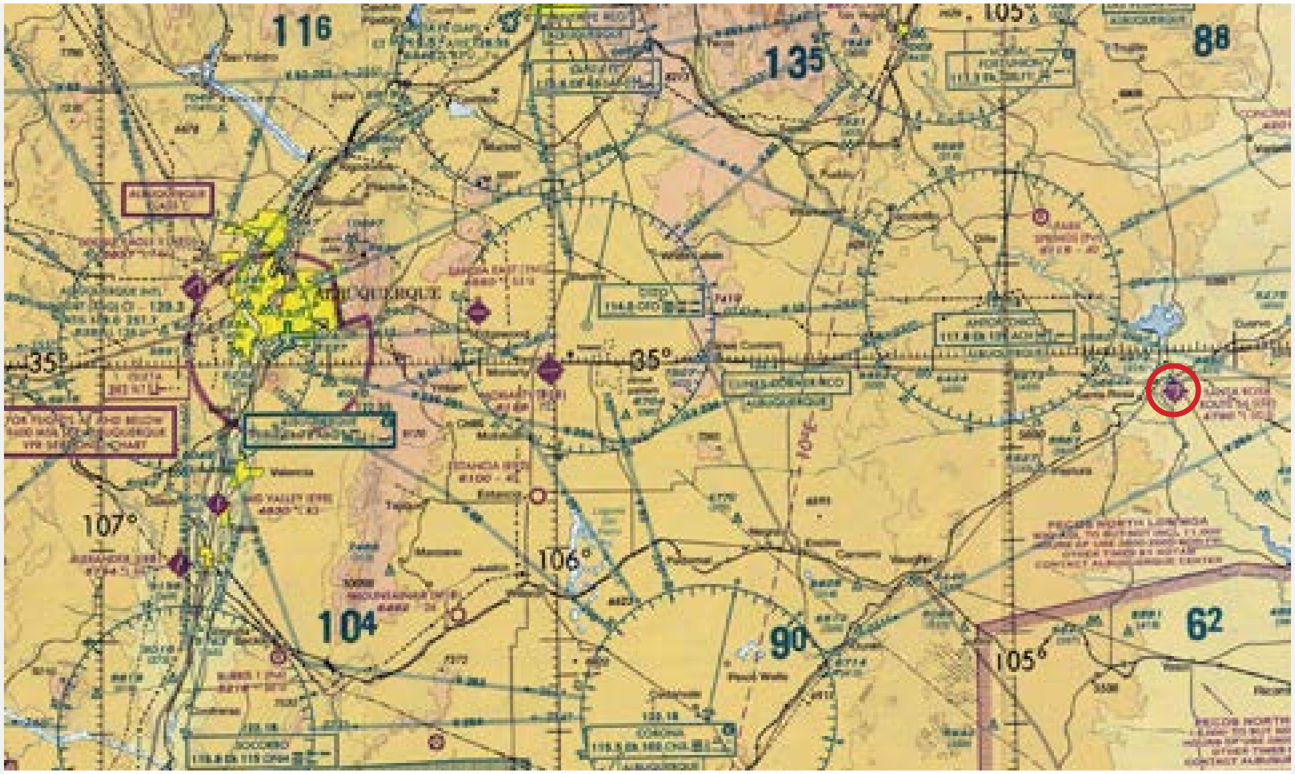
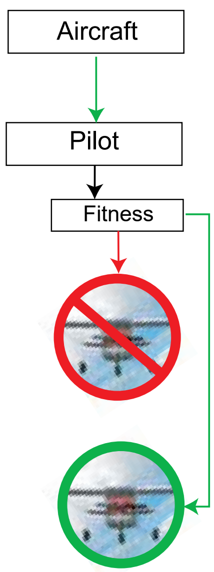


Fig. 8-4. *The Santa Rosa airport is located east of Albuquerque at about the same latitude—red Circle.*

minimums along with the applicable Factors Affecting Personal Minimums matrix. I also have confidence in my ability to make the decision to turn around. As John puts it, “Cowardice is the better part of valor.” (Undoubtedly, an axiom from his Army aviator days.)

Low ceilings and visibilities, even when technically legal, often present an unacceptable risk. Depending on training and experience low ceilings with good visibilities may be acceptable. Time of day is another factor. There is no question that flying at night introduces additional challenges and risk—NO GO for this scenario.

Aircraft: We’re flying an IFR equipped Cessna 172. Should the airplane be in any way unairworthy—includeing equipment—the flight decision is NO GO.



Based on preliminary planning, apply the following Risk Assessment and Management process. Recall that we were stuck in Santa Rosa for two days.

IFR Flight

The airplane would be at the limit of its performance. High minimum altitudes, low freezing level; the airplane was equipped for IFR operations but not equipped or certified for icing. We would be at the MEA in probable icing conditions, unable to climb, over mountainous terrain. What alternates were available? None! Risk too high. Decision: NO GO.

