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# Operational Art of the Accident Investigation Process

**If today I could have a conversation with myself as a newly minted CW3 squadron aviation safety officer (ASO), what would it sound like? What would I tell myself as my young persona looks upon a Class B accident in a division cavalry squadron in 2004? First, I would say: "Do not ever think you will not be a board president or recorder of a major accident investigation as a company-level ASO."**

As personnel availability ebbs and flows, many times you are put in a leadership position above your pay grade and thrust into a job or task that can quickly overwhelm you. What I hope to communicate in this article is a Cliffs Notes version of a simplified, methodical accident investigation process that will hopefully alleviate some of the anxiety associated with this task that has general officer scrutiny. More importantly, I hope it helps you get to the most important answers an ASO can provide to a commander: what happened, why it happened and what to do about it. Without this information, a commander and the unit are introspectively blinded to unacceptable materiel, individual, leadership, standards, training, or support inadequacies threatening life and combat power. Generally, the investigation occurs in four phases, which include organization and preliminary examination, data collection, analysis and deliberations, and completing the field report. For the purposes of this article, we will only discuss the process for Class A and B aviation accidents.

### Phase I – Organization and Preliminary Examination

Although Army Regulation 385-10 requires a board of three, normally a board comprised of a field-grade president, ASO recorder, instructor pilot (IP), maintenance test pilot (MTP) and flight surgeon (FS) is identified and assembled. Obviously, they will be selected from outside of the accident unit. Orders will be typed up and signed by the General Court Martial Convening Authority (GCMCA), which is usually your division commander. The important thing to note concerning the orders is they give the board authorized access to everything. To be more specific, orders are needed to gain access to police reports, civilian medical reports and autopsies, if necessary.

Now that the board is assembled, the recorder must task organize. You will form within the board a human factors (HF) team comprised of the flight surgeon and IP and a materiel factors (MF) team comprised of the MTP and any other subject matter experts associated with a particular airframe or component. As the recorder, it is your responsibility to guide their efforts in data collection and direct them to accomplish their tasks for paragraph writing and completing their assigned 2397 forms. Sometimes you have to be extremely firm and ensure suspense times are met. You are the task master and quality control so, if it is not completed on time or correctly, you will cause yourself extreme pain as you assemble the final report. Additionally, be prepared to conduct morning update briefs to gauge progress, distribute tasks and share insights. This is your time to ensure the board knows what it has to do and/or provide.

It is also important to note that you, as the recorder, should coordinate with the unit point of contact (POC) to begin gathering certain items and data such as aviation life support equipment (ALSE), training files, log books and unit level logistics system – aviation (ULLS-A) computers. Additionally, the POC should ensure the Centralized Aviation Flight Records System (CAFERS) closeouts are conducted and sequestered as well as gather any Class II items required by the board. Class II items could be butcher block paper, dry erase boards, markers and tape.

Lastly, the board must be given a space that can be secured and only allows access to board members.

**Phase II – Data Collection**

To keep it simple, Phase II is pure data collection. The board members will collect everything or copies of everything. Essentially we are talking about collecting every photo, interview, file, record, standard operating procedures (SOP), planning document or piece of equipment as it applies to an aircraft or crewmember, leaving no stone unturned. The board will, as soon as possible, move to the accident site to view the crash. As the recorder, you will document it. An excellent technique is to use a camera with metadata turned on. You will take a picture of the main crash site and all main components separated from the fuselage. From this you can create a kml file and array the site in Google Earth. This can be used to get distance and direction of the main components separated from the main site. This technique will save you two to four days, depending on the size of the debris field. You can also download survey apps onto your phone at a cost, which provide you with angular data and grids overlaid on a photo. This data is crucial for completing the DA Form 2397-5 and 6. If materiel failure is suspected or found, you must get a picture of the component in the area of failure if at all possible. Do not forget to photograph the cockpit. This will show every switch, lever and seat position as it was at the time of the crash and may provide insight into the crew's actions. Photographs are extremely important, so you cannot have too many.

As data is collected and analyzed, each board member must look for anomalies. Anomalies are defined as something that deviates from what is standard, normal or expected. This is where your board members make their money. They must have

an intimate knowledge of tactical and technical doctrine to allow them to find anomalies. You must set up an "anomaly board" where all members of the board write down any and all anomalies they find in their collection efforts. This is extremely crucial since from this anomaly board will come your findings as the board begins deliberations. It is important to remember, as the recorder, you must be the repository and organizer of all this data. The data will be significant in amount and keeping it organized, accessible to every board member and secured daily is important to protect integrity and allow the anomalies to be discovered during analysis.

On the topic of witness interviews, there are some items of note. First and foremost, if you are an ASO of a unit where you are talking to Soldiers who may have witnessed a mishap, do not give them a DA Form 2823 Sworn Statement to fill out. This is a legal document and could be used for collateral purposes. My technique is to use only a white sheet of paper; but you need to make sure you get contact information since their statement may warrant a formal interview.

When conducting interviews, you, as the recorder, will need to separately pre-brief each interviewee on what is about to happen and the promise of confidentiality if desired. Since we are talking about Class A and B aviation mishaps, this is automatically a limited-use investigation where a promise of confidentiality can be offered per AR 385-10. You must understand that all this means is the Army will not disclose the information under the Freedom of Information Act (FOIA) request and will fight in court any other requests from outside agencies or individuals. This does not mean a commander will not see it. A good technique for actual interviews is to initially let the interviewee tell their version of

story as they see it without interruption. Only give them guidance on a starting point, which is usually the initial planning phase of the mission, and get them to provide actual times to the best of their ability for each moment leading to the mishap. Write down your questions and hold them until they complete their version of events. Use open-ended questions and try not to lead the witness into answers. You should record each formal interview and ensure you have all appropriate personal data filled in on a DA Form 2397-4. Once all the interviews are completed, the recorder will summarize each one on the form in third person and without quotes. Once you are complete with the summaries, you should delete the recordings and shred any written statements on your copy paper. You may ask why the DA Form 2397-4 is written in this manner. The reason is this removes this form from any legal ramifications since it is a summary in the recorder's words and not actual words from the interviewee. An important note about the recordings: It is key you delete the recordings, notes and written statements once completed with the summaries. If there is a FOIA request or subpoenas for litigation prior to deleting the recording and written statements, they are then subject to those requests. This helps preserve safety-privileged information and trust in the investigation process.

Finally, it is important to note that data collection can extend into the analysis and deliberations phase if necessary, but by the end of Phase II the board should have an adequate understanding of what happened and the contributing factors.

