Recommended Practice

Spatial Disorientation Induced by a Degraded Visual Environment

Training and Decision-Making Solutions

Helicopter-Safety Enhancement 127A

Prepared for the USHST for promotion through industry stakeholders and safety advocates.
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BACKGROUND

In 2017, the US Helicopter Safety Team (USHST) created a working group to implement its Helicopter - Safety Enhancement (H-SE) 127A, consisting of Government, Academia, and Industry subject matter experts, to analyze and develop a training solution to assist in the reduction of Spatial Disorientation accidents by developing training for recognition of Spatial Disorientation and recovery to controlled flight.

Working group research includes preflight planning and enroute decision triggers along with recognition/recovery from spatial disorientation. Previous use of the term Enroute Decision Point is considered to be synonymous with Enroute Decision Trigger. As the H-SE team conducted its research, it was decided that avoidance techniques combined with a paradigm shift on inadvertent flight in instrument meteorological conditions (IIMC) training community-wide is the most effective method of prevention. In addition, technological advances were found to enhance recognition and training for Degraded Visual Environment (DVE) induced Spatial Disorientation to include in-aircraft visibility simulation systems (VSS).

This paper is intended to provide initial framework for training while a comprehensive training package is developed.

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INTRODUCTION

The accident scenario formerly known as Inadvertent Instrument Meteorological Conditions (IIMC) has recently been described using a multitude of terms creating even greater confusion: unintended flight into IMC (UIMC), controlled flight into terrain (CFIT), loss of situational awareness (LOSA), loss of control inflight (LOC-I), and several other terms. Regardless of the term used, Degraded Visual Environment (DVE) induced Spatial Disorientation accidents are a leading cause of fatal accidents in helicopter aviation. Based on data from the FAA accident database the helicopter community experienced 130 fatal Spatial Disorientation DVE accidents between 2000 – 2019. This paper focuses on training and decision-making solutions prior to and during a DVE Spatial Disorientation event.

Statistics prove DVE induced Spatial Disorientation accidents happen regardless of pilot experience and across all industries (Helicopter Air Ambulance (HAA), Law Enforcement, Corporate, Military, Utility, Flight Instruction, Tour, Private Use, etc.). DVE events are often the product of failed planning, lack of understanding of the DVE environment, or poor decision-making.

Avg. Pilot Age: 48

Avg. Total Flight Hours: 2,673

Avg. Total RW Hours: 2,161

Avg. Total Hours Make & Model: 609

*Combined Helicopter and Airplane

Statistics above are based on FAA and NTSB investigation reports.

For decades, studies, articles, papers, and discussions have been published theorizing why DVE accidents have occurred and continue to occur. To date, clear answers to slowing or stopping these tragic accidents do not exist. Complicating the problem is the broad range of pilot experience and the diversity of communities in which these accidents take place.

Often these DVE encounters occur, in part, due to failed planning, lack of understanding, or poor decision-making. All pilots have the option to turn down a flight before launch, and turn around, proceed to an alternate, or land in a safe place if the weather deteriorates during a flight below company or *personal* minimums, yet we continue to see these accidents in all sectors of the helicopter industry. That is why we propose a paradigm shift in the way we discuss, train and react to deteriorating or “unplanned” weather/conditions.

Pilots are taught Normal Procedures, Emergency Procedures, and Aircraft Limitations. How are conditions conducive to DVE-induced Spatial Disorientation any different? If you are on a flight and you get a **CAUTION** or **WARNING** light, what do you do? You rapidly analyze the situation, considering all surrounding factors, and take the most appropriate action, potentially terminating the flight. You would not continue the flight with an engine oil pressure **CAUTION** light or a transmission **WARNING** light. We should view deteriorating or “unplanned” weather/conditions similarly.

The adoption of the Enroute Decision Trigger, a set of personal or organizational limitations, that clearly define pilots’ in-flight trigger and the actions they WILL take should they encounter DVE, may be the most effective preplanning tool to avoid these tragic accidents. By focusing on an Enroute Decision Trigger during the preflight planning phase, we help pilots clearly define the point at which continued flight is not recommended and pilot action is required.

- The USHST is recommending a scalable training solution that spans the entire industry and every skill level. This paper is a first attempt at defining the academic portion of training with a more robust solution as we engage with external agencies and industry for the required resources. Training will include: An outline of preflight and inflight decision-making.
- Conditions that lead to visual and vestibular illusions.
- Methods to avoid visual and vestibular illusions conditions.
- Training to prepare for DVE-induced Spatial Disorientation.
- Techniques and methods to prepare for recovery.