VFR Flight

Plan A—Climb to VFR on top and fly to Albuquerque and descend through broken clouds—forecast anyway.

Plan B—Fly under the clouds and land at Albuquerque.

Plan C—Fly south, along the railroad to Albuquerque. (For some reason railroad engineers always seem to select the lowest terrain.)

Plan D—Return to Santa Rosa.

Risk, yes; but plenty of options. For me this was a “go take a look” situation. Why? The area was sparsely populated, good visibility, good weather at the departure airport. On the negative side, I was not familiar with the area; familiarity has led many a pilot to disaster. It was daylight.

Airplane performance and equipment GO for the VFR plan.

Pilot: Fit for flight. Decision: GO.

Risk assessment and management does not stop with a GO decision. We must reevaluate conditions throughout the operation, from preflight inspection to the determination that a particular airport is suitable for landing. If conditions at the destination (wind, weather, surface conditions, etc.) change, we may have to divert. If we don't have an alternate plan risk is too high, resulting in a NO GO decision.

Tactical Evaluation Process

The tactical evaluation is typically an inflight operation. Previously we've discussed the limitations of AC 60-22 Aeronautical Decision Making (1991). AC 60-22 failed to adequately address the tactical (inflight) decision process. A refinement to AC 60-22 was the "DECIDE Model" (callout). The mnemonic "DECIDE" is "...a six-step process for the pilot to logically make good aeronautical decisions." However, as the FAA points out, "In an emergency situation, a pilot might not survive if he or she rigorously applied..." this "...model to every decision...."

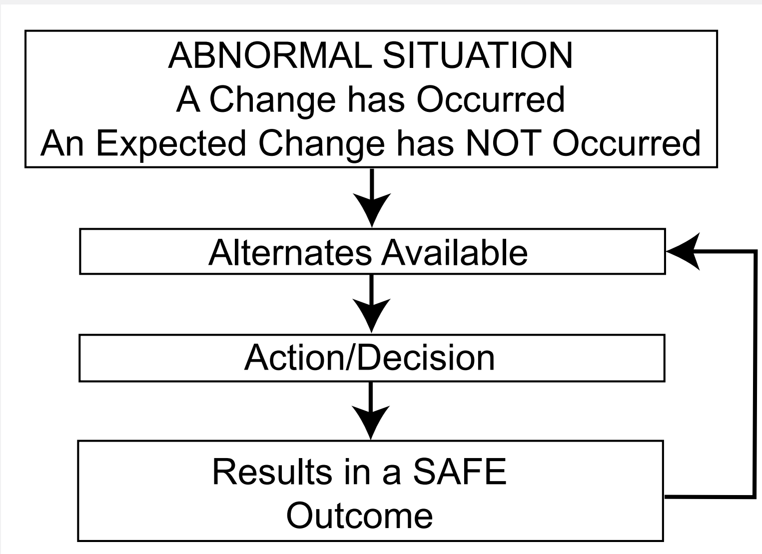
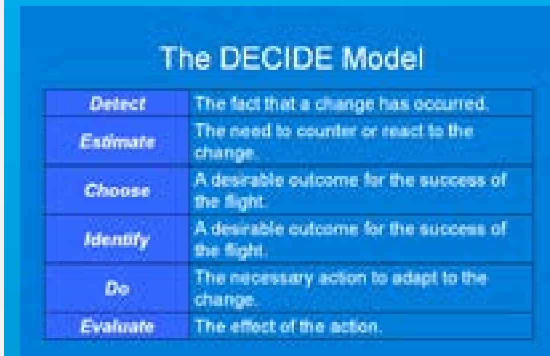


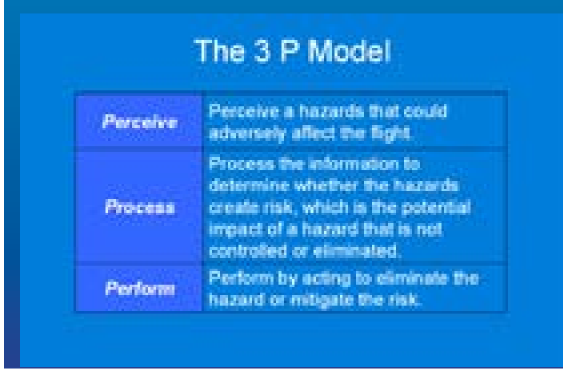
Fig. 8-5. *Pilots must continually reevaluate Alternates Available and Actions/Decisions to ensure a SAFE outcome.*

Like the preflight Risk Evaluation and Management process in Fig. 8-1, the solution to inflight decisions was the Tactical Evaluation Process block diagram in Fig. 8-5. Our first task is to *recognize* and *accept* that something is NOT normal. Something HAS changed, or an expected change HAS NOT. After an assessment of alternatives, decide on a course of action and monitor the results. If the result is NOT a SAFE outcome reevaluate alternatives and select another action/decision.

