The Reality of Aeronautical Knowledge:

The Analysis of Accident Reports Against What Aircrews are Supposed to Know

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PART I

OVERVIEW

Executive Summary

The intent of this product is to supplement FAA-H-8083-21, the Helicopter Flying Handbook (HFH). The Reality of Aeronautical Knowledge as it pertains to flight operation is simple; the pilot, aircrew, maintainer, operations, support personnel, and passengers all play a part in ensuring safe flight operations. When this is not done as set forth in aeronautical knowledge documentation, and previous training then risk elevates, aircraft are destroyed, and potential exists for people to die. This document will use this perspective to stimulate thought beyond the level in which pilots are currently trained.

In this document, the reader will see the combination of practical knowledge beyond the level presented in the HFH, with both results of detailed study from the Joint Helicopter Safety Analysis Team (JHSAT), of the International Helicopter Safety Team (IHST) analysis, and finally, with language from actual accident report data (all part of the JHSAT dataset) from the archives of the National Safety Transportation Board.

This document was originally initiated as a chapter to a safety text at Embry-Riddle Aeronautical University that remained undeveloped. The original goal of this document was to practically illustrate the cause and effect of adherence (or not) to published aeronautical knowledge for the helicopter pilot. This document utilizes recent research by the JHSAT, and it is applicable at any level and through all other components of the helicopter industry. The organization of discussion on topics is driven by the order of occurrence of accident analysis from the JHSAT. The JHSAT reviewed all U.S. - NTSB categorized accidents for the calendar years 2000, 2001, and 2006 for a total of 523 events. Information in Part II is presented to briefly explain the standard aeronautical knowledge items from a practical perspective by taking the HFH discussion further, then in Part III, adding JHSAT accident analysis information with redacted accident descriptions to proffer a deeper understanding and clear association of cause and effect.

Inclusion of actual NTSB accident reports offer a realistic viewpoint and association to the environment in which we operate the helicopter. These are real events, which happened to real people. All information leading to identification of personal or sensitive information is redacted. The result is a bright spotlight on where pilots and aircrews should focus their attention in regards to safety of flight operations, situational awareness, and prevention of complacency.

Ideally, flight operations at companies large and small, owner-operators, and particularly the CFI, will approach the ‘reality’, which this document intends to impart to their daily activity as helicopter operators.

Chapter 1

Introduction

"The thing is helicopters are different from airplanes. An airplane by it's nature wants to fly, and if not interfered with too strongly by unusual events or incompetent piloting, it will fly. A helicopter does not want to fly. It is maintained in the air by a variety of forces and controls working in opposition to each other. And if there is any disturbance in this delicate balance the helicopter stops flying immediately and disastrously. There is no such thing as a gliding helicopter. That's why being a helicopter pilot is so different from being an airplane pilot, and why in generality airplane pilots are open, clear-eyed, buoyant, extroverts. And helicopter pilots are brooders, introspective anticipators of trouble. They know if something bad has not happened it is about to."

ABC NEWS COMMENTARY
By Harry Reasoner
During the Viet Nam War
16 February 1971

In fact, Harry Reasoner, though a very astute journalist, was misstating a well-known fact. Helicopters do glide. Some better than others, but none-the-less, they glide, and as such are well suited to smoothly landing in many areas that an airplane cannot. Unfortunately, the statistics do not bear that fact as well as they could. This chapter will prepare you to associate the complex knowledge from any level of training with accident analysis, and then illustrate the points further with accident narratives. We will discuss the rotorcraft specific details only. The primary thought of safe helicopter flight is to encourage pilots to conduct operations in a way that will mitigate risks and as such, drive down the danger to a level that will allow effective flight operation. Controlled Flight Into Terrain (CFIT) and/or Loss of Control (LOC) is a shared danger that both fixed and rotary-wing pilots are susceptible to, as an example, but we will discuss rotorcraft particular dangers. Ultimately, the reader will take away from this document an increased awareness of the potential dangers of helicopter flight combined with the multi-tasking required of the pilot, a sense of where attention must lie while in flight. The primary reasons that make some helicopter flights more dangerous are:

- The inherent operational proximity of obstacles to flight and the limited reaction time in the event of an emergency.
- Situational Awareness (SA) of operational area immediate to proximity to moving aircraft parts
- Cockpit workload and its effect on both of the above

In this document, we will endeavor to elaborate on all facets of helicopter aviation. It is important to associate that many operational flight techniques evolved from former military pilots, it is prudent for the civil pilot to understand the background. Conversely, a number of civil technologies and procedures have influenced military operations. It is this sharing of technology, techniques and procedures that has greatly enhanced the rotorcraft industry in the last five decades.

As with any technologically evolutional field, there is also a discovery in efficiency and finding a better way to get the job done. If we study the history of Night Vision Devices (NVDs), then it is easy to understand this point. NVDs were fielded (practically) in the Vietnam era. NVDs were primarily developed as a use for detection in an offensive or defensive posture for the soldier on the ground. Through the late seventies, an evolution occurred that placed NVDs in the helicopter cockpit. Over the last 30+ years, the device has transitioned from large cumbersome and unsafe goggles protruding from the face to barely detectable ounces of weight locked securely off of the front of a helmet and a visual acuity change between 20/200 to 20/40 uncorrected, and they keep improving. NVD use in military helicopters was primarily incorporated for operational battlefield considerations and safety. This technology then found its way into the civil aviation industry and is now in use with the air ambulance helicopters, and airborne law enforcement, and rather than assisting in the detection of enemy forces, it allows for the detection of hazards to flight. This example echoes the growth and enhancement of the civil helicopter industry.

Use of the helicopter in the general aviation, municipal and governmental market as discussed, has been prolific since the mid seventies. Nowhere was this shown better than recovery operations immediately following Hurricane Katrina in 2005. The integration of Civil, Military and Public Aircraft helicopters in that short frame of time is indicative of the versatility of not only the helicopter, but of those who use it, manage it, and maintain it. Since the origin of helicopter flight, the ability to hover and conduct vertical takeoff and landing operations has driven both design and use. Several factors have taken engineers to task in order for the craft to operate well in these environments; Design to lower weight, increase payload, lower mean time between failure (MTBF) factors, and reduce costs of operation, all while retaining effective safety capabilities. Helicopters have seen an evolution in use that has pushed their operations to land on the top of Mount Everest in 2005, or to low flight over ocean waters in the black of night in pursuit of drug running boats from Central and South America. There is no debate that versatility is the absolute strength of the helicopter. Chris Dancy states the industry, as identified by Helicopters Association International (HAI), accepts that there are 55 defined helicopter missions (Seimers, 2012). With this versatility, it is imperative that awareness to safety becomes the forethought.

If one reviews helicopter accident data over the years, it is likely one will see a constant trend. In the U.S. JHSAT analysis, their three year assessment of 523 accident events identify that 16% produced a fatality. It must also be said that over half (51%) of these accidents did not produce an injury. What does this say about our industry? Where do these fatalities come from? What is our weakest link? All of these are valid questions and what is important to understand is that organizations like the IHST, HAI, American Helicopter Society (AHS) International, and several others represent a wider audience to put an industry-wide effort into the deliberate attempt to understand those statistics and improve.

The analysis from the U.S. JHSAT reports together with other sources are used in this document together with the appropriate use of aeronautical knowledge and a 'there I was' association (via NTSB accident narrative). In the JHSAT analysis, four separate categories; Missions, Occurrences, Activities and Flight Phases were reviewed. "Missions" was later referred to as "Industry" in the U.S. JHSAT's

work. The highest percentage of accidents came from the (personal/private) Industry category with 97 out of the 523 total accidents (18.5%). The classification "Activity" in the analysis identifies what an aircraft was doing when the accident occurred and Instructional/Training (Dual) incurred the highest percentage of accidents (14%, or 73 accidents). Next in this classification was Positioning/Return to Base with 69 accidents (13%). These points emphasize what was happening when the accident occurred.

To assist determination of what led to an accident, Accident Occurrences became a grouping. In this case, Loss of Control was identified with 41% of the accidents. Loss of Control can occur at various times during a flight, so it was important to further express a category 'Phases of Flight' with sub-categories such as Landing (108 accidents/ 4 fatal accidents) or Enroute (102 accidents/34 fatal accidents). Another perspective from which to view this information is by the type of FAA operation. In this case, FAR Part 91 operations incurred 70% of the total accidents. This is significant and perhaps would identify further study as to why this is the case. Part 91 operations account for just over half of the rotorcraft flight hours each year (amount of exposure). Part 91 ends up accounting for a higher percentage of accidents compared to amount of exposure partly because the Personal/Private and Instructional/Training industries have such a high percentage of the accidents and both are Part 91 operations.

Other accident statistics lend further perspective to understanding what is happening in this industry and may help to provide perspective. Most of the accidents occurred in good weather during the day and over half of the pilots (246 of 523) totaled over 2,000 flight hours and their PIC time was less than 500 hours (for almost the same population). This should be of interest to anyone as it is significant in the sense that the majority of accidents are not attributed to just low-time pilots or environmental conditions. Instead, the majority of accidents were categorized as errors from "Pilot Judgment & Actions", followed by "Safety Management". This information paints a more detailed picture of where the problem lies in the industry: the need for more training, and incorporation of Safety Management in everyday operations. An interesting fact is that for years, Aeronautical Decision-Making and Risk Analysis have been inclusive to the Helicopter Flying Handbook and other very accessible Federal Aviation Administration (FAA) Advisory Circulars and information for no charge other than access to the Internet.

How can the industry improve then, you might ask. It may be as simple as changing our mindsets to what we do and how we do it. A destroyed helicopter with fatalities is far more expensive than implementing a few procedures to mitigate risk, but failure to implement such procedures seems to continue. For this industry to come together with the efforts of the entities involved (Professional Organizations, Government, Manufacturers, Companies and others) in the analysis since 2005, it speaks volumes to the interest in improving safety, yet still we see accidents. Perhaps this document will find the eye of that population of individuals that could help round the corner and really take safety efforts further and begin to cut substantially into accident rates. This is a document like none other as it takes assumed current levels of knowledge, associates it to real categories of accidents, and then illustrates the mortality of not doing what we do correctly.

How this is going to work

As discussed, the ***intended audience for this document are those who do not yet understand the relationship between their current levels of aeronautical knowledge and the risks to which they purposely expose themselves***. Bottom line: you don't know what you don't know, and this is a 'Hello, McFly' moment. In Figure 1 below, you see the percentage of accidents by Occurrence. The figure puts a face on where our problems exist.