Recommended Qualification Change

FAR 61.109(a)(3) requires three hours of flight by reference to instruments for a single-engine airplane, but FAR 61.109(c) does not require that any instrument training for helicopter PPL be conducted. Instrument training should be conducted by every pilot prior to receiving a Private Pilot certificate.

The H-SE 127A team recommends that the FAA consider a change to the FARs to require a minimum of three hours, in addition to current requirements, of flight by reference to instruments prior to issuance of the helicopter private pilot certificate.

AEROMEDICAL

Spatial Disorientation is a broad term often used incorrectly to describe a multitude of illusions a pilot may experience. Not all illusions are spatial disorientation, nor will every illusion lead to the pilot becoming spatially disoriented. Our focus is not an in-depth lesson on types of illusions pilots experience, after all that has been taught for as long as most can remember. Our focus will be how the body and brain handle Spatial Disorientation, how different training models prepare the pilot, and where those methods are lacking.

Terms

Spatial Disorientation – A state characterized by an erroneous sense of one's position and motion relative to the plane of the earth's surface. (Benson, 1978)

Illusions – Something that deceives or misleads intellectually. (Meriam-Webster, 2020)

> *Noteworthy: While illusions can lead to Spatial Disorientation, an illusion itself does not always constitute Spatial Disorientation. Pilots often discuss experiencing illusions during normal instrument flight. For example, a pilot might experience the leans when entering a cloud bank in a turn. Because the focus is on the instruments, they become aware of the illusion the body is experiencing but have not experienced full onset SPATIAL DISORIENTATION. This difference is critical to understand as training methods are implemented.*

Visual System – The visual system is the most dominant of the sensory systems. Through the eyes a pilot receives the vast majority (approx. 80-85%) of their orientation. The visual system is very reliable when a visible horizon is present but can lead to illusions during low visibility/low contrast conditions.

Visual Illusions – Illusions brought on through the visual system (not an exhaustive list but rather illusions expected during DVE):

- **False Horizon** – False horizon illusions occur when a pilot confuses a wide sloping plane of reference such as sloping cloud tops, mountain ridges, or so-called ‘cultural’ lighting at night (such as a coastline or highway) with the true horizon (US Army Aeromedical Training for Flight Personnel TC 3.04.93 August 2018)

- **Confusion with Ground Lights** – Occurs when a pilot mistakes ground lights for stars. The pilot can place the helicopter in an extremely dangerous flight attitude if he or she aligns it with the wrong lights (FAA Helicopter Flying Handbook FAA-H-8083-21B).

Vestibular System – The vestibular system uses the inner ear to orient a person. A series of canals in the inner ear operate in the Pitch, Roll and Yaw axis. The vestibular system provides approximately 15% of a person’s orientation. It is designed to operate in a 1g environment and is easily tricked in flight.

Vestibular Illusions – The vestibular system is poorly designed for orientation in flight and can cause illusions such as (again not an exhaustive list but rather illusions expected during DVE):

- **Leans** – The most common illusion during flight and is caused by a sudden return to level flight following a gradual and prolonged turn that went unnoticed by the pilot. The reason a pilot can be unaware of such a gradual turn is that human exposure to a rotational acceleration of 2 degrees per second or less is below the detection threshold of the semicircular canals (Pilots Handbook of Aviation Knowledge).

- **Graveyard Spiral** – Similar to the leans, however, unlike the leans which can occur without the pilot noticing the turn, a Graveyard Spiral can initiate from a known sustained duration turn. For example, when a right turn continues for an extended period (greater than ~20 seconds), the pilot may feel they turning left while attempting to return to level flight. This can cause the pilot to return the aircraft to its original right turn. As an aircraft turns without an increase in lift it causes the aircraft to descend. If the pilot then makes an aft input into the flight controls the aircraft turn will tighten, “corkscrewing” into the ground.

- **Oculogravic Illusion** – This occurs when an aircraft accelerates and decelerates. Inertia from linear accelerations and decelerations cause the otolith organ to sense a nose-high or nose-low attitude. During acceleration the pilot will sense a nose high attitude and may push the nose of the aircraft down. This condition could occur if a pilot accelerates during times of low visibility.

- **Inversion Illusion** – An abrupt change from climb to straight-and-level flight can stimulate the otolith organs enough to create the illusion of tumbling backwards, causing the pilot to abruptly push the nose of the aircraft which can intensify the illusions (Pilots Handbook of Aviation Knowledge).