With the preflight complete, four and a half hours of fuel, we departed and opened our VFR flight plan to Albuquerque. (A VFR flight plan, especially under these conditions, is part of risk management.) Ceilings were low, but visibility was unlimited. It soon became apparent that "Plan A," over the clouds, was not going to happen. This was confirmed


The DECIDE Model

Detect	The fact that a change has occurred.
Estimate	The need to counter or react to the change.
Choose	A desirable outcome for the success of the flight.
Identify	A desirable outcome for the success of the flight.
Do	The necessary action to adapt to the change.
Evaluate	The effect of the action.



through a conversation with Albuquerque Radio advising that the weather in Albuquerque had not improved.

Tactical Decision Plan A: NO GO.

Plan B—fly under the clouds. Approaching Clines Corners, terrain rises to about 7000 ft. The clouds went right down to the ground! When do we say NO and call it a day? I teach, or maybe it's preach, that the first time the though occurs: "Should I really be here" or "Maybe I should turn around" is a RED FLAG to take positive action now! Don't push the weather, your aircraft, or yourself; turn around and wait it out. We initiated a 180º turn. We would have been flying from poor to worse weather. Risk TOO HIGH.

Tactical Decision Plan B: NO GO.

At this point I resigned myself to return to Santa Rosa—Plan D. However, my wife said, "What about plan C?" An increased risk accompanied Plan C. There were only a couple of dirt strips with high elevations and short runways for alternates. The terrain was lower, ceilings low, but visibility remained unlimited. For navigation we had the "iron compass" (railroad). I called Albuquerque Radio and changed our route and ETA.

Tactical Decision Plan C: GO

As is my practice I made position reports and updated weather with Flight Service—another part of risk management. We always had the option of returning to Santa Rosa should the weather deteriorate—Plan D. Albuquerque did not, in fact, improve and we landed short at Alexander, New Mexico. With the weather now improving from the west the flight continued uneventfully to Palm Springs.

Elements of both the "DECIDE Model" and the "PAVE Checklist" are contained in Fig. 8-1 Evaluation and Management block diagram. To address tactical issues (inflight) the FAA's Risk Management Handbook introduced the "3 P Model." The 3 P Model provides a simplified, practical, and systematic approach to process and eliminate hazards or mitigate risk. Notice the similarity between the "3 P Model" and the Tactical Evaluation Process in Fig. 8-5.

Anatomy of an Accident

Case Study

Seven year old Jessica Dubroff accompanied her father (a passenger) and the pilot in command (a flight instructor) on an attempt at a so called trans-continental record involving 6660 miles of flying in eight consecutive days. The first leg of the trip, about eight hours flying, had been completed the previous day, which began and ended with considerable media attention.

On the second day they participated in media interviews, preflight, and then loaded the Cessna 177 Cardinal. The pilot in command received a weather briefing which included weather advisories for icing, turbulence, and IFR conditions—due to a cold front moving through the area.

The airplane taxied in rain for takeoff. The pilot acknowledged receiving information that the wind was 280º at 20 gusting to 30 knots. A departing Cessna 414 pilot reported moderate low-level wind shear of plus and minus 15 knots. The airplane departed toward a nearby thunderstorm and began a gradual turn to an easterly heading.

Witnesses described the airplane's climb rate and speed as slow. They observed the airplane enter a roll and descent that was consistent with an aerodynamic stall. Density altitude at the airport was 6670 ft. The airplane's gross weight was calculated to be 84 pounds over the maximum limit at the time of impact.

The probable cause was determined to be the pilot's improper decision to takeoff into deteriorating weather conditions. This included turbulence, gusty winds, an advancing thunderstorm, and possible carburetor and structural icing. The airplane was over gross weight. Density altitude was higher than the pilot was accustomed. The result was a stall caused by failure of the pilot to maintain airspeed.

As in many accidents, this event can be attributed to a series of, relatively insignificant, factors that when taken together resulted in a crash.

I say *so called* record because this was nothing more than a publicity stunt. It reminds me of telling friends that my son soloed at age three months. He was the sole occupant of the airplane as we pulled it over to the wash rack.

Dead Mans Hand

"There is *never* a reason why you have to be there."

They were on a tight schedule. Publicity events had been scheduled in advance. The original takeoff was delayed to allow Jessica additional sleep. The pilot was fatigued from the previous day's flight and obtained little rest during the night. The weather was marginal. The pilot had to request a special VFR clearance for departure. Who was really flying the airplane? The pilot in command was seated in the right seat of the Cessna Cardinal. Now add high density altitude, an airplane over gross weight, and a mindset that they must "GO."