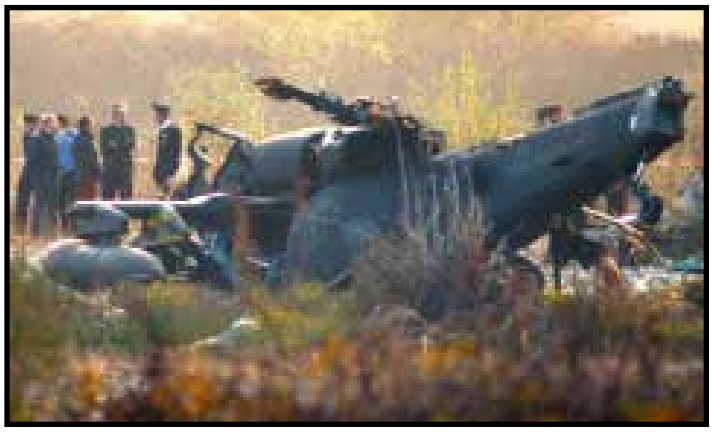
**Phase III – Analysis and Deliberations**

In the analysis phase, the board analyzes and consolidates the anomalies, compares and contrasts them with the appropriate standards, and deduces the actual findings looking at environmental factors, materiel failure and human errors. Human errors are further broken down into support, standards, training, leader and individual. Essentially, the board is getting into why the mishap occurred. DA Pam 385-40 groups findings into four categories: present and contributing, present but not contributing, present and contributing to the severity of injury or damage, and suspected present and contributing. The most common error in an accident investigation report is an improperly written present and contributing (P&C) finding. (P&C) findings are an integral part of the accident reporting process and are imperative in identifying the acts/violations (what happened) and preconditions (why it happened). If the board does not clearly identify why the accident occurred, they cannot formulate properly directed recommendations (what to do about it) addressing the root cause of the accident. In the near future, new versions of AR 385-10 and DA PAM 385-40 will be published that will significantly change the coding system to the Human Factors Analysis and Classification System (HFACS) and adjust the writing structure of accident investigations, making the process more coherent and simple.

When writing out each (P&C) finding, certain components or elements must be included to ensure they are written properly. There are seven elements of a human error P&C finding, six elements of a materiel failure and five elements of an environmental factors P&C finding. You can find these elements explained in detail in DA PAM 385-40, Tables 3-1A, B and C. Note that these elements do not apply to present but not contributing findings. In the end, it will go a long way in helping the board president by vetting each finding against these specific elements.

**Phase IV – Completing the Field Report**

Once your findings are complete, we come to the meat and potatoes of the entire enterprise, which are the recommendations. This is the most important portion of the report and outbrief and it must be relevant, doctrine-based, if possible, and pointed to the correct level of command, person or agency. This not only gives remedy to the situation but, more importantly, addresses prevention of future mishaps, saving lives and assets. Many times it is difficult to determine what person or agency should be tasked with any particular recommendation, especially when it comes to materiel failures and



doctrine issues. Recommendations are directed to the unit level, higher level and Army level. Unit levels encompass company, battalion and brigade. Higher levels are division and corps. Army-level recommendations go to the MACOMs, ASCCs and DRUs. If you have questions as to who or what agency should be tasked at levels above your organization, call the United States Army Combat Readiness Center (CRC) and talk to an aviation investigator. We are here to help.

Finally, it is important to discuss the outbrief. At the conclusion of the investigation, the board president prepares and presents an outbrief to inform the appointing authority of the board's findings and recommendations. It could be up to 60 days or longer before the final report is submitted for distribution through command channels. In most cases, the outbrief is an execution document for the appointing authority to implement corrective actions. Therefore, the brief must be thorough and as clear as possible; however, make it understood that the outbrief is preliminary based on information currently available to the board. Rehearse the brief with the board and anticipate questions that may be asked. Do not read the prepared slides to the appointing authority while briefing. Slides with a significant amount of information should have the main points highlighted. Be prepared to answer fully any question the convening authority asks. When it comes to the findings and recommendations slides, let the convening authority read each finding and acknowledge when complete. There is a template of the format used by the CRC at: https://safety.army.mil/Portals/0/Documents/REPORTINGANDINVESTIGATION/TOOLS/Standard/OUTBRIEF_SLIDES_TEMPLATE_20151026082540.pptx

Lastly, do not hesitate to call the CRC with any questions. The help desk can get you in contact with an investigator who is standing by ready and able to help. You can send us your written products for review and we will provide feedback and techniques on everything you have to help you complete your investigation in the most professional manner possible. Do not forget that all the tools you need are also available at: https://safety.army.mil/REPORTINGINVESTIGATION/Tools.aspx. ■

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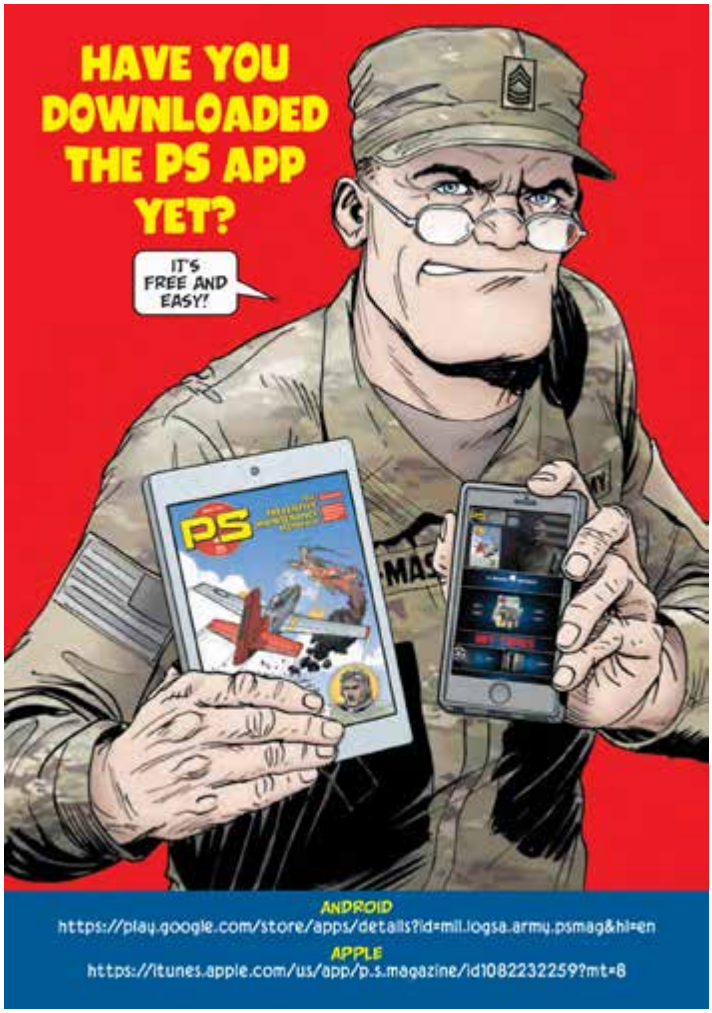