  During DVE conditions pilots have a tendency to “go down and slow down” resulting in an unstable aircraft. The illusions above can exacerbate the situation for the pilot and crew. Even when correctly committing to instrument flight, the pilot continues to be inundated with multiple illusions.

- **Proprioceptive System** – The proprioceptive system is the “seat of the pants” sensation pilots experience. This system is a small portion of orientation and cannot be counted on during flight.

- **Cognitive Brain Function** – The brain’s ability to process information in a relevant manner.

FAA Publication: AM-400-03/1, “MEDICAL FACTS FOR PILOTS” states that “The (vestibular) problem starts when you continue turning your aircraft at a constant rate (as in a coordinated turn) for more than 20 seconds. This means that without sustained motion vestibular illusions won’t be present.

Sensory Interaction

Sensory interaction is critical to understanding how Spatial Disorientation is experienced by a pilot and more important why helicopter aviation continues to experience a high rate of Spatial Disorientation accidents.

- **Demonstrating Visual Illusions:** Simulators and virtual reality (VR) demonstrate visual illusions. For those who have experienced simulation or VR, they will likely remember the sensation of movement even when no movement is present. The visual system is capable of “tricking” the ears when there is limited or no motion; this is the case even in full motion Level D simulators. This false sense of movement stops when the visual environment is taken away.

  Pilots training in a simulator will experience visual illusions brought on by degraded visual environments but can easily transition to their instruments, because there is no conflicting illusion data for the brain to decipher.

- **Demonstrating Vestibular Illusions:** Vestibular illusions experienced during Spatial Disorientation events can be demonstrated in the aircraft. Training pilots close their eyes while safety pilots conduct a series of sustained turns This will stimulate the fluid in the inner ear bringing on vestibular illusions. When a training pilot tries to recover, the eyes will immediately take over as the dominate sensory system. The vestibular system will quickly “pass the controls” to the visual system and once again the brain experiences no conflicting data.

- **Case Scenario:** Let’s take a look at how these sensory systems interact in an example accident sequence: An aircraft encounters decreasing visibility conditions (we will talk later on the most effective Spatial Disorientation method, avoiding these conditions all together). As the pilot continues to fight for visual references, they may pick up a false horizon, this could be caused by a series of lights, roads, land masses or a multitude of other things that will create a “horizon.” The eyes see the aircraft in a level condition rather than the actual condition of the aircraft, which is a descending turn. Much like in the simulator, the eyes can convince the ears of the “truth” that they see but again, the visual system has interpreted the attitude of the aircraft incorrectly.

  As the pilot continues flight, one of two paths will be traveled with our accident aircraft. The first option is continuing to fly visually in low visibility/contrast conditions ultimately flying the aircraft into the ground. This might be considered controlled flight into terrain (CFIT) but the pilot was disoriented and did little to “control” the aircraft into the ground.

  The second option is the pilot deciding to commit to instruments. This decision is often made too late for the accident aircraft. During flight in low visibility conditions, the pilot can experience visual illusions such as a false horizon. During this time, the vestibular system will be stimulated creating illusions such as the leans. Prior to the transition to instruments, the pilot’s visual and vestibular systems are experiencing illusions that indicate an aircraft attitude that is different than actual conditions. When the pilot transitions to instruments, the vestibular system continues sending conflicting information to the brain. The visual system, using the attitude indicator, is telling the pilot’s brain that the visual system was incorrect and attempts to correct the condition, but the brain is dealing with conflicting data for the first time in the pilot’s career. While the visual system is using new information from the instruments, the ears are still experiencing the original conditions. This is where previous training has failed. The simulator training has always lacked the vestibular illusions and the in-aircraft training, without a visibility limiting system, has lacked the visual illusions.

  To better understand the condition of the brain we have to look at how the human brain handles stress. This can be defined by the “fight or flight” concept or the fast brain/slow brain. During normal conditions the brain functions in the slow brain mode. We take in information, process the information, form conclusions, and make decisions. Obviously, this slow brain condition is happening rapidly, but the key is the cognitive side of the brain is working. During high stress events, flight into degrading visual conditions, as well as full-fledged Spatial Disorientation, the brain will transition to the fast brain condition. The brain stops “thinking” and simply responds based on the training that it has received. A problem arises because pilots have not been trained to understand how the systems interact, nor have they been trained how to combat the confusion.