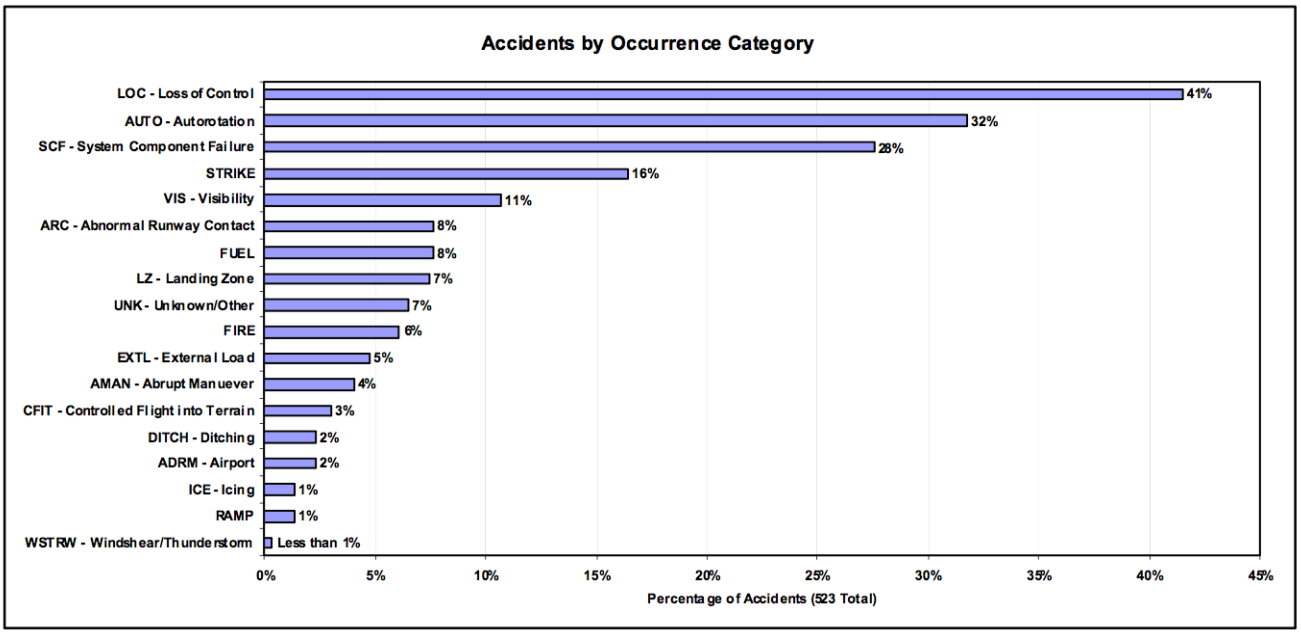

Figure 1. Accidents by Occurrence Category. Adopted from U.S. JHSAT Compendium Volume I Figure 8. The sum of the percentages exceed 100% as each of the 523 accidents analyzed could be assigned to multiple occurrence categories. For example, if the aircraft ran out of fuel, an autorotation ensued, followed by a loss of control, the accident is counted against three separate occurrence categories: Fuel, Autorotation, and Loss of Control

The recommended way of consuming this information is to use the HFH as the base of knowledge, together with the aircraft operators manual (for ease of discussion in this text referred to as the AOM for the variety of labels the document carries; Pilot's Operating Handbook, Rotorcraft Flight Manual, Pilot Flight Manual or any other naming convention), and any (reliable) additional information you were exposed to in a factory course, your initial training, and of course, this document. Further support is available from the IHST Compendium reports, though much of the information contained herein comes from these reports and the associated datasets. The intent is that together, these sources when implemented will prevent unnecessary risks, and encourage risk mitigation through attention before, during and after a flight to potential and real hazards.

In each chapter of Part III Occurrence by Accident Category, you will find the subtopics (seen in Figure 1 above) and their association the most prevalent accidents from the research findings of the IHST/JHSAT and combines them with redacted accident narrative to significantly paint the cause-and-effect picture.

Part III Content Format

1. **Short explanation and introduction.** This is a short relevant discussion, which pertains to the following topic with references to the applicable aeronautical knowledge documents.

2. **Accident Occurrence**. This information is pulled from the IHST's U.S. JHSAT Compendium Report Volume I. The information included is only for the most frequently cited occurrences. Each accident cause is divided into categories (when applicable) that help to define what happened. Occurrences sometimes cross the boundaries between industry segments or reported activity (what the aircraft was doing at that time).

3. **Standard Problem Statement (SPS)**. This information is pulled from the IHST's U.S. JHSAT Compendium Report Volume I and Volume II. When there is an accident that scores in the "Top 20", the example will identify rank in the left column as reflected in the Compendium Volume II. This is a description of what went wrong, defining deficiencies, or the description of a potential reason an action did or did not occur. They represent inappropriate crew responses, latent failures in organizational management and/or regulatory agency oversight. They may also reflect active failures by maintenance personnel or ATC controllers. Equipment failures are also identified as problems. Below is an example of what you will see:

SPS Level 1	SPS Level 2	SPS Level 3
Pilot judgment & actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Ground Duties	Mission/Flight Planning	Inadequate consideration of weather/wind

4. **Intervention Recommendation (IR).** This information is pulled from the IHST's U.S. JHSAT Compendium Report Volume I and Volume II. This is a proposed activity intended to prevent or mitigate a given safety-significant problem associated with the cause of an accident. When there is an accident that scores in the "Top 20", the following example shows how information will be presented from Volume II:

Rank	IR Level 1	IR Level 3
1	Training/Instructional	Autorotation Training Program

5. **Accident Narrative**. This will be redacted narratives from the National Transportation Safety Board's Aviation Accident Database & Synopses website. Each analyzed accident was reviewed to determine the best example of cause and effect. Information is redacted to illustrate the reality of human error when sufficient knowledge is not present to affect accident prevention. In an effort to comprehensively address the frequencies of problem areas, there is an attempt to illustrate various categories with multiple narratives.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID: ***REDACTED***	Aircraft Registration Number: ***REDACTED***
	Occurrence Date: ***REDACTED***	Most Critical Injury: None
	Occurrence Type: Accident	SCF- Mission Equipment
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	
Accident Information Summary- *The information contained in the boxes above is partially redacted. Some boxes will identify the severity of the accident, all will indicate most critical injury and as in the box 'SCF- Mission Equipment', indicate the occurrence category within the IHST analysis* *There will also be a final determination on cause by the NTSB if included in the actual narrative.*		

Notes:

- It is important to synthesize the intent of this analysis. The focus is strictly on the actions by aircrews or operational occupation and not on manufacturing.
- Becoming familiar with the JHSAT Volumes I & II and other IHST documents is suggested for an in depth understanding.
- Instructor level comprehension is best directed at the enhancement of safety management in the entire industry.
- Safety analysis is complex. Accident causes are not simple and often incur multiple factors in resolutions. Vast combinations of conditions, decisions, and actions can result in a unique accident. The approach used by JHSAT was to identify accident contributors that multiple interventions would identify and enable implementation. Consistent human action is unreliable so multiple interventions have the best chance of being actually used and stopping the accident event sequence.

Standard Problem Statements; The following table lists the most frequently cited SPS's across all 523 accidents analyzed by the JHSAT. Extracted portions of this table are shown in detailed discussions in each chapter by category.

Rank	SPS Level 1	SPS Level 3	All	% All
1	Pilot Judgment & Actions	Autorotation – Forced	99	18.9%
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver	92	17.6%
3	Pilot Judgment & Actions	Pilot control/handling deficiencies	80	15.3%
4	Maintenance	Failure to perform proper maintenance procedure	55	10.5%
5	Pilot Judgment & Actions	Autorotation – Practice	54	10.3%
6	Pilot Situational Awareness	Aircraft position and hazards	51	9.8%
7	Pilot Judgment & Actions	Inappropriate Energy/power management	51	9.8%
8	Pilot Judgment & Actions	Pilot's flight profile unsafe – Altitude	47	9.0%
9	Pilot Judgment & Actions	Pilot decision making	45	8.6%
10	Ground Duties	Inadequate consideration of weather/wind	44	8.4%
11	Ground Duties	Performance of Aircraft Preflight procedures inadequate	43	8.2%
12	Pilot Judgment & Actions	Inadequate and untimely CFI action to correct student action	42	8.0%
13	Part/System Failure	Engine Component Failure	40	7.6%
14	Pilot Judgment & Actions	Selection of inappropriate landing site	40	7.6%
15	Safety Management	Management policies/oversight inadequate	36	6.9%
16	Pilot Judgment & Actions	Willful disregard for rules and SOPs	32	6.1%
17	Pilot Judgment & Actions	Improper recognition and response to dynamic rollover	28	5.4%
18	Post-Crash Survival	Post-Crash Fire	28	5.4%
19	Pilot Judgment & Actions	Failed to follow procedures	28	5.4%
20	Pilot Judgment & Actions	Diverted Attention	28	5.4%

Intervention Recommendations; The following table lists the most frequently cited IR's across all 523 accidents analyzed by the JHSAT. Extracted portions of this table are shown in detailed discussions in each chapter by category

Rank	IR Level 1	IR Level 3	All	% All
1	Training/Instructional	Autorotation Training Program	68	13.0%
2	Maintenance	Follow ICA procedures with confirmation of compliance	62	11.9%
3	Training/Instructional	Simulator Training - Advanced Maneuvers	57	10.9%
4	Safety Management	Personal Risk Management Program (IMSAFE)	53	10.1%
5	Training/Instructional	Training emphasis for maintaining awareness of cues critical to safe flight	47	9.0%
6	Maintenance	Better Mx QA oversight to ensure adherence to the ICA/Manual	43	8.2%
7	Safety Management	Mission Specific Risk Management Program	41	7.8%
8	Training/Instructional	Enhanced Aircraft Performance & Limitations Training	37	7.1%
9	Training/Instructional	Emergency Procedures Training	36	6.9%
10	Training/Instructional	CFI judgment and decision making training to follow student more closely	36	6.9%
11	Systems & Equipment	Install proximity detection system	35	6.7%
12	Training/Instructional	In-flight Power/Energy Management Training	34	6.5%
13	Safety Management	Establish/Improve Company Risk Management Program	34	6.5%
14	Data/Information	Install data recording devices	33	6.3%
15	Safety Management	Use Operational Risk Management Program (Preflight)	32	6.1%
16	Safety Management	Use Operational Risk Management Program (In-flight)	30	5.7%
17	Training/Instructional	Simulator Training - Basic Maneuvers	28	5.4%
18	Training/Instructional	Risk assessment/management training	28	5.4%
19	Training/Instructional	Dynamic Rollover Training	28	5.4%
20	Regulatory	Recommend enforcement action - certificate suspension/revocation	28	5.4%

PART II

BEYOND THE

HELICOPTER FLYING HANDBOOK

Extending the Helicopter Flying Handbook Discussion

In this section, an extended discussion of knowledge from the Helicopter Flying Handbook (HFH) (FAA-H- 8083-21A), manufacturer information and other publications, will offer a transition to the information in Section III where cause and effect are expressed in real world terms. Each of the discussion points below relate to points of discussions you will read in Part III. To the right of each topic heading is the location of the information in the Helicopter Flying Handbook or other official document for reference. The order of discussions is not relative to accident frequency.

SITUATIONAL AWARENESS (SA) [HFH 14-13; AC 60-22; AC 61-134]

The combination that exists between reaction time and proximity to obstacles (i.e. ground) in the event of material failure or collision identifies the importance of a complete pilot understanding of the dangers involved (SA requirements) and how this works. Maintain a consideration of SA as a backdrop in the discussion of aeronautical situations (in this section) that defines conditions (related to the complete understanding of aerodynamics) where pilots have perhaps put themselves in danger, or by some kind of failure, been thrust outside the flight envelope. Many documents exist that apply processes to operations that must also include SA.

AERODYNAMICS [HFH Chapter 2-1; FM 3-04.203 Ch 1]

Many people would consider the control of a helicopter in flight significantly more challenging than fixed wing aircraft. Consider the facts. Every limb is doing something different. The mind is trying to coordinate all of these movements into safe, controlled flight. We have not yet even included processing of other tasks that increase mental workload that include obstacle avoidance, communications, navigation, or external manipulations (loads or devices). Competency in all other areas must begin with the understanding the pilot must have of rotary-wing aerodynamics.

The complexities of rotary-wing aerodynamics are different from those of fixed wing aircraft. Wings will be wings, whether in forward flight only, or in rotation. Understanding hazards that self-produced vortices have on flight in a fixed wing aircraft is completely different than how severe they can be in a helicopter. Deadly if the pilot does not have situational awareness. Helicopter aerodynamics is obviously different than that of a fixed wing aircraft, but there is even more consideration required. Helicopters, unlike airplanes, fly in more than one direction. This fact alone changes many things. Most fixed wing aerodynamics considers how performance affects flight in one direction. Understanding how helicopters operate omni-directionally and how aerodynamics change in instances for each direction gives one an idea of the complexities involved.