# Flight Crew Leadership Part II:
## *What Exactly is Leadership?* *(Part I found in issue No. 60)*

**What exactly is Leadership? As one might expect when examining such a complex topic, there are numerous definitions proffered to explain leadership. Some definitions are philosophical while others are inspirational or more pragmatic. The Random House Unabridged Dictionary and The American Heritage Dictionary define leadership as providing guidance and direction.[8] The American Psychological Association's dictionary states that leadership involves organizing, directing, coordinating and motivating followers to fulfill given objectives. The dictionary goes on to state that leaders influence followers and followers influence leaders.[9]**

Others have elaborated on the element of influence to explain leadership as," the process by which an individual influences the behavior and attitudes of others." The difference between ineffective and effective leadership can therefore be seen in the way that influence is operationalized.[10] Such a concept of influence has been investigated even further. For example, some define leadership not just as the use of influence, but as the use of "non-coercive influence to direct and coordinate the activities of the members of an organized group toward the accomplishment of group objectives."[11]

Influence is defined as the ability of someone or something to produce a compelling force that alters the behavior or opinions of others.[12] With regard to individuals exerting influence from designated leadership positions, influence stems directly from a person's position of authority, as supported by institutional hierarchy, and can be used to prompt behavior in others that would normally not be desired by such individuals. Such would be the case with the influence a drill sergeant has over a new recruit, or a police officer has when writing a citation for a speeding motorist, or someone wearing four stripes on epaulets has over fellow crewmembers.

In other occasions, people who are not officially in leadership positions but exert influence — a situation known as functional leadership — can influence others through charisma or intellectual arguments. Such would be the case when a politician attempts to convince peers to pursue a certain initiative, or when a cabin crewmember attempts to convince a caterer to pay more attention to detail when restocking an aircraft. In ideal situations, designated leaders are also functional leaders, using influence to affect both the behavior and attitude of others.

The International Civil Aviation Organization (ICAO) also defines leadership in the context of influence, but goes further and explains how the leader should recognize the desires of the crew, set an example and use persuasion to create an understanding of goals that need to be met. ICAO stresses that leadership and followership skills can be learned and states leadership training is essential for all crewmembers, since even junior employees may be called to perform leadership duties at different times.[13]

In the aviation industry, captains must use a combination of their authority, awareness of a situation and soft skills (such as communication) to guide the behavior of crewmembers. Authority is inherent in the captain's position, often indicated by four prominent stripes on epaulets or jacket sleeves. Such a designated position of authority certainly sets the stage for the proper use of influence, but it does not guarantee it.

This is similar to the badge on the police officer's chest. The mere presence of the badge commands respect among many but does not

guarantee everyone will follow the police officer's instructions. In other words, authority is assigned and may or may not result in effective leadership. However, as was previously stated, leadership can exist with or without authority in much the same way authority can exist with or without leadership. When someone on a crew provides leadership that is not in harmony with their level of authority, a potentially dangerous role reversal may occur, resulting in crew behavior being influenced by someone who is not the assigned leader.

**Tragedies of Leadership**

A great number of individuals placed in leadership positions do not realize they are in a position from which they influence others. How can such confusion exist? How can we be placed in new positions in such a way that we do not realize we are leaders? Whenever we occupy a position where we can exert influence, regardless of whether we are given an official leadership title or not, others may view us as being leaders. We may be oblivious to our leadership status and may therefore take no active steps to develop and use leadership skills.

Functional leaders are people who are not officially appointed as leaders, but who are perceived as being leaders by their peers. Ramp agents or customer service representatives are often perceived by other agents as being leaders, although such a perception may only be based on relative differences in seniority or an awareness of different pay grades. Often an employee will become a functional leader because she is the most technically proficient at a given task. A ramp agent may notice a colleague is performing a loading operation incorrectly and may offer corrective advice without realizing that such a use of influence may make her the functional leader in the eyes of her colleague.

Think of the times in our own personal lives when we have coordinated projects, served on committees or trained other employees but were never officially told we were in a leadership position. Parents are the leaders of their families. Professors are the learning leaders of their students. Senior employees are often, by default, leaders of their peers. Groups of college students, ramp agents and cabin crewmembers all have either designated or functional leaders that guide projects or tasks to fruition. It is a tragedy when someone exerts positive influence on others but does not grasp they are perceived as a leader. Often no one has actually told these people directly they are now in a leadership position.

Life provides numerous examples of individuals who are perceived as being leaders by others, yet they do not know they are in a leadership position and never have received any formal leadership training throughout their entire professional life. An example of this tragedy is the average university professor. Such faculty members are placed in a position that requires leading a group of individuals, many of whom are reluctant participants, toward a common objective.

Take a moment to think about the people who you exert influence over. You are a leader to them. Do you act accordingly? The vast majority of people in life who are in such positions of influence have never taken a single leadership class or attempted to develop their leadership skills. The result is often dysfunction or at least tremendous and tragic squandering of potential.

Another tragedy of leadership occurs when people are appointed to formal leadership positions but are not given leadership training. Such individuals are designated leaders but may not be functional leaders. They may continue working as a follower and never rise to the challenges of leadership because they are not aware such a requirement exists! All along, members of the group will turn to the "leader," either implicitly or explicitly, for guidance. When no such guidance is forthcoming from the leader, others may step up and assume a functional leadership role by exerting influence — or perhaps no one will attempt to do so. In either circumstance, the result is often confusion and frustration.

For example, a cabin crewmember acting as the "number one," "lead," "chief" or "purser" in the cabin is placed in a leadership role yet often does not grasp the responsibilities and possibilities of exerting influence in such a position. As one can imagine, the underlying cause of such dysfunction may be that even the leader's leader does not know the subordinate is in a leadership position. Sometimes the process continues unchecked for far too long.

Perhaps the assumption is that someone proficient in a technical task is qualified and capable of leading others in the accomplishment of the same task. Not so! The soft skills required for effective leadership are extremely different from the skill sets required in most technical undertakings. Therefore, individuals promoted into leadership positions may not be provided leadership training and end up being embarrassed, humiliated and even ridiculed by their followers because of the perceived incompetence of being in charge.

Sometimes, an individual's selection for a position of influence is not based on leadership potential or desire, but on seniority. In the airline industry and some corporate flight departments, first officers are offered the opportunity to upgrade to captain based solely on their seniority and not on their potential for being effective crew leaders.

Leadership skills have a direct bearing on the successful accomplishment of the learning outcomes in an academic course, yet many professors do not realize the link between teaching and leadership. Even if they did, most have not received the most basic training in leadership. In similar fashion, this author has frequently witnessed captains of aircraft who, although technically proficient in cockpit operations, were completely ineffective as leaders.

Technically savvy captains who lack leadership skills are truly tragic figures in aviation. They sit in the left seat and wear four stripes; they know their aircraft inside and out; they know how to fly efficiently in the air traffic system; they are masters of company operating procedures; but they don't have any idea how to efficiently and positively influence the behavior and attitudes of their crew. Such captains can be wonderful people who mean well but have been placed in a very delicate leadership role without having been provided the tools required to fulfill their responsibilities.