The first precursor was the need to keep a schedule (get-there-itis). Precursor two was pilot fatigue. The next precursor was a high density altitude takeoff in a low performance airplane over gross weight. The weather was the fourth precursor, with its low ceilings and visibility, gusty winds, wind shear, turbulence, icing, and thunderstorms. (You could count each of these factors as an individual precursor.) A fifth precursor was the pilot's attempt, under adverse conditions, to try to maintain control of the airplane. We'll never know what exactly happened, but the pilot lost control. The deck was certainly stacked against them.

Like many accidents, we can see how breaking any one individual link may have prevented this accident. The first link was the time schedule. A friend, and excellent pilot, has the philosophy that: "There is never a reason that you absolutely have to be anywhere." The accident pilot's mind set appeared to be, "We're going no matter what."

The second link was fatigue. It was reported that Jessica had slept most of the first leg. As we've discussed, pilot fatigue is a significant factor in both mental and physical skills. This certainly may have clouded the pilot's GO-NO GO decision, along with failure to consider and calculate gross weight and density altitude. The weather was terrible, the third link. If it had been clear and calm, the pilot might have gotten away with fatigue, over loading the airplane, and lack of experience with high density altitude.

Now add the pressure of flying from the right seat, with a novice person in the left—in less than basic VFR conditions. Even a slight, momentary distraction under these conditions can have serious consequences. It's reasonable to conclude that the pilot experienced sensory overload during climb out. All of these factors together aligned the precursors, resulting in a fatal accident.

Single Pilot IFR

Single pilot IFR, especially with TAA aircraft and in congested airspace, introduces additional risk. The pilot planned an IFR flight from Napa (APC), California to San Jose's Reid-Hillview (RHV) airport in the San Francisco Bay area—a distance of less than 60 nm "as the crow flies."

Environment: Terrain rises from sea level to less than 4500 ft over the coastal mountains. Minimum enroute altitudes range from 4000 to 6000 ft. The RHV GPS 31R approach is in a congested, high density traffic area in close proximity to other airports in the southern San Francisco Bay. The final approach course closely parallels the San Jose International approaches. To the east, terrain rises rapidly, leaving little room to maneuver for airplanes below 6000 ft.

IFR to MVFR (Marginal VFR) weather prevailed. Minimums for the RNAV (GPS) RWY 31R approach were visibility 1 1/4 ml, ceiling 1309 ft AGL (airport elevation 135 ft). There are numerous alternate airports along the route. The weather at the destination was reported as visibility 4 ml, ceiling 1200 ft broken 8000 ft overcast.

Note

> Prescribed visibility and ceiling for this non-precision approach are considerably higher than standard due to high terrain in the vicinity of the airport. (When minimums are higher than normal, there's always a reason.)

Aircraft: The airplane was a Cirrus SR20, a Technically Advanced Airplane, equipped, certified, and current for IFR operations.

Pilot: The pilot's total time was about 460 hours (362 dual received); 334 in make and model, 85 logged in the last 90 days. The pilot passed an instrument flight check less than three weeks prior to the accident. (The accident report did not mention how much "actual instrument" time the pilot had accumulated.)

From chapter 7, Table 7-6 DAY instrument personal minimums recommends a ceiling of 800 ft and visibility 2 miles. However, footnote 5 expands this limit to "FAA

Table 7-8. *Acceptable Risk (Excerpt)*			
Flight Category		Ceiling	Visibility
IFR	New[4]	+400	+1 SM
	<10 HR in Type	+400	+1 SM
	<5 HR PIC Inst.	+400	+1 SM
	TAA[5]	+400	+1 SM
	Recent[6]	+400	+1 SM

[4]Less than 10 hours PIC in type and/or less than 5 hours PIC actual instrument.

[5]Or, training/certification in TAA, flying analog or non-TAA aircraft.

[6]Less than double FAA recent flight experience requirements.

published minimums." Therefore, minimums for this flight should have been visibility 2 ml, ceiling 1300 ft—100 ft above reported! Figure 8-5, an excerpt from the Acceptable Risk Factors and Determination matrix, recommends for a low time pilot increased ceiling by at least 400 ft (1700 ft); and with less than 5 hours PIC actual instrument (which may have likely been the case) an additional 400 ft. This would put the ceiling limit at 2100 ft.

History of the Flight

The flight departed Napa County Airport, Napa, California, at 1600 local time. During the initial portions of the flight ATC issued numerous radar vectors and altitude assignments for traffic. At 1627, when the airplane was approximately abeam Oakland International Airport, ATC instructed the pilot to proceed to navigational fixes near Palo Alto airport (PAO). The pilot questioned the clearance and in the subsequent exchanges the acknowledged the mistaken belief that the pilot's destination was PAO.