In the simplest terms, airflow over a fixed wing (V_h) remains somewhat similar in most regimes. Rotor blade airflow is different all the way around the rotor disk in the plane of rotation. Therefore, it is critical for a helicopter pilot to understand the effects of aerodynamics and how they impact performance in every flight regime.

MAST BUMPING [HFH 11-14]

Mast bumping occurs when excessive flapping of the blades occurs in the plane of rotation and allows the components of the rotor hub to contact the mast. This condition occurs primarily in semi-rigid, teetering rotor systems such as during start-up and shut-downs in windy conditions. Improper flight controls in combination with low-g flight can cause severe mast contact and possibly mast separation. Flight control component failure could also contribute to in-flight main rotor separation. Mast bumping is easily preventable through proper SA and loaded-rotor flight conditions within the approved AOM. In-flight rotor separation is a rare event and is a possible outcome of a sequence of events.

SETTLING WITH POWER (SWP)/VORTEX RING STATE (VRS) [HFH 11-9; FM 3-04.203 Ch 1]

Since this event occurs when the helicopter begins to settle in its own rotor produced vortices, it is important to gain an understanding of how to recognize this. As helicopters frequently perform either in a hover or near hover conditions, SWP can occur in these flight conditions. SWP is noticeable to a trained pilot. The aircraft begins shuttering and the rate of descent can rapidly build, sometimes in excess of 1500 FPM. The critical action by the pilot is to fly out of the situation by increasing airspeed, rather than aggravating the settling by attempting to arrest the rate of descent with increased collective.

Prevention of SWP is simple enough in just avoiding those particular areas discussed above. SWP can occur when approximately 20-100% power is applied during a vertical or near vertical descent of at least 300 FPM and at low airspeeds, generally less than 20 knots, as is done in nearly every approach to landing. Several factors influence the situation such as gross weight, rotor RPM, and density altitude (to name a few). Attention to detail is therefore essential. These sometimes are things taken for granted; essentially lack of SA. In the effort to produce, pilots sometimes dismiss basic operational safety as the example below could illustrate. When you are flying within the parameters where the aircraft is susceptible to SWP or VRS, then assess if your altitude and the conditions would allow a recovery.

LOSS OF TAIL ROTOR EFFECTIVENESS (LTE) [HFH 11-17]

Normally associated with hovering or near zero airspeeds, but can occur at slightly higher speeds under certain conditions such as landing in a tail wind. LTE is a characteristic that usually results in an un-commanded rapid yaw rate that is not self-correcting and if not attended to can result in Loss of Control. LTE can occur in a high power state, e.g. speeds below Effective Transitional Lift (ETL). Relative winds of certain directions may initiate a sudden yawing. Winds from certain vectors have been found to cause LTE, but strangely enough, not exactly for the same reasons. Depending on the strength and direction of those winds and more importantly slow airspeeds, the power demand (high), and piloting skills, LTE onset may not be recognized in time and cause some problems. LTE is manifested in three separate regions and do depend on the aircraft design so ensure you consult the aircraft operators manual (AOM= Pilot's Operating Handbook, Rotorcraft Flight Manual, Pilot Flight Manual) for specific details (i.e. clockwise vs. counterclockwise main rotor rotation).

By the 1980s, pilots had identified procedures to deal with the susceptibility of LTE. Some manufacturers added more engine power and redesigned the tail rotor system to reduce the occurrence of LTE significantly. The most important issue concerning LTE prevention is simply knowing the direction and speed of the relative wind, your current airspeed and power conditions. Putting this collection of cues together goes back to excellent Situational Awareness. Consider the following scenarios. Some pilots do not notice winds upon landing. Upon departure, heavy weight due to multiple passengers, they are now even more susceptible to LTE due to heavier weight and accompanying increased power demand. In another case, suppose a pilot is operating in a low-speed / high power flight environment at Out of Ground Effect (OGE) altitudes; LTE is possible and this is the wrong place for that to happen.

RETREATING BLADE STALL (RBS) [HFH pg. 11-11; FM 3-04.203 Ch 1]

Recognize that a stall that begins at or near the tip of a blade because of the high angles of attack required to compensate for dissymmetry of lift and each design of aircraft will experience onset differently. This characteristic is normally associated with high-speed forward flight, though in a search of the FAA accident database & synopses, RBS is commonly included with total rotor stall. RBS specifically limits the high-speed possibilities of the helicopter. The speed of the retreating blade (the blade moving opposite to the direction of flight) decreases as forward speed increases, which is aggravated further from the hub. Normally, causes of RBS are the following:

- High blade loading
- Low rotor RPM
- High Density Altitude
- Steep or Abrupt Turns
- Turbulent Air
- Rotor Blade Tip Design

Prevention of RBS is important as it relates significantly to aircraft control. Since the most prevalent cause is higher airspeeds, the pilot must be aware of the conditions that lead to RBS as they fly faster. Awareness of the limitations of the aircraft you fly against the conditions present (Gross Weight (GW), Density Altitude (DA) and Airspeed) is essential in application of appropriate recovery procedures.

DYNAMIC ROLLOVER (DR) [HFH 11-12; AC 90-87; FM 3-04.203 Ch 1]

Helicopter pilots in general are required to be skillful in operations on both improved and unimproved surfaces. During normal or slope takeoffs and landings on a perfectly level surface or some degree of bank angle or side drift with one skid/wheel on the ground, the bank angle or side drift can place the helicopter in a situation where it is pivoting (rolling) about a skid/wheel, which is still in contact with the ground. When this happens, lateral cyclic control response becomes more sluggish and less effective than for a free hovering helicopter. Consequently, if a roll rate is permitted to develop, a critical bank angle (the angle between the helicopter and the horizon) may be reached where roll cannot be corrected, even with full lateral cyclic. The consequence is that the helicopter will roll over onto its side. As the roll rate increases, the angle at which recovery is still possible is

significantly reduced. The critical rollover angle is also reduced. The critical rollover angle is further reduced under the following conditions:

- One skid/wheel down condition
- Crosswinds
- Lateral center of gravity offset
- Main rotor thrust almost equal to helicopter weight
- Yaw inputs

Another important consideration is manufacturer differences, and in relationship to this event, the directions torque is produced. More specifically, susceptibility to dynamic rollover in a certain direction is affected by whether the helicopter has a clockwise or counterclockwise rotating main rotor and where the tail rotor is positioned. Therefore, the events can manifest themselves on different sides of the aircraft. The tail rotor creates a thrust moment (force at a radius from the center of gravity which is the pivot point during free flight), which is balanced out by the control rigging. When the radius from the main rotor and tail rotor thrusts changes from the aircraft center of gravity to a pivot point at the skid/wheel, the aircraft enters into a dynamic rollover situation unless corrected (precise control is necessary without rushing).

When certain elements of helicopter operations are at or near their most critical condition, such as high gross weight, extreme lateral center of gravity, crosswind, hovering with only one skid/wheel in contact with the surface and with thrust (lift) approximately equal to the weight, very little roll rate is correctable for any given bank angle. A lateral obstruction interfering with the skid/wheel with a slight aircraft lateral motion can initiate a dynamic rollover both on the ground and in a hover. Likewise, be sure that tie-down straps, external battery cable, or fuel hoses are removed before attempting a takeoff. Extreme caution should be taken when taking off or landing on a trailer, elevated structure, etc.

Continuing the Situational Awareness discussion, a pilot must be aware and focused and initiate the proper response to an impending dynamic rollover condition. While still in contact with the ground, reduce collective quickly and smoothly, which allows gravity to provide the correcting control.

SYSTEMS, COMPONENTS AND EQUIPMENT ISSUES [HFH Ch 3, 4]

As with any aircraft, the more extensive a pilot's knowledge of the aircraft capabilities and limitations, the better they are able to more appropriately deal with emergencies. This is particularly important in helicopters as they are potentially less forgiving and require instantaneous SA in order to not lose time in execution of a correct emergency procedure.

MINIMUM RATE OF DESCENT / MAXIMUM GLIDE DISTANCE (MRD / MGD). **[AOM; FM 3-04.203 Ch 1]**

MRD/MGD in helicopters are normally associated with autorotational flight profiles. Certain aircraft will recommend specific airspeeds and rotor RPMs to achieve these two flight profiles. Generally, this flight profile is in a zero or near zero blade pitch condition. The intent in MRD is to slow the descent and utilizes the middle of the power curve and maximizes kinetic (rotor RPM) and potential (altitude) energies to give the pilot additional seconds to identify the potentially safest landing site. Some times this is useful at medium flight altitudes in areas with limited safe landing areas (forests, hilly terrain). In these conditions pilots may need to circle in descent in order to adjust the aircraft into winds and/or align with the best (and safest) autorotative approach path.

MGD is an effort to utilize kinetic (airspeed) and potential (altitude) energies to maximize the glide ratio of altitude to distance. An MGD profile is intended to stretch an autorotative approach in order to make the only possible safe landing site. Another example is over water flight near shore where at the current altitude, the aircraft must have enough height in order to safely glide to the beach to avoid performing a ditching maneuver.

ENGINE FAILURES AND THE AUTOROTATION **[HFH 2-24, 11-2 TO 11-6; AOM; FM 3-04.203 Ch 1]**

Helicopters have a distinct advantage over any airplane in that when the engine stops providing enough power to keep the aircraft airborne, by maintaining a static longitudinal stability, the aircraft is controllable at a minimum or maximum power-off performance glide airspeed. Federal Aviation Administration, 14 CFR Parts 27 and 29, Performance and Handling Qualities Requirements for Rotorcraft; Proposed Rule, July 2006, states:

For the demonstration in autorotation, the current requirement specifies that the rotorcraft be trimmed at speeds found necessary by the Administrator to demonstrate stability. The proposed rule would specify typically used trim speeds — minimum rate of descent and best angle of glide airspeeds — for the stability demonstration. The conditions required to develop these airspeeds are currently stated in §§ 27.67, 27.71, 29.67 and 29.71.

Generally, the sequence is entry, established glide, flare and landing. Helicopters glide extremely well provided the pilot has initiated the proper procedures for the entering the autorotation soon enough. Time is the critical element for several reasons. First, not reacting quickly enough allows rotor RPM to drop which is the most dangerous situation. All aircraft will have a built in estimate (conditions dependent) of how much time you have to react and get the collective lowered and begin entry procedures. The time available is completely dependent upon the design characteristics of the helicopter (weight, rotor designs, velocities, etc.), and therefore, manufacturer guidelines are vital to know. Another problem of late autorotation entry is that it requires the pilot to catch up to an already descending aircraft. This lost time can also affect the landing profile as it compresses the time to maneuver the aircraft into position for a safe and proper power off landing.

The workload of an autorotation is immense. Helicopter pilots practice autorotations frequently. In most cases, these training iterations are completed in a power-on status and to a hover. Initial entry military rotary wing training includes a healthy amount of training autorotations to the ground, and at varying altitudes and airspeeds. There are a number of helicopter organizations in general aviation that are also performing touchdown autorotation training. There are obvious risks involved in doing this (Roskop, 2011); however, pilot benefit is 100% real. Touchdown autorotations have been a point of discussion for quite some time, will continue, and should.

In flight, equilibrium is established and there is no external influence to affect the balance of the pilot's world. Take away the engine in flight, and there is an adrenaline rush affecting the pilot (hopefully in a positive manner). This added motivation to do it right is hopefully all the pilot needs to do it right since at this point, a go-around is not an option. Pay attention to your instructor and fully comprehend the available knowledge on the topic.