Fortunately, the industry also has very capable leaders in the left seats. Such captains look after the welfare of their crew and strive to make a synergistic team that shares common objectives. It would be tempting to perform a study which correlates the leadership effectiveness of captains, as perceived by their crew, with the amount of formal leadership training those captains have received during their careers. Such a research project could prove to be a watershed event for flight training providers by highlighting the need for formal captain leadership training.

Since the birth of the crew resource management (CRM) movement decades ago, some aviation companies have gone to great lengths to teach captains basic leadership skills and customized applications. Other flight departments are still in great need of such programs. The sad reality is many operators expect their captains to magically pick up the skills required of leadership through trial and error. Such an approach is akin to asking a captain to learn leadership skills by practicing such skills.

**End Notes**

[8]Leadership. (2008). The American heritage dictionary of the English language, Fourth Edition. Retrieved September 17, 2008, from Dictionary.com website: http://dictionary.reference.com/browse/leadership

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[10]Hines, W. E. (1998). Teams and technology: Flight crew performance in standard and automated aircraft. Unpublished doctoral dissertation. The University of Texas. Retrieved May 14, 2007, from ProQuest Dissertation Library.

[11]Wagner, J. A., & Hollenbeck, J. R. (2005). Organizational behavior. Securing competitive advantage. Mason, OH: Thomson South-Western, p. G-5.

[12]Influence. (2008). The American heritage dictionary of the English language, Fourth Edition. Retrieved September 17, 2008, from Dictionary.com website: http://dictionary.reference.com/browse/influence

[13]ICAO HF Digest No. 1: Fundamental Human Factors Concepts. ICAO Circular 216-AN/131.

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# Degraded Visual Environment Product Office Update

**To maintain Army aviation's asymmetric advantage over its enemies and mitigate risk, the Degraded Visual Environment (DVE) Product Office is committed to delivering solutions that will provide pilots the capability to fly and maneuver in DVE.**

The Army aviation community defines DVE as an environment of reduced visibility, wherein situational awareness of the aircrew or control of the aircraft can be completely lost or cannot be maintained as comprehensively as they are during flight operations within clear or undiminished visibility. DVE conditions are further categorized into 11 different types: smoke, smog, clouds, rain, fog, snow, whiteout, night, flat light, sand and brownout. Brownout, a condition often encountered during an approach for landing or a departure from an unimproved and dusty surface, is created by the helicopter's own rotor wash interacting with loose dirt and debris, eliminating visual cues and significantly inhibiting the aircrew's ability to determine the accurate position, attitude and motion of the aircraft relative to the earth's surface. Of all the DVE types, brownout poses the most familiar and immediate threat to Soldiers operating abroad, especially within the U.S. Central Command area of responsibility.

## DVE Impacts on Army Aviation

To maintain an asymmetric advantage over our enemies and mitigate risk, Army aviation must develop the ability to fly and maneuver in DVE. Along with threat weapons systems, aircrews must also negotiate a variety of obstacles and hazards while operating in DVE. Although our warfighters have established combat-proven tactics, techniques and procedures to mitigate the risks associated with DVE, a significant threat remains to our personnel and our ability to project combat power.

## An Incremental Path

Focused on minimizing the DVE threat while maximizing capability for combatant commanders, the U.S. Congress identified DVE as an item of interest and has remained steadfast in its support of the Army with continued investment toward solving this complex problem. Working in concert with a Combatant Command (COCOM), the Training and Doctrine Command (TRADOC) Capability Manager for Aviation Brigades (TCM-AB), and key stakeholders across the Department of Defense (DoD), the DVE product office is postured to provide Army aviation with solutions to enhance operational overmatch in DVE through the following two lines of effort.

In the near term, the first line of effort focuses on a directed requirement (DR) approved by the deputy chief of staff, G-8 on May 25, 2017. The DR is intended to leverage a COCOM DVE materiel solution for integration and fielding on 15 HH-60M medical evacuation (MEDEVAC) Black Hawk helicopters by 2020 in the CENTCOM area of operation. Implementation of the DR addresses an immediate gap in DVE brownout capability as

well as critical needs identified by the MEDEVAC community. The COCOM DVE materiel solution currently consists of two sensors: an infrared camera and a laser imaging detection and ranging (LiDAR) system. Outputs from both sensors will be fused using a synthetic vision avionics backbone (SVAB) and presented to the aircrew via a panel-mounted, federated display as an aid to situational awareness.

The second line of effort is focused on incrementally introducing enduring capability improvements providing an overmatch operational capability and tactical advantage over the enemy. TCM-AB has recently published an incremental capabilities development document (CDD) for the DVE Program of Record (POR) which has been established in parallel to the DR. The DVE POR will conduct a disposition analysis to determine the feasibility of fulfilling an Army Requirements and Oversight Council (AROC)-validated CDD with the COCOM DVE materiel solution, and if required, make necessary adjustments to yield an efficient and informed path forward. The POR for Increment I, targeting CH-47F Chinook and HH-60M and UH-60M Black Hawk helicopters, implements a schedule that accounts for system software modifications, sensor and fusion configuration, system capability refinement, airframe integration engineering, enduring logistical support, developmental test and operational test requirements. Initial operational capability (IOC) is expected by the early to mid-2020s.

**Future Outlook**

Future increments of the POR will expand focus from brownout to other types of DVE such as visible moisture and man-made obscurants. The ultimate goal for a DVE materiel solution is to synchronize advanced flight controls, symbology/cueing and sensor fusion into a capability that provides not just an aid to situational awareness, but a fully qualified pilotage system that exponentially increases multi-ship combat capability and enables aircrews to safely operate with precision and confidence, regardless of weather conditions in multiple environments. This will enable our ability to take advantage of less-than-optimal environmental conditions and present the enemy with multiple dilemmas when least expected. In the future, an ability to operate in DVE will promote our ability to maneuver from a position of advantage and attack the enemy from several directions at the time and place of our choosing. ■

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# Mishap Review - CH-47D Degraded Visual Environment

**While conducting general support resupply, equipment and passenger transport at 40 knots and 100 feet above ground level (AGL), the aircrew experienced DVE due to blowing dust and executed the inadvertent instrument meteorological condition (IIMC) procedure, during which aircraft control was lost. The aircraft struck the ground inverted and a post-crash fire ensued. All crewmembers and passengers died.**

**History of Flight.**

The mission was to conduct general support resupply. The two CH-47D aircraft had been scheduled to conduct the resupply of multiple forward operating bases located over 100 miles from the base. The aircrews began their duty day at 0500 when they arrived at the task force operations to receive the go/no-go briefing for the mission. The crews were briefed and completed the risk assessment. A re-brief was required due to one-mile visibility en route due to blowing dust. The crew noted they would depart 30 minutes early to start the mission and the one-mile visibility would be on the portion when they were en route back to the staging base. The crews departed at 0735 and conducted the resupply to six different locations. When the flight departed the last resupply location, visibility began to decrease due to the expected blowing dust. The crew in Chalk 1 decided to divert the route to stay in areas where the visibility was better. They managed to continue with visibility increasing to three miles, but then it decreased. As the aircraft approached 40 knots indicated airspeed (KIAS) and 100 AGL, Chalk 1 called IIMC and stated their turn to heading. Chalk 2 executed the IIMC turn to its heading and began a climb. During Chalk 2's climb to altitude, the crew heard transmissions by Chalk 1 indicating they were having problems gaining control of the aircraft based on the PC of Chalk 1's directives over radio. No further communication could be gained with Chalk 1. Chalk 1 crashed inverted, with the fuel cells rupturing and starting a fire.