Refer to Fig. 8-6. The controller asked the pilot from which fix he would like to initiate the approach, and the pilot requested vectors to the approach "around OZNUM." OZNUM is the Final Approach Fix (FAF). The controller issued a clearance direct to OZNUM. After this exchange, radar indicated the airplane turned almost 90 degrees to the right, and tracked on a course consistent with proceeding direct to PAO. The controller noticed the course deviation and queried the pilot. The controller told the pilot to make a right turn to avoid traffic associated with San Jose International and to proceed to OZNUM. The pilot acknowledged and made a right turn of approximately 270 degrees, briefly tracking on an approximately southbound course, which did not appear to be aligned with any relevant navigational fix.

After approximately three miles on this course, the pilot turned left to a track consistent with proceeding direct to OZNUM. The radar data showed that this ground track resulted in the airplane flying overhead RHV, on approximately the reciprocal of the final approach course.

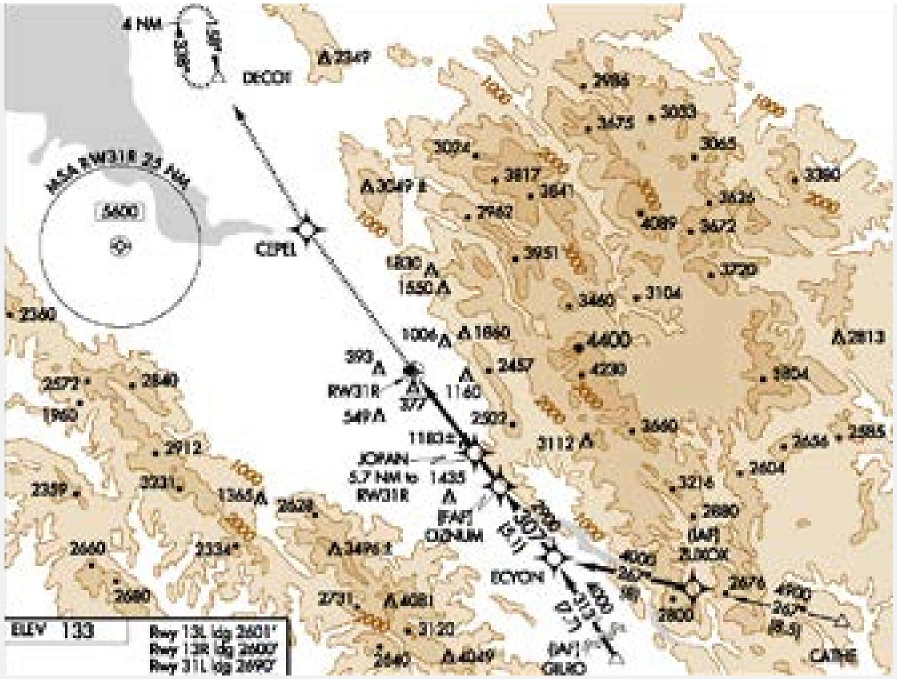


Fig. 8-6. *Plan View of the Reid-Hillview GPS RWY 31R approach.*

The controller said he believed the pilot required extra attention and intended to provide additional assistance. Upon the pilot's initial contact with the next sector, the airplane had passed OZNUM and begun a slight left turn to the east. At this point the pilot had no further clearance to follow, since the previous controller had cleared him direct to OZNUM with the expectation that the subsequent controller would provide vectors.

The pilot was issued instructions to proceed direct to ECYON; the pilot's response was to question the fix. According to the controller's statements, the airplane was in a position coincident with a downwind leg, and the turn toward ECYON would work out to be the same as a vector to final. Recorded radar data indicates the airplane was flying a course approximately aligned with the Initial Approach Fix (IAF) ZUXOX. Shortly after this exchange, the controller noted the airplane appeared to begin a left turn towards OZNUM, but he instructed the pilot to turn right toward ECYON in order to remain clear of a higher terrain area.

At this time, OZNUM was directly behind the airplane, and ECYON at about the four o'clock position. The pilot completed a right turn, briefly flying a course consistent with tracking towards OZNUM, then made a slight left turn and flew a course consistent with the published segment between ZUXOX and ECYON. The controller said he observed the pilot on this course and issued clearance for the approach.

While the flight was progressing between ECYON and OZNUM, a controller change occurred. The second controller was advised that the airplane was on the approach and the only remaining task was to issue frequency change to RHV tower. As the airplane passed just northwest of OZNUM, the controller instructed the pilot to contact the tower on frequency "118.6." This frequency is actually assigned to PAO tower. The pilot queried the controller if that was actually correct. The controller insisted, "Yes sir, it is." The pilot complied and contacted PAO tower. The pilot and the PAO controller discussed that he was on the wrong frequency and the pilot said he would switch to the RHV frequency of 119.8.