HYDRAULICS FAILURES [HFH 4-14; AOM]

Most turbine engine helicopters are equipped with a hydraulics system. Few reciprocating engine helicopters have these systems. Hydraulics on helicopters becomes a necessity on larger rotor systems. High control loads at the pilot's controls are the primary reasons for requiring this capability. The need for pilot training on systems malfunctions is essential. Hydraulics losses greatly influence helicopter controllability. Some helicopters can still be flown with the hydraulics off or in a failed condition. If the control loads (with a failed hydraulics) are even higher the design typically includes a secondary hydraulics. Some will allow only limited amount of stored emergency hydraulic pressure to make a needed landing while others may have a full-time second hydraulic system. Hydraulic failure is one of the common practiced emergencies. For dual hydraulic systems, the tendency is for one system to fail at a time, thus degrading the assistance available to manage control loads, but still enabling the aircraft to continue flight. Other aircraft may be equipped with an emergency hydraulic system. These systems are less capable than the primary systems, but can prevent a lockout situation from developing into anything more than an inflight emergency.

For most helicopters equipped with hydraulics, the associated emergency procedures are to conduct flight in a shallower approach profile and slower airspeeds and get to a runway that will allow a run-on landing. All aircraft will vary and will come with recommended procedures for that specific airframe.

TAIL ROTOR CONTROL FAILURES [HFH 11-16; AOM; FM 3-04.203 Ch 1]

When not associated with hydraulic system malfunctions, a tail rotor malfunction will result in yaw control issues that will exacerbate at differing power levels. Malfunctions can be as limited as a high frequency vibration in the pedals to a stuck pedal or even complete loss of thrust from severed controls. Emergency procedures must be followed in any case.

Vertical stabilizers will add some self-correcting capability, but generally only at higher airspeeds. This is due to an asymmetrical airfoil or canted fin/stabilizer that provides some thrust in the

same direction as the tail rotor. The ability to gather some heading control from the vertical stabilizer is usually associated with partial pedal control situations and some stuck pedal scenarios.

Vibrating pedals are indicative of a possibly loose rotating component, or possible tail rotor blade de-bonding or other change in the blade shape. These vibrations may be noticeable in the cockpit.

Stuck pedal scenarios can be most dangerous. If large pedal inputs existed at the time of failure, then the power change inputs will result in large yaw angles. In some instances, the ability for the aircraft to wind-vane may allow the aircraft to conduct a successful run-on landing. In other instances, the aircraft heading is controlled using airspeed and throttle inputs. Slight reductions in throttle settings can change the heading enough that a controlled run-on landing is possible. Still, other aircraft will require entry into an autorotation.

VIBRATIONS AND RESONANCE [HFH 11-11; AOM; FM 3-04.203 Ch 1]

Vibrations and resonance in helicopters can result from several sources. Generally, these manifest at low, medium and high frequencies. Each frequency range is specific to different components on the aircraft. Identification of these levels point the pilot toward an appropriate emergency procedure. Failure to execute the correct procedure delays the proper performance and can have catastrophic results. Vibrations are generally associated with main rotor, tail rotor or engine/transmission components.

One difficulty with vibrations is the challenge of not noticing the vibration as a genuine problem and treating it with complacency. Once attention is given, time is then the critical component of accident prevention, or mitigation.

Ground Resonance is normally associated with landing in fully articulated or similar rotor systems with blade drag dampening and deals exclusively with an out-of-phase main rotor blade in rotation. This imbalance then creates a significant oscillation that reverberates between the masthead and the ground through the aircraft. Immediate action is required. Depending on the aircraft, picking back up to a hover or landing immediately and rolling off the throttle are methods for terminating this event.

INTERNAL/EXTERNAL LOADING ISSUES [HFH 6-3, 8-4]

Pilots have a tendency at times to default to experience rather than conduct thorough pre-flight planning. More detail requires more time, i.e. external loading, passenger or cargo hauls. In these cases, poor pre-flight planning leads to negative results because of the deterioration in the SA. As we've established, SA is a critical component to accident prevention. This requires effective pre-flight communication between crewmembers (air and ground) and when applicable, the customer. Trying to make up for poor planning once airborne is often too late. Turbulence, collision avoidance maneuvering, and showing off only add to the risk and shorten the margin for error.

Operating handbooks and supplements are the tested and approved manufacturer's guides to internal and external loading for a specific aircraft. FAA approved training ensures that pilots are aware of safe operating standards. The accident narratives in Part III highlight failures in this area succinctly.

AERONAUTICAL DECISION MAKING (ADM) ISSUES [HFH Ch. 14; AC 60-22]

Aeronautical knowledge is important in the assisting pilot's ability to focus on particular issues that deal specifically with rapid, in-flight decision-making. Where a mechanical malfunction or aerodynamic issue might occur that changes the normal flight operation, established procedures from the manufacturer identify the proper reaction. When the human factors involved in flight operations become affected by improper decision-making, there are various factors present that might have instigated an event, such as follows:

The edges of space in this illustration consist of the things that stop normal operation of the helicopter in its environment. These 'things' can be attached to the ground or airborne, but understanding that contact with these things may cause catastrophic events is paramount. Space is, as it would logically proceed, that environment that enables the normal operation of the helicopter in the chosen mission profile. This should provide the motivation to promote thorough ADM.

In consuming available and applicable knowledge to operate a helicopter, there is perhaps one tool that does an exceptional job of enhancing ADM and preventing collisions at the edge of space: risk analysis. The presence of a process from which to assess hazards in an intended environment of flight beforehand, is akin to a coherent decision that prevents bodily harm as a novice skier should probably do when selecting between beginner, novice or advanced runs on a ski slope. Application of common sense rarely kills people.

ENVIRONMENTAL FLIGHT [FM 3-04.203, Ch. 3; AOM]

Helicopter flight is considered by many to be exclusive to operation within environmental flight. That is, the predominant flight envelope used by the helicopter pilot is done in close proximity to the ground, in varying weather and light conditions. Other environmental considerations include low level terrain flight, night or limited visibility, hover flight, and execution of emergency procedures at low altitudes. Operations in combinations of environmental conditions can pose unique hazards that are inherently dangerous. Quality training is an important method a pilot can use to mitigate the risks.

NIGHT FLIGHT [HFH Ch. 13; PHAK Ch. 16; FM 3-04.203 Ch. 4]

As altitude and airspeed are directly related to recovery time and ability in the advent of engine failures, the helicopter pilot trains to successfully maneuver the aircraft using potential and kinetic energy. At night however, our depth perception is taken away and we must use visual cues outside the aircraft to assist us in our assessments. Flight instruments are other useful tools to assist in helping us identify altitudes required to implement recovery tasks.

Night Vision Goggles (NVG). Use of Night Vision Goggles requires extensive training. This training evolved originally from US Army tactics, techniques and procedures and have been revised to fit commercial aviation needs. Early NVG flight was extremely dangerous, using full-faced goggles. Generation-III and higher NVGs utilize lightweight mechanisms and allow the pilot to view the cockpit or view performance data through the integration of heads-up display data in the goggles. This is an aspect of rotorcraft aviation that constantly evolves and consistently becomes safer. Technological advancements do not preclude the continued need for training. The understanding of flight physiology with respect to unaided vs. aided vision is perhaps underemphasized in the industry.

LOW LEVEL FLIGHT [HFH 14-11, 2-10, 7-2; FM 3-04.203, Ch. 5]

Helicopters by nature are very capable to conduct operations at locations in close proximity to mother earth. Unfortunately, this same capability also enables pilots to make bad decisions regarding how best to fly at low altitude. The US Army trains at very low levels every day (and night) (FM 3-04.203): Cross country navigation at night in bad weather, hovering with the aircraft nose into the tree, following terrain at 10 ft. above obstacles and landing with feet to spare on either side of the rotor tips. While very, very few general aviation pilots have a need to operate in these extreme situations, some commercial pilots do find themselves in low-level flight in many parts of the industry. For all pilots engaged in these types of missions, they work frequently in this environment and as such, build a specific skill set needed to be safe. The biggest obstacle to safety for these pilots is distraction as it relates to all of the issues we discuss: weather, obstacles, aircraft conditions, etc. In reality, low level flight is an environment where situational awareness is most important as margins for error are infinitely smaller than operating at altitude.

IN-GROUND AND OUT OF GROUND FLIGHT

Winds. Paying attention to the signatures for wind make a large difference, as does paying attention to slow airspeeds and high power settings. Hovering in and around obstacles or other things that can change the winds has a varying impact on aircraft control due to the shifting patterns of wind. Other aircraft hovering in close proximity will also change the situation. Aircraft with substantially larger rotorwash forces than your aircraft will have a tendency to create a difficult to control situation. Adverse winds can also cause LTE (both in and out of ground effect), which was discussed earlier.

For Out of Ground Effect (OGE) situations, the pilot must take great care in pre-flight planning to ensure there will be enough power (especially for external loads). Normally, aircraft that are capable of continuous flight in the OGE region are equipped with planning charts that enable the pilot to determine performance limits for OGE at given conditions. Pilots then predetermine Go-No-Go values and verify them before getting into a dangerous situation.

Power. Knowledge of power required and power available in a given hover scenario is essential for pilots. As discussed above, some aircraft have performance charts that indicate planned power. Regardless, conditions change and then knowledge of the aircraft capability is necessary to stay in a

safe envelope. Our previous discussion of winds must also factor into discussion of power. For example, tail rotor into the wind translates to more power required, whether IGE or OGE.

Obstacles. Pilots in the field often find themselves close to obstacles. Maneuvering around obstacles requires a sense of depth perception, the ability to visualize how far back your aircraft extends, and a feel for sensing where the aircraft is in relation to obstacles. Turn off the sun and add an awkward lighting situation (or no lights at all), and you double the trouble. Shall we add winds, dust or rain? We all strive to slow down around these things and make certain our control touch is set to extra-fine.

Distractions. It has to be said that helicopter pilots are required to handle distractions better than any other pilot. Why is that? We discussed the multi-tasked nature of the helicopter pilot and this need is supported by a review of aptitude tests and pilot functions in flight (Buckingham, 2010). Compartmentalization of helicopter flight requires and tasks the pilot to be able to take on more tasks than normal. The key for helicopter pilots is to recognize task saturation when it occurs and the ability to immediately prioritize the tasks of immediate importance. Knowing where and when to slow down is essential.

LIMITED VISIBILITY

Under the FARs, helicopter pilots are allowed to conduct Special VFR flight in conditions that no other pilot (unless flying IFR) is privy to. Conditions less than 800 ft. ceilings and less than ½ mile visibility are risky for flight operations. If you have to slow down to see better, then be prepared to land safely to the ground as it is likely the better option. In a VFR environment, you have to know what obstacles are in front of you; so, if you can't see what is in front of you, do not continue. Making an immediate and professional aeronautical decision to land rather than relying on a split second decision will allow yourself to stay out of trouble and keep you from becoming an accident statistic.

Unless it is a life threatening situation or military/law enforcement emergency, pilots should avoid getting into SVFR situations in the first place. Nighttime is even worse. Night Vision Goggles enhance the capability, but they also mask dangers too well. Again it returns again to appropriate pre-flight planning. Knowing the light and weather conditions prior to the flight and having the tools prepare you to handle the necessary changes will ensure a successful flight!

Low Ceilings. As discussed, helicopter pilots are more adept at flight at low altitudes and frequently fly there. Generally, pilots in this low level envelope are trained specially to do so. Accidents here can and will occur with any pilot who becomes complacent regardless of their experience.

Low level flight is a skill that requires frequency. It is something that no pilot should get overly comfortable with. When a pilot thinks their abilities are at their peak and bad weather at night sets in, their environment is vastly different. The US Army covers low level flight techniques and knowledge in great depth for their specific mission profiles. Their field manual does provide extensive knowledge for low level conditions and use of their information must be tempered to civil flight mission profiles.