**Crewmember Experience.**

The pilot in command (PC) had 721 total hours and 579 hours in series, while the pilot had 297 total hours with 180 hours in series.

**Commentary.**

DVE continues to be a factor in aviation accidents. As crews go through their mission planning and risk assessment, they must give particular attention to en route weather. Many times destination weather is at or above the minimums; yet when crews review the en route weather, certain locations can be below the minimums provided by regulation or unit standard operating procedure. Aviation unit standardization programs should develop and maintain a functional training program for instrument flight and for IIMC formation breakup. As Army aviators, we know there is no substitute for realistic training — more so when it involves multi-ship operations. This realistic planned training reinforces the skills and techniques necessary for new aviators to gain proficiency in instruments and in executing IIMC breakups while reinforcing and maintaining proficiency for seasoned aviators. ■

# Lessons from History

**Present and Contributing: Human Error - Standards, Training, and Leader Failure (CH-47 Ground Crew)**

While conducting external load training using a CH-47D and a stripped-down Navy aircraft fuselage as the load, the ground crew members failed to identify a hazardous situation. The ground crew members hooking the training load to the CH-47D's external load hooks connected the load slings to the aircraft and then released two of the four load stabilizing (cargo) straps from the load. Due to miscommunication, the crew released the sling load and repositioned the aircraft to the right of the load. With two of the four stabilizing straps released, the aircraft's rotor wash caused the load to become unstable and roll. The ground crew hook up Soldier positioned on top of the load fell to the ground and the load rolled over him, causing fatal injuries.

**Present and Contributing: Human Error - Individual Failure (UH-60)**

While conducting day ground taxi operations following a passenger drop-off, the PC not on the controls failed to scan. As the PI maneuvered the aircraft near a stationary aircraft, the PC did not assist in clearing the aircraft. This is in contravention to Training Circular 1-237, Task 1034, Perform Ground Taxi. The maneuvering aircraft's main rotor system contacted the tail rotor of a stationary aircraft located to their front, causing significant damage to both aircraft. There were no injuries.

**Present but Not Contributing: (TH-67)**

During the investigation, several discrepancies in maintenance practices were found. On two separate occasions, following swash plate friction adjustments, required re-checks were not completed in the specified 10- to 25-hour window. Also, two power assurance checks were not performed and recorded turbine outlet temperatures were above those specified in the power check chart. ■

# Class A - C Mishap Tables

| | Manned Aircraft Class A – C Mishap Table | | | | | | | | | as of 21 Feb 18 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Month | FY 17 | | | | | FY 18 | | | |
| | | Class A Mishaps | Class B Mishaps | Class C Mishaps | Fatalities | | Class A Mishaps | Class B Mishaps | Class C Mishaps | Fatalities |
| 1st Qtr | October | 0 | 0 | 7 | 0 | | 1 | 2 | 6 | 0 |
| | November | 1 | 0 | 4 | 0 | | 0 | 1 | 3 | 0 |
| | December | 1 | 0 | 2 | 2 | | 1 | 0 | 6 | 0 |
| 2nd Qtr | January | 1 | 0 | 2 | 0 | | 1 | 1 | 1 | 2 |
| | February | 0 | 1 | 3 | 0 | | 0 | 0 | 1 | 0 |
| | March | 0 | 1 | 5 | 0 | | | | | |
| 3rd Qtr | April | 1 | 0 | 6 | 1 | | | | | |
| | May | 1 | 0 | 7 | 0 | | | | | |
| | June | 0 | 3 | 4 | 0 | | | | | |
| 4th Qtr | July | 0 | 1 | 7 | 0 | | | | | |
| | August | 3 | 3 | 4 | 6 | | | | | |
| | September | 1 | 1 | 6 | 1 | | | | | |
| | Total for Year | 9 | 10 | 57 | 10 | Year to Date | 3 | 4 | 17 | 2 |
| | Class A Flight Accident rate per 100,000 Flight Hours | | | | | | | | | |
| | 5 Yr Avg: 1.14 | | 3 Yr Avg: 1.09 | | | FY 17: 0.99 | | | Current FY: 1.03 | |

| UAS Class A – C Mishap Table | | | | | | | | | as of 21 Feb 18 |
|---|---|---|---|---|---|---|---|---|---|
| | FY 17 | | | | | FY 18 | | | |
| | Class A Mishaps | Class B Mishaps | Class C Mishaps | Total | | Class A Mishaps | Class B Mishaps | Class C Mishaps | Total |
| MQ-1 | 10 | 2 | 4 | 16 | W/GE | 2 | 0 | 1 | 3 |
| MQ-5 | 5 | 0 | 1 | 6 | Hunter | 0 | 0 | 0 | 0 |
| RQ-7 | 0 | 15 | 37 | 52 | Shadow | 0 | 1 | 9 | 10 |
| RQ-11 | 0 | 0 | 1 | 1 | Raven | 0 | 0 | 0 | 0 |
| RQ-20 | 0 | 0 | 0 | 0 | Puma | 0 | 0 | 0 | 0 |
| SUAV | 0 | 0 | 0 | 0 | SUAV | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| UAS | 15 | 17 | 43 | 75 | UAS | 2 | 1 | 10 | 13 |
| Aerostat | 6 | 0 | 1 | 7 | Aerostat | 2 | 0 | 0 | 2 |
| Total for Year | 21 | 17 | 44 | 82 | Year to Date | 4 | 1 | 10 | 15 |

# Winter Weather Characteristics

**During winter, precipitation occurs in several forms. Depending on where you live, you can expect to see rain, freezing rain, sleet or snow. With these different types of precipitation, you can expect to also see diverse types of icing. *Figure 1* shows a profile graphic of environmental conditions for different types of precipitation.**