Back to our pilot, who has now transitioned to instruments, but the cognitive brain has become overwhelmed. During Spatial Disorientation accidents, the pilots often have less than 30 seconds to recognize and take corrective action. This allows little time for a decision to be made, and is even less forgiving to an incorrect control input.

Understanding the limitations of your current training and incorporating training and recovery methods discussed later will better prepare you if your decision-making fails or if the weather "truth has changed" and you find yourself in a degraded visual environment.

TRAINING

In order for this training to have the most widespread affect, it needs to be scalable. We recommend the training be broken down into four categories:

- Academic
- In-aircraft (no visibility simulation)
- Simulation
- In-aircraft (with visibility simulation system (VSS))

The training selected depends on the time, financial resources, and equipment available to a person or organization. The different training methods are offered in no particular order; a combination will provide the most effective and realistic training. Below we will look at available training and the pros and cons of each. Regardless of the method(s), all have limitations.

- Knowing what your training is missing is as important as knowing what your training provides.
- Spatial Disorientation training will not be effective as a "one and done" solution and requires frequent recurrent training.
- A combination of frequent academic and hands-on training will provide the most effective training program.
- Effective training must be **CURRENT**, **RELEVANT**, and **REALISTIC** and challenge the pilot, regardless of skill level.
- Implementing a safe training program that integrates a degraded visual environment while creating Spatial Disorientation is critical. Disorienting a pilot midflight MUST have effective safeties in place to protect both pilot and crew.

Academic

This document is not intended as the final training product from H-SE 127A but rather a framework on which to build a comprehensive training program. This document and the additional training materials we develop through external partners will be the building block. Academic training is the cheapest and easiest to conduct. This is the place all training must start, but it should not end here.

In-aircraft (no visibility simulation)

All pilots, in theory, have access to an aircraft. The safety pilot has the training pilot close their eyes to demonstrate vestibular illusions during flight. This training is capable of demonstrating how unreliable the vestibular system is during flight but does not train the pilot with all the illusions and stressors of DVE. When the training pilot opens his or her eyes the visual system takes over. Because the training was accomplished without the visual illusions, there is no conflict in the sensory systems.

Simulation

The expansion of simulation has made various models of simulators and flight training devices more readily available to pilots of all levels. Simulators are a tool for training basic instrument flight and instrument procedures. Simulation offers visual illusion training but even Level D simulators lack the 20 seconds of sustained motion required for vestibular illusions. Simulation will be most effective using equipment that is set up exactly as the pilot's aircraft.

In-aircraft (with visibility simulation system (VSS))

VSS is an emerging technology in Spatial Disorientation training that allows visibility simulating in-aircraft. In-aircraft training with a VSS puts pilots in their aircraft, airspace, and, if done correctly, provides for simulated flight activity, putting the pilot in the most realistic environment for training. Through visibility simulation the pilot can enter simulated DVE conditions that expose them to the potential for visual illusions. Through the natural forces of flight, the vestibular system is stimulated exactly as expected during actual low visibility flight conditions.

*Both in-aircraft with VSS and simulation should consider utilizing techniques from H-SE 123 Simulations for Safe Decision-Making.

Training Scenarios

In-aircraft with VSS and simulation training can be broken down into four key areas.

- Decision-Making Before the Flight Training

  Pilots will be challenged with the decision to take off given all available information. Pilots should be given a flight that matches their standard flight profile including weather, illumination, and other information typically expected for pre-flight planning.

- Decision-Making During Flight

  Once in-flight, pilot decision-making can be trained and evaluated on how conditions change and the response to the changing conditions. This training should include Recognition of Spatial Disorientation and Conditions Conducive to Spatial Disorientation discussed below, but the focus is the pilot’s aeronautical decision-making with the information.

- Recognition of Spatial Disorientation and Conditions Conducive to SPATIAL DISORIENTATION

  This training, incorporated with Decision-Making During Flight, will focus on physical conditions that the pilot observed, as well as the physiological effects on the body and brain.

- Recovery from Spatial Disorientation

  Not every training scenario will cause the pilot to develop Spatial Disorientation. Training should regularly attempt to induce complete visual and vestibular Spatial Disorientation. A successful recovery is important to build skill and confidence, unsuccessful recovery attempts should not be considered a bad training iteration or a failure. The unsuccessful training events can teach pilots more about Spatial Disorientation than would be possible if the pilot did not become disoriented.