PART III

ACCIDENTS BY OCCURRENCE CATEGORY

BY

DESCRIPTIONS/ FACTORS / ACTUAL CRASHES

Chapter 2
Loss of Control

1. **Short explanation and introduction**. **[HFH Ch. 9, 10, 11; AOM]**

Loss of control accidents account for the largest group of accidents from the studies. Additionally, as the chart below depicts, there are sub-occurrence categories within loss of control accidents. In this document, we will review the top group which include performance management, dynamic rollover, exceeding operating limits, emergency procedures, and loss of tail rotor effectiveness.

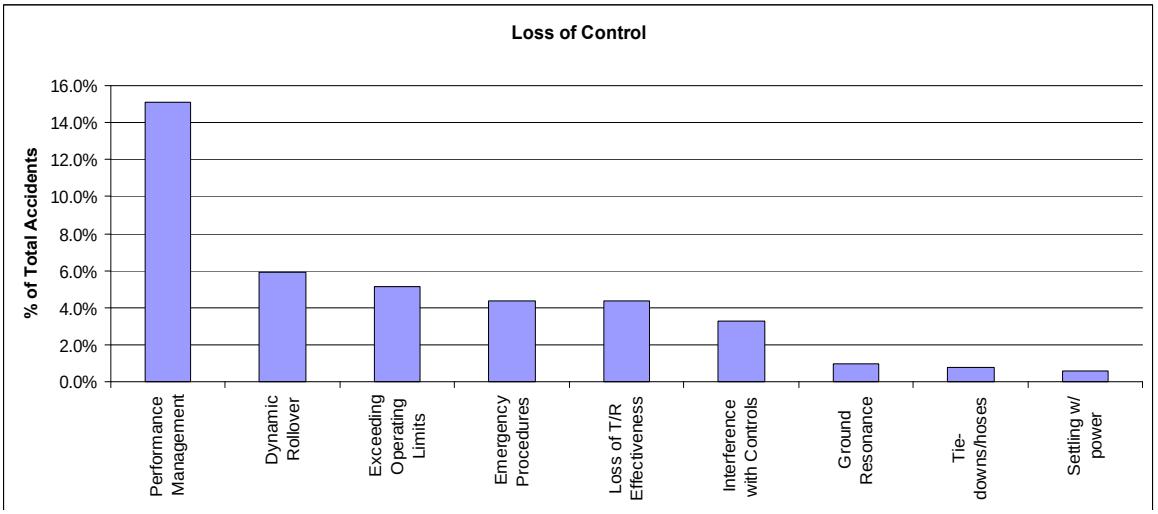

Figure 2. Loss of Control. Adopted from U.S. JHSAT Compendium Volume I Figure 9. The sum of the percentages exceed 100% as each of the 523 accidents analyzed could be assigned to multiple occurrence categories. For example, if the aircraft ran out of fuel, an autorotation ensued, followed by a loss of control, the accident is counted against three separate occurrence categories: Fuel, Autorotation, and Loss of Control

2. **Accident Occurrence**. Loss of Control (LOC) occurred in 41% of the 523 accidents studied by the U.S. JHSAT. LOC is defined as the pilot losing control of the aircraft for any of these reasons:
   - Performance Management - pilot maintaining insufficient power or rotor RPM for conditions.
   - Dynamic Rollover – the tendency of the helicopter to continue rolling when the critical angle is exceeded, if one gear is on the ground, and the helicopter is pivoting around that point.
   - Exceeding Operating Limits - helicopter is operated near the established limitations of the model/type.
   - Emergency Procedures - improperly responding to an onboard emergency.
   - Interference with Controls - interference by pilots, passengers, loose baggage, or factors related to maintenance.
   - Ground Resonance
   - Loss of Tail Rotor Effectiveness (LTE) or Unanticipated Yaw is an occurrence of an uncommanded yaw, which, if not corrected, can result in loss of control
   - Tie-downs/Hoses
   - Settling with Power

3. **Standard Problem Statement**. The most common Loss of Control problem came from Performance management. Within this occurrence it is clear that the pilot decision-making was a problem. Additionally, there appears to be a significant amount of information missing to pinpoint specific performance management issues. Accident reporting vs. engine monitoring equipment contributed to this lack of solid causal factors and the industry is engaged in improving this situation. What the reader can take away from the following charts is how at each level, loss of control predominantly occurs from a human factors point of view. In most cases the underlying cause was the failure to perform specific procedures, execute a proper decision, communicate, or adequately plan.

Performance Management (Loss of Control) (present in in 79 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Procedure Implementation	Inappropriate Energy/power management
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Landing Procedures	Autorotation – Practice
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action

Dynamic Rollover (Loss of Control) (present in in 31 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Procedure Implementation	Improper recognition and response to dynamic rollover
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action
Pilot Judgment & Actions	Landing Procedures	Selection of inappropriate landing site

Exceeding Operating Limits (Loss of Control) (present in 27 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Ground Duties	Mission/Flight Planning	Inadequate consideration of aircraft performance
Ground Duties	Mission/Flight Planning	Inadequate consideration of aircraft operational limits
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Situational Awareness	External Environment Awareness	Lack of knowledge of aircraft's aerodynamic state (envelope)

Emergency Procedures (Loss of Control) (present in 23 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Maintenance	Performance of MX Duties	Failure to perform proper maintenance procedure
Pilot judgment & actions	Procedure Implementation	Pilot control/handling deficiencies
Ground Duties	Aircraft Preflight	Performance of Aircraft Preflight procedures inadequate

Loss Of Tail Rotor Effectiveness (Loss of Control) (present in 23 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot judgment & actions	Procedure Implementation	Inadequate response to Loss of tail rotor effectiveness
Pilot judgment & actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Safety Management	Flight Procedure Training	Inadequate avoidance, recognition and recovery training: Loss of Tail Rotor Effectiveness (LTE)

4. **Intervention Recommendation**. Training and Safety Management were the two primary recommendations for intervention for loss of control accidents. This is followed by specifically suggesting training it by topic of aeronautical knowledge relating to piloting skills, airframe knowledge, and specific information regarding typical flight operations and missions. All recommendations center on the integration of safety and operations management.

For Loss of Control in general, the Top 3 IRs for training were: Training emphasis for maintaining awareness of cues critical to safe flight, Enhanced Aircraft Performance & Limitations Training, and Inflight Power/Energy Management Training.

For Loss of Control in general, the Top 3 IRs for Safety Management were: Personal Risk Management Program (IMSAFE), Use Operational Risk Management Program (Preflight), Establish/Improve Company Risk Management Program.

Often times young pilots are attuned to what their aircraft control requirements are in the cockpit and what directly relates to those tasks such as CRM. This mentality is sometimes carried forward as the pilot graduates to instructor, and perhaps more so in these small companies. It is important to integrate pilot training and education with environment that includes a comprehensive management system for both operations and safety. This should occur early in a pilot training program.

5. **Accident Narratives**. Since we are reviewing several Loss of Control (LOC) areas, there will be several narratives for each of the loss of control discussions above.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Performance Management
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
A helicopter was destroyed following a loss of tailrotor effectiveness landing. The flight was conducted under the provisions of 14 CFR Part 135 and was on a visual flight rules flight plan. Visual meteorological conditions prevailed at the time of the accident. The pilot reported minor injuries to himself and one passenger. There were a total of four occupants including the pilot.
After losing tail rotor effectiveness, the pilot was able to land the helicopter in a field amongst pine trees. The main rotor stuck the trees and the helicopter rolled over on its right side. A fire erupted and the helicopter was consumed. The occupants had exited the aircraft prior to the fire.
In a written statement, the pilot said that, as he approached the landing area, the helicopter was, "...about 250 pounds below maximum gross weight of 3,200 pounds." The pilot stated that, while on approach to land, he noticed a tree that he had not seen before and decided to abort the landing. He said he, "...began a power pull to 100 percent torque and a transition to forward flight. The helicopter immediately began a rapidly accelerating yaw to the right. I applied maximum left pedal to halt the yaw, which was ineffectual." The pilot stated that, when he was clear of obstacles, he attempted to regain control. He said that, at that point, he, "...believed [he] still had a functioning tail rotor, but that it may have entered a 'loss of tail rotor effectiveness' state and need only be regained." The pilot also stated that, "the 'low rotor RPM' warning light and horn began to come on with each pull of the collective..."

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The pilot's failure to attain translational lift following an aborted landing and the loss of tail rotor effectiveness encountered by the pilot. Factors to the accident were the low rotor rpm and the trees.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: fatal
	Occurrence Type: Accident	LOC - Performance Management

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The flight instructor was cruising or maneuvering the helicopter during an introductory flight with a new student. Witnesses in the area reported observing the helicopter in what appeared to be normal flight, heard a loud bang, and then saw the helicopter abruptly pitch nose down while the main rotor blades separated from the helicopter. One of the witnesses observed the helicopter turn and climb moments before the accident sequence initiated; two of the witnesses reported that just prior to the accident the helicopter was flying in level cruise flight. At the time of the accident, the sky was clear, the visibility was at least 10 miles, a light breeze existed, and no other aircraft were flying in the immediate area. The on-scene examination of the accident site revealed Plexiglas fragments and left door components about 400 feet from where the main wreckage fell into an open dirt field. Additional items, including sunglasses, a left skid tube-mounted component and the main rotor blade assembly, were found 140 to 330 feet from the main wreckage. An examination of the rotor hub revealed the teetering stops were cracked and both of the rotor blade spindles had broken their respective (droop stop) tusks. The physical evidence indicates the main rotor diverged from its normal plane of rotation, resulting in mast bumping, main rotor blade contact with the fuselage, and separation of the main rotor assembly. No evidence of any pre-impact mechanical malfunction was found with the helicopter. The initiating event that produced the main rotor divergence could not be determined.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The divergence of the main rotor from its normal plane of rotation for an undetermined reason, which resulted in mast bumping and rotor contact with the fuselage.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Performance Management

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The pilot stated he approached the lighted rooftop helipad from the southwest, at night, with light winds. The helipad and hangar were just ahead of him, and he initiated a right pedal turn to align the helicopter towards the south. He heard a loud bang, and the helicopter rotated uncontrollably, nose right. He lowered the collective, and the helicopter struck the landing area. Examination revealed the tail rotor blade ends were fragmented, and marks on the top corner of the hangar were similar to a tail rotor blade strike. Due to other helicopters parked on the ramp, the only approach was from the southwest. Winds were estimated to be from 220 degrees at 10 knots with gusts to 15 knots. Examination of the hydraulic pump and hydraulic tail rotor actuator found no evidence of failure or malfunction. Personnel reported the windsock would occasionally get caught on its support structure, and not indicate the true nature of the wind. There was no other wind information available to the pilot.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows; The pilot's misjudgment of his closure rate, while turning to land on the rooftop helipad, which resulted in a collision with the building. Factors in the accident were the tailwind and the stuck windsock.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: fatal
	Occurrence Type: Accident	LOC - Performance Management
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
During a test flight, following maintenance on the helicopter, which required a functional flight check for vibration and autorotation, the helicopter was observed by witnesses to enter a rapid descent. During this maneuver, the rotor system was observed to slow down and the rotor blades to "fold" over the top of the helicopter. Pieces, which were later identified as fragments from the transmission cowling, were observed exiting the helicopter when the rotor system slowed down. The helicopter descended into the ground in a right hand turning maneuver. Examination of the wreckage revealed no evidence of either a structural or system failure or malfunction. According to the helicopter's manufacturer, as the main rotor system slows while under aerodynamic load, the main gear box can "walk" (horizontal orbital movement) on its mounting structure, which can result in contact between the transmission cowling and the main rotor control rod ends. Examination of the engines revealed evidence that engine power was applied when the rotor system was at low rotational speed. No evidence of preimpact engine failure or malfunction was found. According to available information, the pilot had received no training from the operator regarding the conduct of a maintenance test flight, not does the FAA require such training.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to maintain rotor speed during an intentional autorotation, which resulted in a loss of control.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Dynamic Rollover
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
According to the CFI's written statement, they were practicing a running takeoff on runway 18 and after traversing approximately ten feet of the takeoff run the student applied right pedal input. The CFI stated that he tried to overcome the student's right pedal input by depressing the left pedal input and verbally commanding the student to do the same. The CFI reported that he was unable to counteract the students control input and the aircraft yawed to the right. The left skid of the helicopter impacted the terrain, the aircraft rolled onto its left side and slid 15-feet before coming to rest.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The proper alignment not being maintained by the dual student during an attempted running takeoff and the inadequate supervision of the pilot-in-command (CFI).