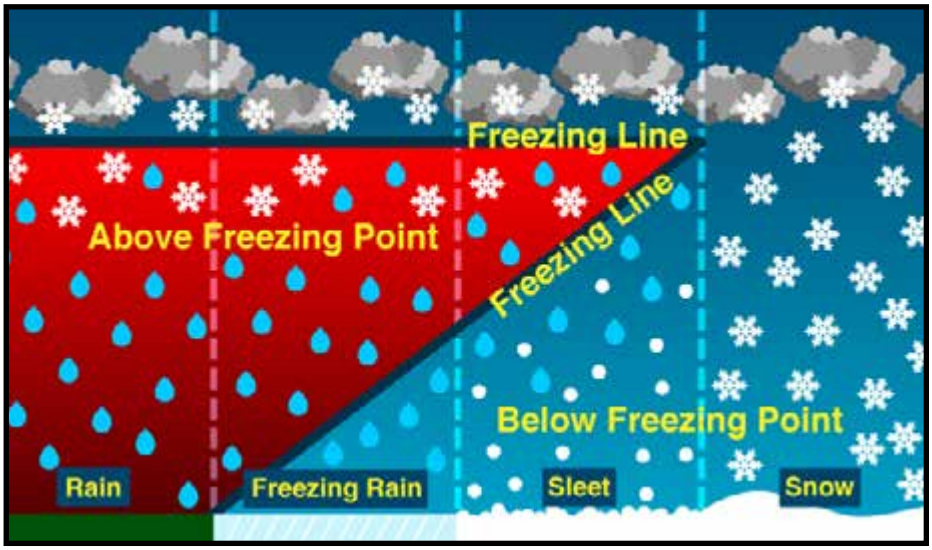


*Figure 1. Profile view of environmental conditions for different types of precipitation.*

## Precipitation

All precipitation starts off as ice crystals in the clouds. As the ice crystals fall through layers in the atmosphere, whether the layer is warm or cold will determine if it will be rain, snow, freezing rain or sleet. Rain in the winter is just like rain in any other season. Ice crystals will fall through a warm layer in the atmosphere and melt before hitting the earth's surface as rain. When snow falls, it will pass through a cold layer in the atmosphere and, with temperatures at the surface freezing, remain as snow. Freezing rain is when ice crystals fall through a warm layer before hitting the surface as rain; but with the surface already at freezing temperature, it freezes on contact. Lastly, sleet is the ice crystals falling through a warm, shallow layer and refreezing before hitting the surface as ice pellets. The big difference between freezing rain and sleet is that freezing rain freezes on contact at the surface while sleet is already frozen when it hits the surface. ***Figure 2*** shows examples of freezing rain and sleet.

## Icing

Icing can cause adverse effects to the lift, drag, weight and thrust on an aircraft, depending on what type of icing and intensity. There are three different types of icing that can occur: rime, clear and mixed icing. Most icing tends to happen in the temperature range of 0 C and minus 20 C. Rime icing is small super-cooled droplets that freeze on contact and have a milky white or opaque color due to trapped air. Clear icing has a clear, smooth or glaze-like appearance; this type of icing is considered the most dangerous. It forms when larger super-cooled droplets hit the aircraft and freeze gradually. Mixed icing has both rime and clear icing characteristics. It appears white, rough and irregular in shape. ***Figure 3*** on page 6 shows examples of the three types of icing that can occur.

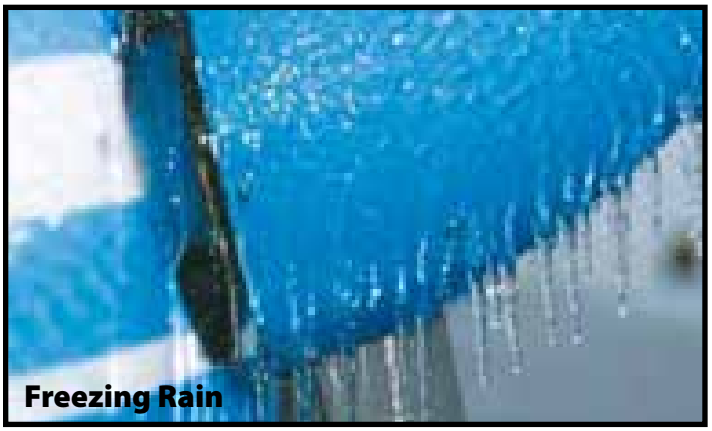

*Figure 2. Freezing rain and sleet examples.*

*Figure 3. Rime, Clear and mixed Icing on aircraft*

**Clear Free**

Icing intensity can be put into four categories: trace, light, moderate and severe. A trace of icing has no significant accumulation and usually is not hazardous. Light icing is significant accumulations when the aircraft is exposed over a prolonged amount of time, usually over an hour. If de-icing equipment is used during light icing, it can prevent accumulation. Moderate icing is when significant accumulations occur during short flights. If no de-icing equipment is used, moderate icing can become hazardous. Severe icing is rapid and dangerous accumulations on an aircraft, and de-icing equipment fails to reduce the accumulation.

During the winter, precipitation and icing can cause adverse effects on aircraft. Knowing what to expect can minimize the hazards of winter flight by allowing crews to make better pre-flight mission risk decisions based on the forecasted weather. ■

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# Flightfax Hot Topics

**JAGIC ATP revision:** Airspace Control Proponent Office (ACPO) continues the revision of ATP 3-91.1. ACPO estimates completion of the ATP revision will occur in 4th quarter FY18; it will include both a traditional paper and a digital Living Doctrine.

**JAGIC Training Circular:** ACPO continues the development of TC 3-91.1. ACPO estimates completion of the TC will happen in 4th quarter FY18.

**Echelons Above Brigade Airspace Course POI development:** ACPO is working with Army Joint Support Team to further develop the individual critical task list for the EAB Airspace Course. ACPO and Training Development hosted a teleconference with AJST 19 Jan 18.

**Airspace Control Portfolio review GOSC:** The next Airspace Control portfolio review is tentatively scheduled for 18 May 18.

**TCM-EAB Tactical Corps WG:** ACPO is supporting the TCM-EAB WG that is assessing proposed capabilities of USAF element at a tactical Corps headquarters.

**JAGIC Deep fight lessons worth sharing:** CALL posted an AAR from a former division fire support officer/JAGIC chief for 25th ID following its successful experiences from Warfighter 17-04 in a 45-minute video. The video is a .zip file, which will require downloading. The link is on the Airspace Control page on milBook, or use the following to access the AAR: https://call2.army.mil/toc.aspx?document=17574&file=true

For questions, comments or concerns, contact ACPO via the Airspace Control page on milBook (https://www.milsuite.mil/book/community/spaces/airspace-control). Be sure to follow the page to stay informed on products, discussions and updates regarding all things relating to airspace control and airspace management.