Training Frequency

- Formal academics annually
- Informal academics during safety meetings or other informal gatherings
- Simulation, if available, at least 1-2 times per year
- In-aircraft training with a visibility simulation system (VSS) once per quarter
- Evaluated during flight reviews at least annually and/or bi-annually
- Annual checks to meet FAR 135.293 (7)(ii) and FAR 135.293 (9) should be evaluated in-aircraft

Scenario Based Training

Training should be designed around the primary flight activity of the pilot. Establishing flows that reflect real world events will enhance the decision-making portion of any training event. Time and attention should be given to put the pilot in a realistic scenario. This added realism and creates a higher level of stress that will more accurately reflect the stress and fatigue of an actual flight.

PREFLIGHT PLANNING

As the statistics above indicate, pilots of all experience levels and in all industry sectors are susceptible to Spatial Disorientation.

AVOIDANCE IS THE BEST DEFENSE

There are several tools at a pilot's disposal to ensure the pilot, the crew, and the passengers in the best position for a safe, successful flight. Often, that may be opting to delay or cancel the launch based on conditions present or anticipated during the flight. These decisions can be difficult to make, but when a pilot conducts a thorough preflight analysis, the preponderance of evidence can make that risk management decision straightforward and data-based.

Regardless of whether a pilot is flying for revenue, a rescue operation, combat operations, or a personal/private flight, all pilots must maintain a level of professionalism in their operation, which begins with a thorough preflight plan. Comprehensive preflight planning with focus in a few key areas will give a pilot the best opportunity to avoid encountering conditions where Spatial Disorientation is more likely. Understanding these key variables and adjusting the focus of the preflight planning will give pilots the highest likelihood of completely avoiding Spatial Disorientation. Hence, the Enroute Decision Trigger.

Preflight planning can be broken down into six areas:

- Flight Activity Analysis
- Weather Brief
- Route Planning
- Enroute Decision Trigger
- Risk Analysis
- Crew/Passenger Brief

Flight Analysis

Identifying the primary purpose of the (flight), pilot capability/experience, aircraft capabilities, and acceptable risk versus benefit analysis should help define the acceptable risk level. Understanding the value of conducting the flight will prove useful as the planning phase continues. By defining the value of the flight activity, the pilot will have identified the level of risk they are willing to accept for this flight.

Flight conditions must be considered, including time of day, length of flight, overwater, low contrast or in other degraded visual environments. Each pilot should set "personal minimums" and review them with mentors, instructors or senior pilots.

Understanding the environment and conducting thorough preflight planning is the best way to begin maintaining situational awareness and the ideal time to establish an Enroute Decision Trigger.

Consideration must be given to pressures for flight operation accomplishment. These can be self-induced but may also be organization- or customer-induced. These pressures, real and perceived, can lead to acceptance of risk greater than the flight dictates.

Weather Brief

A comprehensive preflight plan must include a thorough weather brief (whether formal or informal) and an understanding of when conditions that lead to Spatial Disorientation are most likely. It is important to look specifically at the departure and arrival aerodromes as well as the enroute flight path. Detailed weather information may not be available at the departure or arrival airports; instead weather information from the nearest reporting station may be the best source available. When this method is used, extra planning is needed and an understanding of local weather phenomenon is critical to safe flight operations.

A lot of focus is often spent on the departure and destination weather, but changes to forecasted or unknown enroute weather can play a significant role in DVE conditions. Pay particular attention to temperature-dew point spread, areas prone to fog and low clouds (especially in the areas of rising terrain), low contrast flight conditions, illumination, and moon elevation times (for night flights), as well as convective activity in the area, which tends to move quickly and may introduce heavy rain showers and rapidly reduced visibility. Weather planning helps in the development of Enroute Decision Triggers.

There are several open-source weather options available, from basic METAR and TAF services that interface with carry on board devices and cameras being installed in places like Alaska and Colorado.

> *Understanding of the sources and equipment used for weather is essential for successful use. It is critical to understand weather depiction details, including latency prior to using radar through ADS-B or other sources.*

Route Planning

Route selection can be anything from a written, thorough, and defined process mandated by the organization, to a hasty plan that is put together upon flight acceptance.

Much like the weather planning phase, the route selection process should incorporate the Enroute Decision Trigger. Proper route planning allows pilots to familiarize themselves with the area in which they will be operating. This can help identify possible choke points that create elevated risks, unique or complex airspace, or terrain that might result in weather development and hazards.