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Dynamic Rollover
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot of the med-vac helicopter reported that, during liftoff at the remote site, he encountered a loss of visual reference due to a "brown out" condition created by blowing dust at 3 feet AGL. He then attempted to land the helicopter without any visual reference; however, the right skid contacted the ground first. A rolling motion to the left was created and, after the left skid contacted the ground, a dynamic rollover ensued. The helicopter came to rest on its left side.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's selection of an unsuitable landing site, which caused "brown-out" conditions during departure liftoff and resulted in loss of control of the helicopter.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	LOC - Exceeding Operating Limits
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot was assigned to fly for a geophysical seismic team in rugged high desert conditions (elevation 5,366 feet). On his second day of flying, he was requested, by one of the team members, to "fly a little easier; less aggressively." On his third day of flying, he was assigned to pick up five team members and their equipment. Once airborne (density altitude was 8,908 feet), he had been briefed that he would receive GPS team distribution coordinates; instead, he was instructed to land and hold for a period of time. A witness observed the helicopter fly eastbound, and then make a 45 to 60 degree bank turn [180 degrees] back to the west. The witness then saw the helicopter turn southbound, lower its nose down almost vertically, and then reduce its nose low pitch to approximately 45 degrees as it disappeared from sight. Post accident examination of the engine revealed that the manual throttle pointer on the fuel control was in the emergency position. The first and second stage turbine wheels were found with their blades 50 to 70 percent melted, indicating an engine that functioned for a time at a temperature level well above its limits.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's loss of aircraft control due to abrupt flight maneuvering. Contributing factors were the high density altitude weather condition, the total loss of engine power due to the pilot manually introducing excessive fuel into the engine and over temping the turbine section, and the lack of suitable terrain for the ensuing autorotation.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	LOC - Exceeding Operating Limits
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

The pilot and his passenger, an aerial photographer, departed and headed for a mountain pass. With the available engine power on the hot day, and the pilot's close proximity to the rising terrain, the helicopter did not have adequate climb performance to traverse the first mountain pass route selected. The second available route was 500 feet lower, but it also exceeded the performance capability of the helicopter. As the helicopter climbed, its clearance above the rising mountainous terrain decreased to 300 feet, at which time the pilot reversed course to head toward lower elevation terrain. The pilot failed to maintain adequate main rotor rpm to sustain flight, and impacted the 6,400-foot mean sea level mountainside in an uncontrolled descent. The approximate density altitude was about 8,600 feet. The helicopter was 41 pounds over its maximum certificated gross weight at takeoff, and about 18 pounds below its maximum certificated gross weight at the time of the accident.

The NTSB determines the probable cause(s) of this accident as follows. The pilot's failure to maintain adequate rotor rpm and adequate terrain clearance while maneuvering to reverse direction. Contributing factors were the high density altitude that exceeded the helicopter's performance capability, and the rising mountainous terrain.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	LOC - Exceeding Operating Limits
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

The helicopter was damaged when it struck a pole adjacent to a hangar during takeoff. The helicopter was configured to seat four occupants with four seatbelts. There were five occupants on-board at the time of the accident, and a 2 year, 8 month old child, who was not seat belted, was ejected from the helicopter. Federal Aviation Administration regulations require that all occupants that have reached their second birthday wear a seat belt during takeoff, landing and ground movement of an aircraft. The pilot reported that he started to lift off to a hover and the helicopter "bolted forward." He stated that he attempted to stop the forward movement and at the same time tried to avoid the hangar and the "weather pole" by the hangar. No anomalies were found with regard to the helicopter or its systems. The pilot informed the National Transportation Safety board investigator that he did not calculate the center of gravity, and only calculated the weight prior to flight. Separate center of gravity calculations were performed using passenger weights as understood by the pilot and actual passenger weights obtained during the investigation. The center of gravity was found to be 2.4 inches and 2.9 inches forward of the forward limit respectively by each calculation using these weights. In addition, the takeoff gross weight was found to be 57 pounds over the maximum gross weight limit using the actual passenger weights. The Federal Aviation Administration Helicopter Flying Handbook states that a forward center of gravity can be recognized when coming to a hover by a nose low attitude and excessive rearward displacement of the cyclic control to maintain hover. The handbook further states that further flight should not be continued when this condition exists. A video of the accident taken by a witness on the ground does not show a hover prior to forward movement, nor does it show an attempt to abort the takeoff.

The NTSB determines the probable cause(s) of this accident as follows. The pilot's failure to calculate the weight and balance of the helicopter prior to flight, his failure to recognize and correct the forward center of gravity condition and his failure to abort the takeoff. A factors was the pilot's improper decision to conduct the flight without seatbelts available for all passengers.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Emergency Procedures
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
Two commercial helicopter pilots, both certificated helicopter instructors, were in a turbine-powered helicopter practicing autorotations with a power recovery prior to touchdown. The flying pilot inadvertently activated the flight stop augmented fuel flow switch during a power recovery, and overspeed the engine and main rotor. The other pilot joined him on the controls, and increased collective to reduce rotor rpm. The helicopter climbed abruptly to about 60 feet above the ground, where the tail rotor drive shaft separated. The engine subsequently lost power, and an autorotation was accomplished. Investigation disclosed that the engine and main rotor system had been exposed to significant overspeed conditions, resulting in a catastrophic failure of the turbine engine, and the tail rotor drive shaft coupling. The flight stop switch on the collective has no protective guard, and can be readily engaged, allowing the engine to enter the augmented fuel flow regime and, under certain conditions, causing the engine to overspeed. The switch has a history of inadvertent activation, and resultant engine overspeed events.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadvertent activation of the collective flight stop/emergency fuel augmentation switch, which resulted in engine and main rotor overspeeds, thereby precipitating failures of the tail rotor drive shaft coupling and power turbine blades. A factor associated with the accident was the manufacturer's inadequate design of the flight stop switch, which has insufficient safeguards to preclude inadvertent activation.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Emergency Procedures
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
After the patient was placed aboard the helicopter, the pilot started the engines and performed a hover check. He then moved the helicopter forward to gain airspeed and initiated a climb to cruise altitude. After reaching an altitude of about 100 feet, the main rotor rpm light and audio warning system activated, and the number 2 engine N1 rpm and torque began to decay. The pilot attempted to regain normal engine parameters, but was unable to regain engine rpm. The pilot maneuvered to avoid several light poles as he attempted to land in a parking lot. By this time, main rotor rpm had bled off sufficiently to prevent the hydraulic pumps from pressurizing the hydraulic system, and all flight controls locked is a slight right-banked attitude. This prevented the helicopter from reaching the parking lot. The helicopter impacted a construction area in a right bank, nose down attitude. An on-site and later follow-up investigation by FAA and Rolls-Royce investigators revealed a B-nut on the Pc line connecting the power turbine governor (PTGOV) to the fuel control unit (FCU) had become loose at the T-fitting end. It was partially torqued and could be moved with the fingers. The female end was threaded onto the male end three-quarters of a turn. There was no cross-threading. The torque stripe was broken. According to Rolls-Royce Allison, "This line serves a critical function to the engine control system and when leakage occurs will cause the engine to roll back to an idle or near idle condition."

The NTSB determines the probable cause(s) of this accident as follows. A loose B-nut on the PC line connecting the power turbine governor (PTGOV) to the fuel control unit (FCU) that created a leak and caused the engine to roll back to an idle condition, causing a low hydraulic system pressure and subsequent control lock. A contributing factor was the unsuitable terrain (construction area) on which to make a forced landing.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	LOC - Emergency Procedures
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

The pilot reported that, during his first approach to the hospital helipad, the helicopter "shuffled," and the No. 1 engine rpm increased. The pilot stated that he increased collective pitch, reduced the throttle on the No. 1 engine, and aborted the landing. He noted that the No. 1 engine was no longer controlled by the full authority digital engine control (FADEC) system and that he had to control it manually. The pilot twice overflew the helipad, and, while maneuvering for another approach, he lost control of the helicopter, and it descended and struck a tree and the ground. Examination of the throttles, throttle linkages, engines, control systems, cockpit display system (CDS), and FADEC units revealed no evidence of any pre-impact mechanical anomalies.

Post-accident testing of the engines and analysis of data retrieved from the CDS and FADEC units revealed that the accident pilot had inadvertently moved the No. 1 throttle out of its neutral detent, placing the engine in manual mode and out of FADEC control. Although the pilot recognized that the No. 1 engine was no longer controlled by the FADEC, he responded with further manual throttle adjustments and did not perform the published procedure to restore FADEC control to the engine. The data showed that, as the pilot continued to manually control the No. 1 engine, he subsequently moved the No. 2 throttle out of its detent, placing that engine also in manual mode and out of FADEC control. With neither engine under FADEC control, the pilot attempted control of the rotor rpm while controlling both engines manually. This configuration resulted in a high-workload scenario in which it would be particularly challenging for the pilot to control the helicopter during the maneuvering and approach-to-land phases of flight.

The accident helicopter was the only CDS variant in the operator's fleet. Its engines, its displays, and its procedure for restoring FADEC control differed from the variant in which the accident pilot was trained. According to the manufacturer's training guidelines, differences training is recommended before a pilot who is trained on another variant flies the model with a CDS. However, the investigation revealed that the operator provided the accident pilot only about an hour of formal differences training in the model with a CDS, and there was no evidence that the training adequately covered that variant's FADEC-restore procedures and other issues pertinent to flight safety. The pilot had accumulated about 914 hours of flight experience in this model, with about 45 hours in the CDS variant.

The accident was not the first indication to the operator that pilots who were trained in another variant experienced difficulties with the accident helicopter. According to one other pilot and the accident pilot, they each previously experienced events involving loss of FADEC control in the accident helicopter (twice in previous 2 years) but completed successful landings. The operator determined no mechanical explanation for the events and did not report, and was not required to report, them to its Federal Aviation Administration (FAA) principal operations and maintenance inspectors. The other pilot reported that, at the time of his November 2005 event, he was untrained in the CDS variant and was completely unfamiliar with the procedure required to restore FADEC control. That pilot reported that, during his event, he oversped the helicopter's engines and the main rotor, and, as a result, the operator removed the helicopter from service, conducted inspections of the engines and main rotor system, and determined that differences training was needed for the CDS variant; however, the operator failed to adequately provide such training. Because the FAA had no knowledge of the previous events with the accident helicopter, it had no indication to suspect that the differences training implemented by the operator was deficient.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The operator's inadequate training program and the pilot's failure to maintain control of the helicopter following his inadvertent disabling of the No. 1 and then the No. 2 engine full authority digital engine control system.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	LOC - Loss Of Tail Rotor Effectiveness

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The police helicopter was providing night airborne surveillance support to a ground unit, which had responded to an alarm at a store. Witnesses on the ground said the helicopter was heading northwest when it "started spinning" and "the nose went straight down." An examination of the wreckage revealed no anomalies. The pilot had very low time in helicopters, but all within 2.5 months preceding the accident. The winds reported at local airport, were 180 degrees at 12 knots. The loss of translational lift results in increased power demand and additional anti-torque requirements. When operating at or near maximum power, this increased power demand could result in a decrease in rotor rpm.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to maintain translational lift while maneuvering, and the loss of tail rotor effectiveness. Factors relating to this accident were the tailwind, low airspeed, low rotor rpm, and the pilot's lack of overall experience in helicopters.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Loss Of Tail Rotor Effectiveness