# Blast From The Past: Helicopter Icing

*Articles from the archives of past **Flightfax** issues*

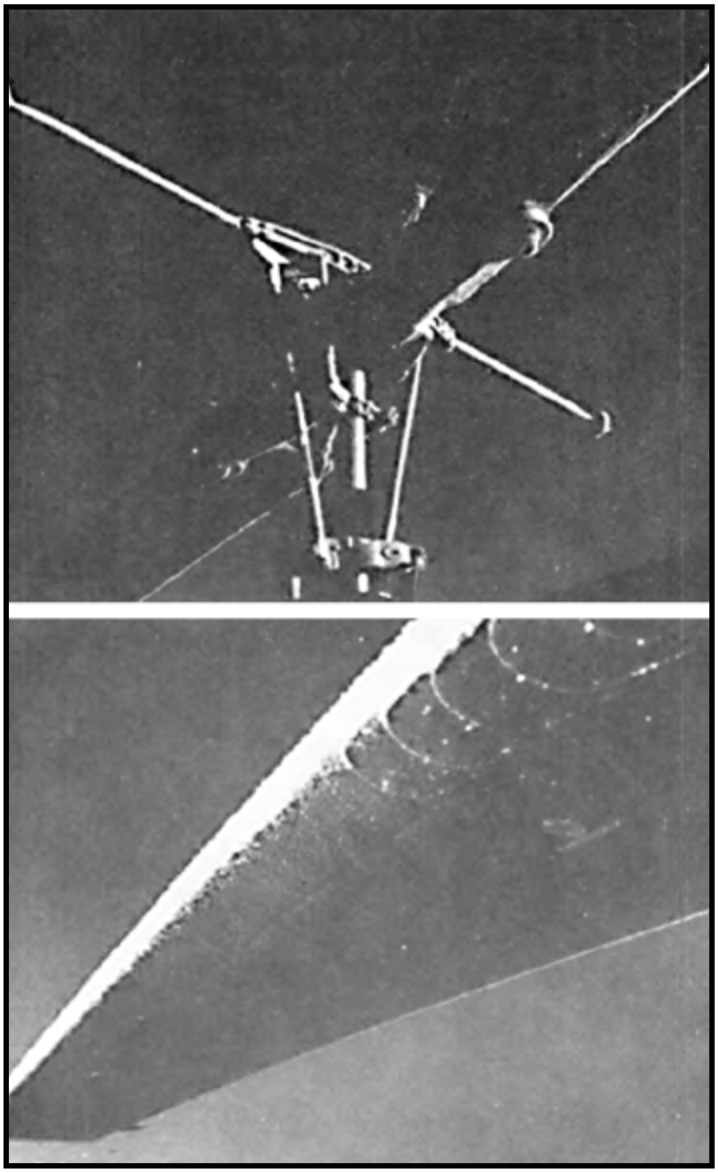
**VOL 7, NO. 3, 18 October 1979**

**Traditionally, in-flight icing has been given only passing consideration as a limiting factor in helicopter operations. The underlying rationale for this philosophy was that icing is primarily a problem resulting from flight in instrument meteorological conditions (IMC). Since most helicopters were not capable of instrument flight, there was little justification for expending time and resources on this aspect of rotary wing flight.**

Contemporary helicopters have deviated from the traditional role of operating only in visual meteorological conditions (VMC) and routinely perform under instrument flight rules. It is this expansion of the helicopter's operating envelope that compels a more thorough understanding of the hazards associated with in-flight icing.

Typically, we have characterized icing problems by their effect on fixed wing performance, i.e., lift, drag, weight and thrust. It is readily accepted that in-flight icing reduces thrust and lift and increases drag and weight, all to the detriment of an airplane's performance.

Rotary wing aircraft also suffer from these effects and, in addition, are susceptible to various complications that are not common to fixed wing aircraft.



### Deterioration of Autorotational Qualities

The adverse effect of main rotor icing on autorotational performance went unnoticed until artificial and natural icing tests were conducted by the U.S. Army in 1974. A major finding of this research was that moderate ice accumulation (approximately one-half inch) on inboard portions of the UH-lH rotor blade, and similar aircraft, was sufficient to preclude a safe autorotation in the event of an engine failure.

This abnormality results from ice accumulation in greater amounts near the inner portions of the rotor disc, which directly affects the blade's efficiency with respect to upward airflows during autorotation. The reported result is that, with approximately one-half inch of ice on the main rotor blades' inner portion, minimum (safe) rotor rpm cannot be maintained during autorotation.

Helicopter pilots are cautioned not to judge or estimate main rotor blade ice accumulation by observed buildup on the windshield or other parts of the aircraft, since icing occurs at an accelerated rate on the rotor blade as compared to accumulation on the fuselage. A more reliable method fox operators of UH-1 aircraft is to estimate ice buildup on the main rotor blades by monitoring power required (torque indications). Researchers indicate that blade icing of one-half inch or greater will be accompanied by a 5-6 psi torque increase over the before or "no ice" power requirement.

This phenomenon does not appear to be unique to the UH-1 and deserves the attention and consideration of all helicopter operators.

**Ice Shedding**

Many helicopter pilots are inclined to disregard the potential hazards of main rotor blade icing owing to the in-flight "shedding" of ice. In-flight shedding can and does occur; unfortunately, it is as likely to create a problem as it is to relieve one.

Symmetrical (affecting all rotor blades simultaneously in the same way) shedding in flight can be beneficial by restoring the rotor blades to a more efficient or clean configuration and by reducing the weight of the aircraft. Asymmetrical shedding (affecting less than all of the main rotor blades), however, can create extremely severe vibrations, depending on the amount of ice discharged, rotor system and other factors.

The severity of vibrations resulting from asymmetrical shedding axe generally a function of the unbalanced weight of the rotor system and, therefore, may be expected to be greater for semirigid (2-bladed) systems and 3-bladed fully articulated systems than those rotor systems employing four, five, or more main rotor blades.

In short, the severity of vibrations resulting from asymmetrical main rotor shedding can be extremely hazardous and operators can expect the vibration levels caused by asymmetrical shedding to decrease with an increase in the number of main rotor blades (for a constant rotor mass) since the imbalance represents a smaller percentage of the rotor mass. Conversely, vibration levels may be expected to be greater when asymmetrical shedding occurs on 2- and 3-bladed systems.

Ice shedding from the main or tail rotor can also produce problems apart from an unbalanced rotor system. Though documentation is less than authoritative, researchers have experienced and expressed a concern for structural or foreign object damage (FOD) to the helicopter's fuselage, rotors or engines resulting from rotor blade shedding. This particular hazard appears to be more threatening to large multi-engine aircraft (over 12,500 pounds) and especially tandem rotor systems.

Asymmetrical shedding can be minimized By avoiding static temperatures lower than - 5° C. Research indicates that by operating in environments of - 5° C or warmer, shedding will .generally occur symmetrically. Tests of UH-1 aircraft suggest that by rapidly varying main rotor speed or entering autorotation, symmetrical shedding may be induced when static temperatures are - 5° C or warmer. Collective and cyclic inputs were generally ineffective in producing symmetrical shedding and may result in asymmetrical shedding. At temperatures below - 5° C, it is not possible for the pilot to induce shedding.