In the event that the weather or conditions are not as predicted, it is essential know the terrain requirements along the route of flight. Good tools to keep in mind are the Maximum Elevation Figure (MEF) on the VFR sectional, or the Minimum Enroute Altitude (MEA) or Off Route Obstruction Clearance Altitude (OROCA) depicted on the IFR enroute low altitude charts. Several commercial GPS and navigation programs provide this data as an optional display field. An additional tool to include in thorough route planning is bailout airports or landing areas. Knowing these references for each leg of the flight will ensure a pilot can maintain or climb to a safe altitude while addressing the situation.

Enroute Decision Trigger

Much like the Flight Activity Analysis phase, the Enroute Decision Trigger (EDT) should be planned early in the process to prevent other factors to impact the Enroute Decision Trigger. Enroute Decision Triggers should be planned and discussed for every flight – not just the flights in which you anticipate weather to be an issue.

Enroute Decision Triggers can best be defined as a PRE-DETERMINED set of conditions that trigger a decision point in the flight. When a preset Enroute Decision Trigger is reached, the pilot executes a predetermined action that was planned, briefed, and reviewed *at the planning table*. Previous research has been conducted by groups including National EMS Pilots Association (NEMSPA) and NASA AMES, and this training intends to make the Enroute Decision Trigger process part of every flight. Not having your Enroute Decision Trigger planned is like taking off before you have completed a preflight.

With the diversity of helicopter operations, pilot skill and aircraft equipment, this training will not dictate what an individual pilot's Enroute Decision Trigger should be but rather gives examples that can be used based on each individual pilot, aircraft, and flight.

Similar to **CAUTION** or **WARNING** lights applied to aircraft systems, the same can be implemented for weather through the Enroute Decision Trigger process. Add weather Emergency Procedures under the TAB, **PILOT INDUCED EMERGENCY – FIND SAFEST METHOD TO DISCONTINUE FLIGHT.**

Each pilot's Enroute Decision Triggers will be different based on their training, experience, qualifications, proficiency and equipment capability.

Example Enroute Decision Triggers:

- Weather **CAUTION** (example using VFR minimums)
  - If weather drops below 3 SM visibility we will…
  - If ceilings fall below 1,000 feet we will…
- Route **CAUTION**
  - If we divert more than ## miles from our planned route we will…
  - If we lower the collective more than ## times we will…
- Airspeeds **WARNING**
  - If we slow below ## KIAS we will…
  - If decrease airspeed by ## KIAS of our planned airspeed we will…
- Altitude **WARNING**
  - If we descend below ### AGL/MSL we will…
  - If we descend more than ### below our planned altitude we will…

Much like the uniqueness of Enroute Decision Triggers a pilot's action will vary based on their training, experience, qualifications proficiency and equipment capability.

Example Actions When Enroute Decision Trigger is Reached:

- Turn to ***KNOWN*** improving weather conditions (if VMC maintained during standard rate turn)
- Land (if a safe landing can be assured)
- Commit to instruments

Moving the decision-making process to the planning table reduces the likelihood of errors, reduces the impact of flight pressures, and keeps all crewmembers more engaged in flying the aircraft.

By building Enroute Decision Triggers into every flight, the plan will always be in place. This prepares a pilot for known DVE areas, and changes in weather or flight activity.

Risk Analysis

Operation Risk Management or Flight Risk Assessment is an important aspect to decision-making with respect to limiting exposure to conditions conducive to Spatial Disorientation.

The Risk Analysis should be completed after initial planning has been accomplished but will not always be the final step in planning. The Risk Analysis might send the crew back to the planning table to mitigate risk, change the plan, or push the flight "fly another day."

Establishing personal minimums is critical to safe aircraft operation and should be present in every phase of flight planning, flight execution, and even hangar talk.

Crew/Passenger Brief

Many professional organizations rely on an operations staff or dispatch to aid in risk acceptance and go/no-go decision-making. Personal/Private pilots and those without those type resources may have to be a little more creative for a "sanity check." If, after you've conducted your preflight planning, you are still uncertain whether to launch, consider running the question by a fellow pilot, friend, passenger or even telling yourself the plan (out loud). Often just having the conversation aloud (even to yourself) may present factors you hadn't yet considered and make that decision even clearer.

The pilot gathers the entire crew (and passengers) to discuss items pertaining to the upcoming sequence of flights. This might be conducted prior to a start of a shift or prior to leaving the hanger. It sets the "tone" of the flight and offers the pilot an opportunity to brief relevant operational issues, weather concerns, delays, personal issues and the overall conduct of the flight. It also allows for questions from the entire crew and passengers.