During this conversation, radar indicated the airplane began a turn to the right, with the first target visibly displaced from the final approach course at 1652:33, approximately over JOPAN waypoint. At 1652:50, the pilot reported to RHV tower, "descending from JOPAN two thousand feet five point four miles from missed approach point."

Radar data agreed with the pilot's report; however, the course had diverged almost 90 degrees from the final approach course. Within two seconds of the pilot making initial contact with RHV tower, the Minimum Safe Altitude Warning System (MSAW) provided a visual and audible alert at the RHV tower. In response to the pilot's call, the RHV tower controller cleared the pilot to land then said, "low altitude alert, check your altitude immediately."

Based on the radar data, the airplane's projected track was diverging away from the centerline of the approach, and toward higher terrain. At the time of the alert the airplane was at about 1900 ft, and the minimum altitude for the final segment is 1440 ft. About 30 seconds later, the tower controller notified the pilot that he appeared off course. The pilot made a brief unintelligible transmission and no further radio or transponder signals were received. The radar track of the airplane was lost 6.7 miles southeast of the Reid-Hillview airport at an altitude of 1600 ft MSL.

Analysis

The only objective weather data was the RHV observation taken at the time of the accident. It reported the ceiling above basic VFR, but below GPS landing minimums.

There were numerous distractions during the flight. This is not unusual in busy, congested airspace. The pilot requested "vectors" for the approach and was subsequently given various "direct to" and "vector" clearances. Again, not unusual. The pilot never requested clarification.

The pilot established the airplane on the final approach course at the proper altitude. Then ATC assigned the wrong tower frequency. This was when the airplane's heading began to deviate. Shortly after this course deviation, the pilot was given a "low altitude alert."

Speculation

The pilot could have flown the San Jose approach and, weather permitting, flown VFR to Reid-Hillview—a common practice. Had the pilot applied higher minimums (1700 ft/2100 ft), actual conditions would have put this approach well below recommended "personal minimums." Had the "personal minimums" prevailed, the airplane would have broken out well before impacting terrain.

FAA Instrument Rating Aviation Certification Standards (ACS) require applicants be tested on their ability to cope with distractions.

Use of Distractions During Practical Tests

> Numerous studies indicate that many accidents have occurred when the pilot has been distracted during critical phases of flight. To evaluate the pilot's ability to utilize proper control technique while dividing attention both inside and/or outside the cockpit, the examiner shall cause a realistic distraction during the flight portion of the practical test to evaluate the applicant's ability to divide attention while maintaining safe flight.

Aviation Certification Standards emphasize scenario based training. Realistic distractions are an integral part of this program.

Probable Cause(s): NTSB probable cause is NOT a legal determination and may NOT be used in any suit or action. Only a “Court of Law” can determine cause and assign liability.

What distractions do instructors and examiners use? Could this have been the first time this pilot was subjected to these types of distractions? Controllers want to “move iron;” expedite the flow of traffic. This can lead to short cuts with clearances, as in this case.

Did the pilot loose “situational awareness” while being vectored? The pilot could have requested a longer “turn on” to the approach or clearance to an initial approach fix (IAF). Like controllers, as pilots we sometimes take short cuts to our ultimate regret. Never request or accept a “short turn on” to an approach in actual instrument conditions.

The pilot appears to have reached “sensory overload” trying to fly the approach, communicate, and process the “low altitude alert.” During the last minutes heading awareness was lost. The pilot was not below the minimum altitude for the approach and MSAW is known to give “false alarms.”

The National Transportation Safety Board determined the probable cause(s) of this accident as:

> “The pilot’s failure to maintain the course for the published approach procedure due to his diverted attention. The distraction responsible for the pilot’s diverted attention was the erroneous frequency assignment provided by ATC and the resultant task overload induced by this problem and the confusion surrounding the ATC clearances to get established on the final approach course, which likely involved repeated reprogramming of the navigation system. Factors in the accident include the failure of ATC to provide the pilot with a timely and effective safety alert concerning the deviation from the proper course, which was influenced in part by the features of the radar display...which made the deviation more difficult to detect, and the nature of radar as a secondary tool for a VFR tower controller. An additional factor was the nonstandard method of providing approach clearance, which likely may have exacerbated pilot task overload.”

Should the pilot have attempted the approach in the first place? Should the pilot have abandoned the approach? Hindsight would indicate yes. Recall the discussion of "accident precursors." Unfortunately, in this case, the wheels aligned resulting in a tragic accident.

We touched on abandoning a plan. We said that the first time the though occurs: "Should I really be here" or "Maybe I should turn around" is a RED FLAG to take positive action now! Don't push the weather, your aircraft, or yourself. Turn around and wait it out. Risk factors are cumulative, when things aren't right select another option.