**Visibility**

Most helicopters are not equipped with windshield anti-icing systems and, therefore, a complete or substantial loss of forward visibility will normally occur following prolonged flight in icing conditions. Normal defogging systems are not capable of preventing this windshield buildup; however, visibility usually remains clear through the side windows even in moderate icing.

**Power And Control Limitations**

Light helicopters such as the OH-6 and the OH-58 are "ultrasensitive" to in-flight icing. The limited power available and smaller control surface make this type of aircraft extremely susceptible to icing. Flight tests in icing conditions indicate that light helicopters experience a rapid degradation in aerodynamic characteristics and handling qualities with a corresponding increase in vibration levels. These limitations are vividly illustrated by icing flight tests with the OH-58A where five test flights were conducted. One flight in the cloud was as short as 1 minute and the longest was only 7 minutes.

**Meteorological Conditions Conducive To Icing**

Aviation weather education has oriented pilots to think of aircraft icing as a function of the following two atmospheric conditions that must prevail simultaneously:

1. Free air temperature at or below freezing (0° C), and
2. Supercooled visible liquid moisture or high humidity.

Though this explanation provides some insight into aircraft ice formation, it presents only a meager perspective of the icing environment for operators of rotary wing aircraft. The inherent limitations of rotary wing aircraft (service ceiling range, endurance, speed and power availability) and the previously discussed icing hazards require a more comprehensive understanding of in-flight icing conditions and their relationship to helicopter operations.

Research studies indicate that in flight encounters with icing conditions occur most frequently in the vicinity of frontal zones. In addition to the threat of icing in frontal clouds, frontal systems also create the necessary conditions for in-flight icing "outside of clouds."

Warm front icing may occur both below and above the frontal surface. ***Figure 1*** illustrates how freezing rain or drizzle can be produced by precipitation falling through the front into subfreezing cold air below. As noted in ***figure 1*** this particular form of icing is most often found when the temperature above the frontal inversion is greater than 0° C and the temperature below is less than 0° C. Where temperatures above the frontal surface are subzero, ice pellets or snow may be noticed below the front and are normally not of concern to helicopter operators.

Icing in the clouds above the warm front's surface is characteristic of icing found in stratiform and stratocumulus clouds and usually consists of rime or mixed rime and clear ice.

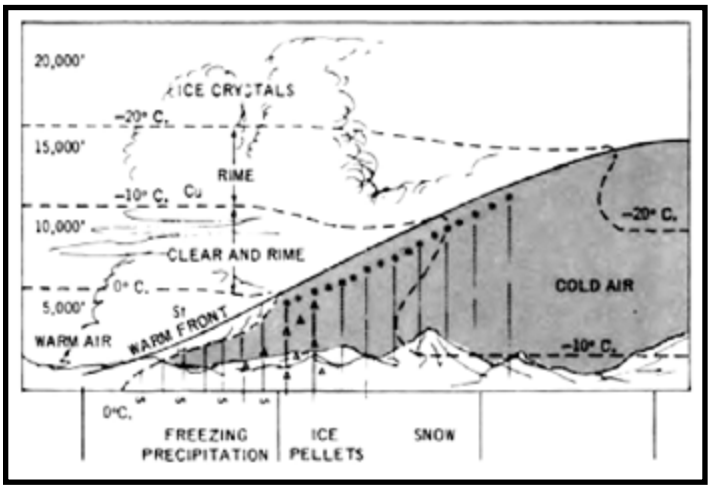



*Figure 1. Warm Front*

Cold front icing normally occurs in an area preceding and following the front (***figure 2***). In this region, aircraft are likely to encounter the most intensive icing in clouds immediately above the frontal zone. Aircraft penetrating a cold front can expect clear icing to be prevalent in the system's clouds at the lower altitudes (0-15,000 feet msl) and a mix of clear and rime ice at higher altitudes.

Freezing rain or drizzle may also be experienced in a "shallow" or " slow moving'' front where the warm air is lifted over the advancing cold front. This condition often produces clouds and precipitation well behind the surface position of the front. Upon falling through a subfreezing cold front, the rain becomes supercooled and freezes on impact with the aircraft.

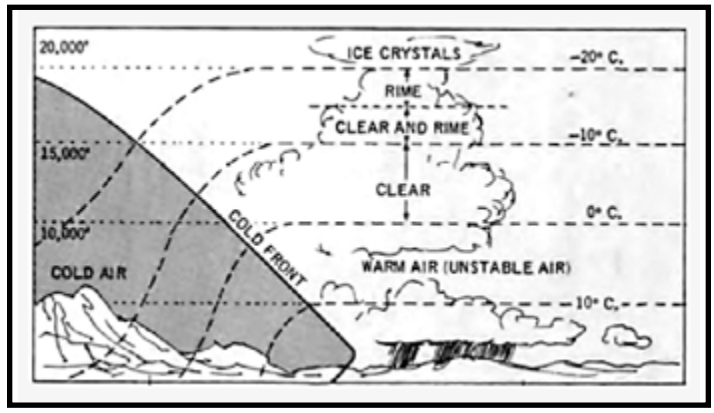



*Figure 2. Cold Front*

Aircraft icing is more probable and severe over mountainous or steep terrain than over low or flat elevations. The presence of a mountain range causes strong upward air currents on its windward side which are capable of supporting larger than average water droplets and thereby compounding the icing hazard. The movement of a frontal system, with its companion turbulence and updrafts across a mountain range, combines the normal frontal lift· with the upslope currents of the mountains to create an extremely hazardous environment for rotary wing aircraft.

The severest icing occurs above the crest and to the windward side of the ridges. This zone usually extends 4,000- 5,000 feet above the mountain and can extend much higher when cumuliform clouds have developed. ■

**Adapted from *Aerospace Safety*.**

# Mishap Briefs

## Attack Helicopters

**AH-64**

E Model – During the conduct of a hasty attack training mission the aircraft descended and struck terrain. Two fatalities. (Class A)

D Model - Crew was conducting a post-'500-Hr phase' MTF when the aircraft reportedly initiated an un-commanded right yaw from a 5' hover. Aircraft contacted the ground, sustaining significant damage. (Class B)

## Utility Helicopters

**H-60**

M Model – Aircraft sustained damage to the FLIR upon landing on an upslope in an unimproved area while conducting a dust landing. (Class C)

## Unmanned Aircraft Systems

**RQ-7B**

- After decision point the AV MLG struck a railing at the end of the runway causing it to break off. The AV slid to a stop on the runway causing damage to the payload. (Class C)

- Crew experienced engine failure during flight and initiated the FTS. Recovery chute was deployed and the system was recovered with damage. (Class C)

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