Pre-Takeoff Brief

The crew discuss flight leg assignments, weather issues, any mechanical or equipment limitations, departure SIDS, weather, special procedures, and the Enroute Decision Triggers.

RECOGNITION

For pilot to recognize Spatial Disorientation, they must understand SPATIAL DISORIENTATION. Effective academic training includes the physical inputs during flight and anticipated body, and brain, reaction. For a complete understanding of Spatial Disorientation training, training must include DVE-induced Spatial Disorientation that includes both visual and vestibular illusions.

Altitude chambers are an excellent example of the need to expose pilots to the conditions they are attempting to recognize – onsite of hypoxia. Although the current regulations do not require a pilot to participate in altitude chamber runs, many consider it "Highly recommended."

Although every Spatial Disorientation event is different, the most effective training must include the pilot experiencing both visual and vestibular illusions. As discussed previously, due to limitations of simulators and in-aircraft training that does not include visibility simulation system (VSS), this training should be conducted in-aircraft with a VSS.

For VSS training to be most effective it must include:

- **Scenario based training** – Training must replicate the environment, typical flight operation or activity the pilot flies. These scenarios are also more effective in training decision-making. As the scenario develops the pilot will have to decide to continue or to change the plan.
- **Conducted in pilot's aircraft type**– The most effective training will be conducted in the pilot's primary aircraft. There is still value in VSS training, however, if this is not possible.
- **Safety** – Spatial Disorientation training is unlike standard instrument training. A disoriented pilot can depart controlled flight and quickly enter an unrecoverable rate of descent.
- **Development of Spatial Disorientation** – To train the brain to disregard the vestibular illusions and focus on the instruments, the pilot must experience fully-developed Spatial Disorientation multiple times. Just like the ballerina that trains to overcome the dizziness from spins, the pilot's brain can be trained to disregard the vestibular illusions. This is not to say that by making a pilot dizzy the pilot can be trained for Spatial Disorientation (these accidents are most often a more subtle form of SPATIAL DISORIENTATION), but rather a comparison to the ability for the brain to be trained to fight SPATIAL DISORIENTATION.

Declaring an emergency should not be considered a "last resort" in a DVE condition. Getting ATC involved early can take stressors away from pilots as they focus on their next action. AIM 6-122 further discusses declaring emergency.

6-1-2 Emergency Condition- Request Assistance Immediately

a. An emergency can be either a distress or urgency condition as defined in the Pilot/Controller Glossary. Pilots do not hesitate to declare an emergency when they are faced with distress conditions such as fire, mechanical failure, or structural damage. However, some are reluctant to report an urgency condition when they encounter situations which may not be immediately perilous, but are potentially catastrophic. An aircraft is in at least an urgency condition the moment the pilot becomes doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety. This is the time to ask for help, not after the situation has developed into a distress condition.

b. Pilots who become apprehensive for their safety for any reason should request assistance immediately. "Ready and willing help is available in the form of radio, radar, direction finding stations and other aircraft. Delay has caused accidents and cost lives. Safety is not a luxury! Take action!

Example Radio Call – "Helicopter 123 is declaring an Emergency for IIMC"

RECOVERY TECHNIQUES

Recovery from full onset Spatial Disorientation requires extensive training with in-flight illusions. As stated above, the best technique for survival of Spatial Disorientation encounters is to avoid them.

Consideration should be given to the pilot's capabilities, training and instrument proficiency, as well the aircraft equipment during any DVE flight.

Trust Instruments

This simple guidance has been around for years and has proven ineffective, but with proper training the pilot can be more successful in trusting instruments. For pilots to trust their instruments they have to train their brains to disregard the vestibular illusions experienced during DVE induced SPATIAL DISORIENTATION. This is accomplished by simultaneously exposing them to visual and vestibular illusions in training. This exposure will provide their brains with the training it requires to function in "fast brain" and successfully disregard the conflicting illusions and focus on the instruments.

Stabilized Power

This technique is designed for unusual attitude recovery only.

Unusual attitudes in helicopters can lead to large deviations in both torque/power and rotor speed. By fighting these swings, the pilot further destabilizes the aircraft through large changes in power.

This can best be prevented by establishing a set power and maintaining that setting. This limits the power inputs on the aircraft, prevents "chasing" the problem, and help stabilize torque and rotor speed allowing the pilot to focus on the leveling the aircraft.