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The pilot was maneuvering the helicopter to land on an offshore platform. He initially approached the platform from the N, heading into the wind, which was from the SSE at 20-25 Kts. The pilot began a right turn to circle clockwise around the platform at 300 to 400 feet agl and 70 to 80 mph indicated airspeed. Approximately 3/4 of the way around the platform, the helicopter 'began to spin' to the right. The pilot applied left pedal in an attempt to stop the spin, however, there was 'no tail rotor response.' The pilot 'made an effort to try to come out of [the spin] by lowering the collective and dropping the nose of the aircraft.' Control inputs had no effect on stopping the spin, and the helicopter descended and impacted the water. There were no reported anomalies to the tail rotor system prior to the accident.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's right turn maneuver during low speed resulting in a loss of tail rotor effectiveness and subsequent loss of control.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	LOC - Loss Of Tail Rotor Effectiveness

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
During landing approach at the completion of a solo cross-country flight, the student pilot was slowing below 30 knots to enter a hover when the helicopter began spinning to the right. The student was unable to arrest the right yaw and entered an autorotation, which terminated in a rotating collision with terrain 137 feet short of the runway. He was attempting to land with a left crosswind and/or quartering tailwind from a direction and at a speed conducive to a tail rotor vortex ring state condition. The condition results in tail rotor thrust variations, which can require rapid and continuous pedal movements to maintain heading and cause unanticipated right yaw rates to develop. If the yaw rate is not controlled immediately, the helicopter can rotate into a wind azimuth region where weather cock instability will accelerate the right yaw. This condition will be aggravated at airspeeds below 30 knots when the loss of translational lift results in an increased power demand (more torque) and a corresponding increase in antitorque requirement. The student's total flying experience was very low (brand new PIC).

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The student's failure to maintain directional control after encountering a tail rotor vortex ring state induced right yaw.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Loss Of Tail Rotor Effectiveness

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
The pilot was aerial taxiing the helicopter to a parking area at 10 knots and into a slight quartering headwind. There was some thunderstorm activity west of the airport, and the nearest recorded winds were from 260 degrees at 20 knots, with gusts to 36 knots. As he turned towards the tie down area, there was a strong gust of wind from the left. The helicopter yawed to the left and full right pedal had no effect on arresting the spin. The helicopter struck the ground and rolled over. The pilot had 4,000 total flight hours in helicopters, but had recently transitioned to this make and model helicopter and had 8 hours in type.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The loss of tail rotor effectiveness while air taxiing. Contributing factors were the high winds and gusts, and the pilot's limited experience in aircraft make/model.

Chapter 3
Autorotation: Forced Landing- Emergency

1. **Short explanation and introduction**. **[HFH Ch. 11; AOM; FM 3-04.203 Ch 1]**

ENGINE FAILURES AND THE AUTOROTATION – Helicopters have a distinct advantage over any airplane in that when the engine stops providing enough power to keep the aircraft airborne, it can glide safely to a place selected by the pilot in almost any condition. By maintaining a static longitudinal stability, the aircraft is controllable at minimum or maximum power-off performance glide airspeed. Federal Aviation Administration, 14 CFR Parts 27 and 29, Performance and Handling Qualities Requirements for Rotorcraft; Proposed Rule, July 2006, states," For the demonstration in autorotation, the current requirement specifies that the rotorcraft be trimmed at speeds found necessary by the Administrator to demonstrate stability. The proposed rule would specify typically used trim speeds—minimum rate of descent and best angle of glide airspeeds—for the stability demonstration. The conditions required to develop these airspeeds are currently stated in §§ 27.67, 27.71, 29.67 and 29.71."

Generally, the sequence is entry, established glide, flare and landing. Helicopters glide extremely well provided the pilot has initiated the proper procedures for the entering the autorotation as soon as possible. Time is the critical element for several reasons. First, not reacting quickly enough allows rotor RPM to drop which is the most dangerous situation. All certified aircraft will have an estimate based upon extensive flight testing (conditions dependent) of how much time a pilots has to react, get the collective lowered, and begin entry procedures. Some aircraft may require action in less than a few seconds before losing recoverable RPM. The amount of time varies among models so follow the appropriate flight manual.

Another problem of late autorotation entry is that it can cause the pilot to fall behind in attempting to control an already descending aircraft. This lost time early in the autorotation can also affect the landing profile as it compresses the time to maneuver the aircraft into position for a safe and proper power off landing.

The workload of an autorotation is immense. Helicopter pilots must practice autorotations frequently in order to be proficient with this maneuver. In most cases, these training iterations are completed in a power-on status and terminated with a power recovery or to a hover. Helicopter organizations must assess the risk of performing their training autorotations to the ground by accomplishing full touchdown autos or terminating the maneuver with a power recovery. There are associated costs involved in doing this including cumulative wear and tear on the aircraft; however, pilot benefit is 100% real. U.S. JHSAT accident analysis identified Intervention Recommendations (IRs) associated with Full-touchdown autorotations for training require a quality training program and a CFI with judgment and decision making focused on following the student more closely during the

maneuver and an emphasis on training for maintaining awareness of cues critical to safe flight. Also very important are exceptional risk management and the adherence of those procedures.

In flight, equilibrium is established and there is no external influence to affect the balance of the pilot's world. Take away the engine for real and there is an adrenaline rush affecting the pilot (hopefully in a positive manner). This added motivation to do it right is hopefully all the pilot needs to do it right since at this point, a go-around is not an option. Here is when proper training pays off.

There are instances where pilots have a mechanical malfunction that may cause the engine to quit. These malfunctions themselves may not be attributable to pilot error. However, pilot error may occur and result in an accident if the reaction of the pilot prevents proper autorotative techniques.

2. **Accident Occurrence**. Autorotations involving forced landings were a cited as an occurrence in 22% (114 accidents) of the 523 accidents analyzed in the U.S. JHSAT's Compendium report. Autorotations maneuvers were regularly identified because they became necessary during the execution of an Emergency Procedure (EP).

The accident data shows that there were several Standard Problem Statements at levels that require some discussion to help express the most common origin of accidents from the forced landing scenario. The following chart details where the problems occurred and help capture the essence of causal areas.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Maintenance	Performance of MX Duties	Failure to perform proper maintenance procedure
Part/System Failure	Powerplant	Engine Component failure
Ground Duties	Aircraft Preflight	Performance of Aircraft Preflight procedures inadequate
Mission Risk	Terrain/Obstacles	Mission involves flight over unsuitable emergency landing terrain

Note: Data compiled from the IHST/JHSAT database.

3. **Standard Problem Statement.** The importance of the proper execution of an autorotation can be illustrated in the JHSAT's Compendium II statistics. A total of 99 out of the 523 accidents (19%) occurred where an SPS Level 1 of Pilot Judgment & Actions occurred in concert with SPS Level 3, Autorotation – Forced. This ranked as the highest pairing in the JHSAT's list of Top 20 SPSs.

RANK	SPS LVL 1	SPS LVL 3
1	Pilot Judgment & Actions	Autorotation – Forced

4. **Intervention Recommendation.** As the U.S. JHSAT continued their analysis, several Intervention Recommendations (IR's) were developed for this event and aligned against specific Standard Problem Statements. These Level 3 IR's were derived from the accident event supplemental causal events and further identify areas for intervention.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/ Instructional	Advanced Maneuver Training	Autorotation Training Program
Maintenance	Instructions for Continued Airworthiness (ICA)	Follow ICA procedures with confirmation of compliance
Maintenance	QA	Better Mx QA oversight to ensure adherence to the ICA/Manual
Maintenance	Recorder/Monitor	Install part failure detection system (HUMS)
Training/ Instructional	Advanced Maneuver Training	Simulator Training - Advanced Maneuvers
Training/ Instructional	Safety Training	Training emphasis for maintaining awareness of cues critical to safe flight
Training/ Instructional	Advanced Maneuver Training	Emergency Procedures Training

i. The Intervention Recommendation cited in more accidents than all others was an autorotation training program. The JHSAT intervention narrative is as follows

1. **T2010 - Autorotation Training Program.** (13%) Improve autorotation training in both primary and advanced flight training and develop simulator programs to improve autorotation skills. (Compendium I)

RANK	IR LVL 1	IR LVL 3
1	Training/Instructional	Autorotation Training Program

5. Accident Narratives

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AUTOROTATION - Forced
Airport Proximity: Off	Distance From Landing Facility:	

Accident Information Summary-

The pilot experience a loss of engine power due to the failure of the No. 3 exhaust valve for undetermined reasons. The pilot entered autorotation and failed to maintain rotor rpm and the proper rate of descent resulting in an in-flight collision with terrain. The pilot had accumulated 67 hours in helicopters of which 18 were as pilot-in-command. The pilot's last known autorotation was 4 months before the accident.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The pilot's failure to maintain rotor rpm and the proper rate of descent during a forced landing/autorotation resulting in an in-flight collision with terrain. Contributing to the accident was a loss of engine power due to the failure of the No. 3 exhaust valve for undetermined reasons, and the pilot's lack of total experience in the R22 and recent experience in autorotations.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AUTOROTATION - Forced
Airport Proximity: Off	Distance From Landing Facility:	

Accident Information Summary-

An aircraft was destroyed when it collided with terrain while maneuvering. The airline transport certificated pilot sustained minor injuries. Visual meteorological conditions prevailed, and no flight plan had been filed. The helicopter was being operated under Title 14 CFR Part 133. The flight originated at a nearby staging area at an undetermined time. According to the pilot's accident report, he was logging with a 150 foot long line. As he approached ground personnel, he heard a "Shhhh" sound and was advised there was smoke coming from the engine. Seeing smoke on the left side of the helicopter, he turned and proceeded down the mountain. The engine then "quit." The terrain was wooded and steep, and he attempted to fly towards a clearing. He "pulled pitch" to clear trees. The rotor blades struck the trees and the helicopter fell into a snow bank.
The wreckage was moved and the engine was given a preliminary examination by FAA inspectors and various representatives. The number 1 and 2 bearings and the number 1 sealing nut were submitted to a metallurgical laboratory for examination. According to its report, "the most likely cause of [the] engine malfunction was degradation of the Position #1 bearing due to insufficient lubrication." All other damage appeared to be "secondary." The accessory carrier assembly was oil flow tested and found to be "acceptable," albeit "near the lower end of requirements." Debris in the bearing oil strainer was believed to be "coked oil and epoxy hardener, both unusual for this area of the engine." In a telephone interview, the pilot stated he had previously experienced a number 1 bearing failure in another, but similar, helicopter. The operator was asked to submit the engine maintenance records but has gone out of business, and all attempts to contact him have been to no avail.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
Total failure of the number 1 bearing due to lack of lubrication, the oil flow being restricted by a foreign object (epoxy hardener). Factors were trees and the unavailability of suitable terrain for a forced landing.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AUTOROTATION - Forced

Airport Proximity: Off	Distance From Landing Facility:

Accident Information Summary- The pilot was performing an aerial observation flight of vehicle traffic, operating about 500 feet AGL, when the engine missed and lost power. The pilot performed a run-on landing on the edge of the road, next to a median. One skid was on asphalt and the other skin was in the grass/dirt. The skid in grass/dirt dug in and the helicopter rotated 90 degrees and rolled over. Examination of the helicopter revealed no fuel in the tank, the fuel cap in place, and no evidence of leakage. When fuel was added, the fuel gauge consistently read less than the actual amount of fuel onboard. The pilot told the Safety Board he had checked the fuel prior to departure; however, in follow-up interviews with the FAA, the pilot reported he had not checked the fuel tanks prior to departure and had not paid attention to the fuel gauge while flying.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.