Case Study

> We were on an IFR flight, in actual instrument conditions, from Van Nuys to Santa Monica, California. At the time the approach began at a fix made up of a Pomona (POM) VOR radial and a Santa Monica (SMO) VOR radial. We tuned, identified, and set the radios. As we approached the fix both course deviation indicators (CDI) were pegged "off scale." We double checked the frequencies and radials. At this point we should have intercepted the SMO radial (the final approach course). "Trouble shooting" on an approach in actual conditions—especially single pilot—is extremely risky. We requested vectors to ON TOP and cancelled IFR.

Once ON TOP we selected the Van Nuys (VNY) VOR on both radios and everything checked out. To this day the only thing I can surmise is that on the approach we put the SMO VOR in NAV 1 and POM VOR in NAV 2; then put the *SMO radial in CDI #2* and the *POM radial in CDI #1*.

The 2009 addition of the FAA's Risk Management Handbook points out that Single Pilot Resource Management "...requires a way for pilots to understand and use it in their daily flight." "One practical application is...the Five Ps (5 Ps)...." "The 5 P Model" closely resembles the elements in the "PAVE Checklist" and Fig. 8-1. ("The 5 P Model" does not appear in 2022 edition of the FAA's Risk Management Handbook.)

Managing Risk

Keys to managing risk are sound Aeronautical Decision Making (Strategic and Tactical), adherence to personal minimums, and pilot and passenger physical and

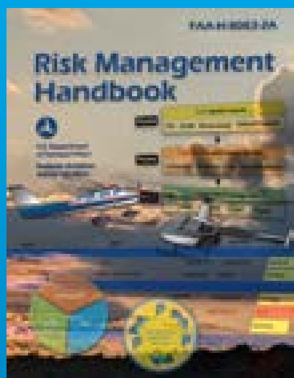
Hindsight is always "20-20."

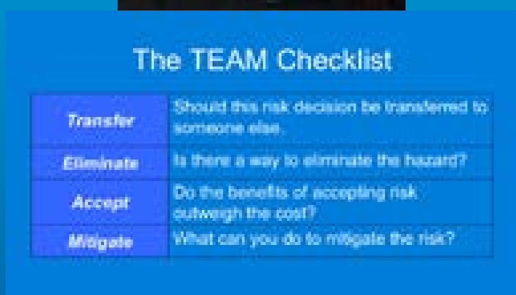
The 5 P Model

Plan	The plan or mission or task.
Plane	The aircraft and its equipment.
Pilot	I'm SAFE Checklist.
Passengers	Passengers are an essential part of CRM.
Programming	Plan where and when to program the aircraft's advanced electronics.

psychological considerations. To manage and mitigate risk:

- Obtain a complete weather briefing.
- File a flight plan.
- Make position reports.
- Update weather enroute.
- Fly with another qualified pilot.
- Never subordinate flying the airplane (aviate).
- Do not allowing anyone (peer pressure including ATC) to put you in an uncomfortable or untenable position.





The TEAM Checklist

Transfer	Should this risk decision be transferred to someone else.
Eliminate	Is there a way to eliminate the hazard?
Accept	Do the benefits of accepting risk outweigh the cost?
Mitigate	What can you do to mitigate the risk?

The CARE Checklist

Pilot	Experience, recency, currency, physical, and emotional condition
Aircraft	Fuel reserves, experience in type, aircraft performance, aircraft equipment
enVironment	Airport conditions, weather, runways, lighting, terrain
External Pressures	Allowance for delays and diversions, alternative plans, personal equipment

Case Study

> One of our local FAA Flight Standards Operations Inspectors had a flight in a Mooney 252 from Hayward to Ukiah in California. There was a stratus layer over the San Francisco Bay. This individual had thousands of hours as a Navy P3 pilot. Even though this individual was qualified and current, he was not comfortable conducting this IFR operation single pilot. I volunteered to fly with him and we had an enjoyable, uneventful flight to Ukiah.

A 2013 National Transportation Safety Board Safety Alert noted that effective risk management involves developing good decision making practices. In 2022 the FAA revised FAA-H-8083-2A *Risk Management Handbook* (callout). Over the years these and other publications have introduced various checklists, acronyms, and mnemonics to assist in the risk evaluation and management process.

In addition to the acronyms mentioned, the 2022 version of the FAA's Risk Management Handbook contains the "CARE" and "TEAM" checklists (callout). The "CARE Checklist" identifies which hazards are risks during the PAVE and 3 P process. The "TEAM Checklist" suggests ways to manage risks. TEAM shares the "perform" step in the "3 P Model" as well as the alternatives from the "CARE Checklist."

No matter which method you use, checklist, acronym, or mnemonic, develop and adhere to a risk evaluation and management process.