This technique is focused on recovering the aircraft to stabilized flight first so that a full recovery can be accomplished. The power setting will vary by aircraft; the goal is to establish a setting that will prevent a descent—ideally a setting that will provide a positive rate of climb with the nose on the horizon. Once a power setting for the specific aircraft is identified, this technique can be best accomplished through muscle memory training for the collective position. Through muscle memory, the pilot instinctively moves the collective to this predetermined position. Once power is set, the pilot should maintain control of the collective and not depend on trim or friction. The power setting considerations:

- Power at or above standard climb power
- Consider transient power requirements (A rule of thumb is 20-30% below max power)
- Train to know (muscle memory) the collective position for desired power setting

Once the power is set, the pilot can focus on the recovery of the aircraft. By setting the power and limiting the pilot's scan requirements they can focus on the pitch and roll, limiting the pilot's focus to the attitude indicator. Once stabilized, a standard instrument scan should be established. Once initial recovery is complete, a pilot can expect to continue experiencing illusions. Focus must remain on a trained instrument scan to reduce the likelihood of illusions developing Spatial Disorientation again.

Immediate Action

There are multiple methods that can be used for Immediate Action steps. Two methods will be discussed in this training.

AHTTA – Adopted from US Army training, it can be recalled with the mnemonic "*All Helicopters Turn Toward Alabama*."

- Attitude – Roll wings level, nose on the horizon.
- Heading – Turn only to avoid known obstacles.
- Torque – Power was set using muscle memory above but should be checked during the Immediate Action steps.
- Trim – Confirm aircraft is in trim.
- Airspeed – Check.

PAB – An acronym for another recovery method.

- Power – Set cruise power.
- Attitude – Wings level, nose on the horizon.
- Balance – Aircraft in trim.

Recovery

After initiating the Immediate Action steps, the pilot needs to establish a standard instrument scan. Prioritizing actions is critical to maintaining aircraft control. This list is a specific order of actions to conduct during the recovery phase.

- Aviate – Fly the aircraft, primary consideration should be aircraft control.
- Navigate – During initial recovery it is likely that straight and level is sufficient navigation.
- Communicate – Contact ATC, declare an EMERGENCY and SQUAWK accordingly. ATC is there to help and should be used as a tool. If you have a plan, tell them; if not, request what you need from them.

BRIEFING CHECKLIST (SAMPLE)

SAMPLE PREFLIGHT BRIEFING CHECKLIST

- ☐ **Why Are We Flying?**
- ☐ **Weather**
  - ☐ Departure
  - ☐ Enroute
  - ☐ Destination
- ☐ **Route**
  - ☐ Airspeeds
  - ☐ Altitudes
  - ☐ Key Points of interest for weather or terrain considerations
- ☐ **Greatest Risk for Today**
  - ☐ How that risk is being mitigated
- ☐ **Automation and Technology**
  - ☐ What is to be used
  - ☐ How it will be used
  - ☐ When will it be used
- ☐ **IIMC/UIMC- Specific Responses**
  - ☐ Intended airspeed
  - ☐ Desired pitch or climb rate
  - ☐ Climb altitudes (MEF, MEA, OROCA)
- ☐ **Personal Minimums**
  - ☐ Weather
  - ☐ Airspeed
  - ☐ Altitude
  - ☐ Other personal limits
- ☐ **Enroute Decision Triggers**
  - ☐ Enroute Decision Triggers
    - CAUTION
    - WARNING
  - ☐ Intended Action
    - Turn to KNOWN good weather
    - Land
    - Commit to instruments

Note: Sample checklist provided as a supplement only and is focused on prevention of SD. Always comply with applicable regulations, policies, and procedures.

RESOURCES

Aeromedical Training

- FAA Visual and Vestibular Illusions

Videos

- USHST 56 Seconds to Live
- Brazilian Wedding Flight
- Alaska Department of Public Safety
- Helicopter Flying Erratic Over New York
- The Light was the Moon

Risk Analysis Tools

- FAA Safety Team Flight Risk Assessment Tool (FAAST FRAT)
- USHST H-SE-22A
  - Recommended Practice: Detection and Management of Risk Level Changes
  - Recommended Practice: U.S. Army Aircrew Coordination Training Using Crew Resource Management on All Helicopter Flights
  - Crew Resource Management Briefing Card

Personal Minimums Kneeboard Card

- USHST Kneeboard Card