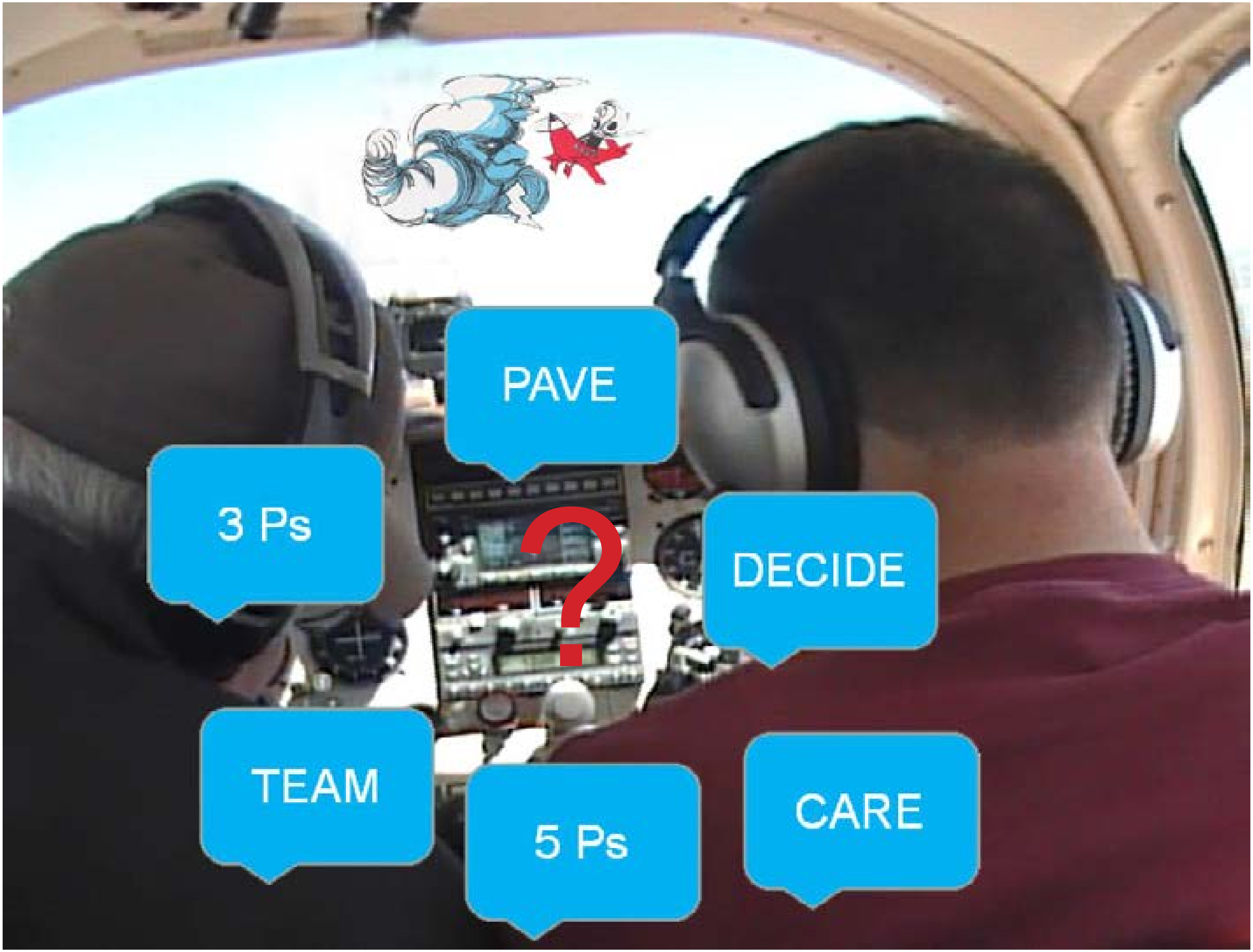
We've mentioned the "3 Ps" and the "5 Ps;" then there's my favorite the "6 Ps."

Prior Planning Prevents Piss Poor Performance

We'll continue with the application of sound Aeronautical Decision Making principles in Part Three and Part Four.

Instructors (senior pilots) should never tell or demonstrate to learners (junior pilots) anything they don't want them to emulate. (And, yes, I've been guilty of this behavior.) Instructors, flight schools, and senior pilots must lead by example as well as influence. Any disregard (ignoring/bending) of regulations or procedures will negatively affect learner/junior pilot's behavior.

The callout is a portion of the chapter banner. It illustrates poor instructor/senior pilot behavior. Our inept instructor is using the cowl of the airplane as a desk. Never unnecessarily place any portion of your body in the arc of the propeller!


PAVE
3 Ps
DECIDE
TEAM
5 Ps
CARE