The pilot's inadequate preflight of the helicopter, and his subsequent failure to monitor his fuel supply, which resulted in a power loss due to fuel exhaustion, over unsuitable terrain.

Chapter 4
Autorotation: Practice – Training

1. **Short explanation and introduction**. **[HFH Ch. 11; AOM]** Practice autorotations are a vital part of helicopter training. Part of the FAA requirement to helicopter manufacturers is an autorotative capability for their certification. This drives a need to test their products capability to produce requisite procedures for this maneuver in the AOM, and the height velocity charts. The important thing for young pilots to remember is that altitudes, positioning, and pre-maneuver parameters are all essential components of learning this maneuver correctly from the beginning of training.

   Logic suggests that learning an autorotation procedure all the way to the ground is ideal. It prepares the student pilot for what the maneuver will really look and feel like when it happens for real. The advantages for not training all the way to the ground are subject to many discussions in the industry. Suggestions on how to best train the practice autorotation have been thoroughly discussed within the industry and it appears that this will continue into the future.

   The following information will discuss the challenges of practice autorotations gone awry. The reader is encouraged to evaluate their practice autorotation experience, against the information presented here and glean an increased awareness to the entire scope of this maneuver.

2. **Accident Occurrence**. During the 47 out of 523 accidents that occurred as the result of autorotation training , 82% of the 47 accidents resulted from a Pilot Judgment & Action where the pilot failed to perform the maneuver correctly. Another frequently cited problem was the Certified Flight Instructor (CFI) failure to intervene in time to prevent the accident. The pilot's lack of experience was involved in 23% of these accidents.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Landing Procedures	Autorotation – Practice
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Procedure Implementation	Inappropriate Energy/power management
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver

3. **Standard Problem Statement**. It is clear that in most Practice-Autorotation accidents, they involved poor decision making or action by the pilots involved. In the Top 20 Standard Problem Statement charts from the JHSAT Compendium II, this problem was cited in the Top 5 for frequency.

RANK	SPS LVL 1	SPS LVL 3
5	Pilot Judgment & Actions	Autorotation – Practice

4. **Intervention Recommendation.** Similar to the previous discussion regarding autorotations that occurred as the result of a forced landing situation, the most frequently cited Intervention Recommendation for cases of accidents resulting from practice autorotations was an autorotation training program. Simulator training also ranked high on the list and offers a learning opportunities from student and instructor errors that could not be safely attempted in the actual aircraft. CFI training was cited across numerous interventions, emphasizing the need for instructors to rapidly recognize and intervene if the safety of the crew and aircraft is jeopardized during a practice autorotation.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/ Instructional	Advanced Maneuver Training	Autorotation Training Program
Training/ Instructional	Advanced Maneuver Training	Simulator Training - Advanced Maneuvers
Training/ Instructional	CFI Training	CFI judgment and decision making training to follow student more closely
Training/ Instructional	CFI Training	Training and Refresher training on advanced handling techniques / cues / procedures for CFIs
Training/ Instructional	CFI Training	Increase CFI training on cues for low RPM, airspeed issues
Training/ Instructional	Basic Training	Inflight Power/Energy Management Training
Training/ Instructional	Basic Training	Simulator Training - Basic Maneuvers
Safety Management	SOP - Ops Pilot	Formal Preflight Briefing Guide for flight procedures

5. Accident Narratives

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AUTOROTATION - PRACTICE
Airport Proximity:	Distance From Landing Facility:	

Accident Information Summary-
During a dual instructional flight lesson, the flight instructor directed his student to perform a practice autorotation. Both he and his student were handling the flight controls. The CFI directed that the student enter the autorotation while hovering between 2 and 3 feet above the dirt field. The student responded by rapidly lowering the collective, and the helicopter descended. Before the CFI could regain control, the helicopter's left skid touched down in the dirt and "dug in." Thereafter, the main rotor blades impacted the ground, and the helicopter rolled over onto its side. During the 5-minute period that preceded the accident, the student had accomplished the training maneuver without demonstrating any unusual problems. During the preceding 90-day period, the CFI gave 180 hours of instruction to various students in the helicopter. His total dual instruction experience in the helicopter was 1,800 hours.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The dual student's improper use of the collective and the flight instructor's inadequate supervision during the practice autorotation maneuver. A factor was the underlying soft dirt terrain, which promoted the rollover event.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	AUTOROTATION - PRACTICE
Airport Proximity:	Distance From Landing Facility:	

Accident Information Summary-
The single engine helicopter impacted the ground hard during an autorotational landing following a simulated loss of engine power. The flight instructor was simulating the loss of engine power to his student and noticed the rotor rpm was low when the helicopter was approximately 400 feet above the ground. The instructor ensured the collective was lowered all the way and placed the cyclic forward, but was unable to recover the rotor rpm. He flared the helicopter, but it landed hard resulting in the main rotor blades severing the tail boom.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. the pilot's failure to maintain rotor rpm during a practice autorotational landing, which resulted in a hard landing.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	AUTOROTATION - PRACTICE

Airport Proximity:	Distance From Landing Facility:

Accident Information Summary-
During an instructional flight, radar data identified the helicopter maneuvering in level flight before making a rapid descent below radar coverage. About 33 seconds later, the helicopter was picked up on radar in a climbing right turn, then a left turn before radar contact was lost at an altitude of 1,500 feet MSL (1,060 AGL). Witnesses in the area reported observing the helicopter make "some radical flight maneuvers" before it lost altitude. "wobbling" attitude while it spun to the ground. Prior to the helicopter before they lost site of it in the trees. tail section. The helicopter then collided with trees. tail rotor blades made contact with the side of the wreckage. Both tail rotor blades separated from the tail rotor hub. Components that separated were due to overload. Although a pitch change link and teeter bumper stop were not recovered, metallurgical examination of the tail rotor pitch control assembly determined that they were attached at impact. There was no evidence that pitch change control was lost prior to the tail rotor blade striking the tail boom. No evidence of a mechanical failure or malfunction was found. Further investigation determined that abrupt application of full left pedal during a simulated power failure could result in excessive flapping of the tail rotor and possible tail rotor blade contact with the tail boom. At the time of the accident, the mean tail rotor blade angle was 21.5 degrees to 22.0 degrees. Approximately three months after the accident, the manufacturer issued a service bulletin to re-rig the tail rotor to reduce maximum blade angle at the left pedal stop and required the installation of a harder teeter bumper.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. An abrupt application of the tail rotor/anti-torque pedal by an unknown pilot resulting in tail rotor contact with the tail boom. Tail rotor blades and empennage assembly separation, and trees were factors.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AUTOROTATION - PRACTICE

Airport Proximity:	Distance From Landing Facility:

Accident Information Summary-
During a practice autorotation, the helicopter landed hard bending the tail boom. An examination of the helicopter indicated the damage resulted from the hard landing. The tail boom had ripped out at the aft bulkhead, and the landing skids were bent upward at the aft end. The nose of the helicopter was also damaged when the helicopter rocked forward after the hard landing. The helicopter then stopped upright on the skids with no damage to the main rotor blades. The pilot stated that he was doing a practice autorotation landing when the accident occurred. During the last landing, the helicopter "fell through" much faster than anticipated. The pilot stated that no mechanical anomalies were experienced before or after the accident. The temperature at the time of the accident was 100 degrees Fahrenheit. The pilot stated that in the future he will allow a higher margin for autorotation power recovery in hot conditions.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's improper autorotation in that he failed to attain the proper descent rate resulting in a hard landing and subsequent airframe damage. A factor was the high temperature.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AUTOROTATION - PRACTICE

Airport Proximity:	Distance From Landing Facility:

Accident Information Summary-
While demonstrating a 180 degree autorotation to landing, the instructor pilot inadvertently allowed the helicopter to attain an excessive rate of descent. Although he added power and initiated a go-around, he had waited too long to begin the go-around, and he was unable to keep the helicopter from impacting the end of the runway and bouncing back into the air. After hover-taxiing to parking, the instructor inspected the helicopter, whereupon it was determined it had sustained substantial damage.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The instructor pilot's inadvertent excessive descent rate, and his delay of remedial action during the demonstration of a 180 degree autorotation.

Chapter 5
System Component Failure

1. **Short explanation and introduction**. **[HFH Ch. 3, 4, 5, 11; AOM]** System Component Failure (SCF) is defined as an occurrence when a system or component on the helicopter did not function correctly. The occurrence could be a mechanical failure, an intermittent electrical/system malfunction or failure to meet Aircraft Flight Manual (AFM) performance requirements (JHSAT, 2006).

   Man-made things can break. This is no secret. The amount of design, testing, and years of experience in the manufacturing environment are indicative of the low component failure accident rates due to a mechanical failure. Accident investigations do not always have the ability to capture enough information (crew perceptions versus lack of confirmation) and in these types of accidents to proffer completely accurate data, however, this imparts a very important message: maintenance and flight operation procedures and instructions and manuals, are so very important.

2. **Accident Occurrence**. By occurrence, a system component failure (SCF) was present in 28% of accidents (144 of 523 accidents). Part/System Failure, Pilot Judgment & Actions, and Maintenance were the most frequently cited problems that led to the occurrences. Delving deeper into one of the areas, 60% (86 of 144 accidents) were related to maintenance. More specifically, the most frequently cited maintenance problem was failure to perform proper procedures (53 of 144 accidents). In many cases, a poor maintenance preflight preparation missed impending failures. There are four specific sub-occurrence categories for SCF. They include engine, helicopter, mission equipment, and unconfirmed or perceived. The following chart combines analysis from each of these four sub-occurrence categories.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Maintenance	Performance of MX Duties	Failure to perform proper maintenance procedure
Part/System Failure	Powerplant	Engine Component failure
Ground Duties	Aircraft Preflight	Performance of Aircraft Preflight procedures inadequate
Maintenance	Performance of MX Duties	Maintenance did not detect impending failure
Maintenance	Maintenance Tools	Lack of airborne equipment to detect impending part failure
Maintenance	Maintenance Procedures/Management	Aircraft released in un-airworthy condition
Mission Risk	Terrain/Obstacles	Mission involves flight over unsuitable emergency landing terrain
Part/System Failure	Aircraft	Tail Rotor Drive system component failure

Maintenance	Maintenance Procedures/Management	Inadequate documentation of aircraft records
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Maintenance	Maintenance Procedures/Management	Failure of QA or supervisory oversight
Part/System failure	Aircraft	Main Rotor Drive system component failure
Part/System failure	Powerplant	Powerplant – Other

3. **Standard Problem Statement**. Within the Standard Problem Statement in the Compendium II report, several of the JHSAT's top 20 SPSs at Level 3 can be associated with System Component Failure.

RANK	SPS LVL 1	SPS LVL 3
4	Maintenance	Failure to perform proper maintenance procedure
13	Part/System Failure	Engine Component Failure

4. **Intervention Recommendation**. As shown in the table below, Maintenance operations and Training/Instruction were determined to be instrumental in future prevention and or awareness of impending SCF. As with the analysis above, there are four specific sub-occurrence categories for SCF, which include engine, helicopter, mission equipment, and unconfirmed or perceived. The following chart combines analysis from each of these sub-occurrence categories.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Maintenance	Instructions for Continued Airworthiness (ICA)	Follow ICA procedures with confirmation of compliance
Maintenance	QA	Better MX QA oversight to ensure adherence to the ICA/Manual
Maintenance	Recorder/ Monitor	Install part failure detection system (HUMS)
Training/Instructional	Advanced Maneuver Training	Autorotation Training Program
Systems & Equipment	PAH corrective action	Design approval holder implement corrective action and mitigate field risk
Training/Instructional	Advanced Maneuver Training	Emergency Procedures Training
Training/Instructional	Advanced Maneuver Training	Simulator Training - Advanced Maneuvers
Maintenance	QA	Improve preflight and/or Mx inspections
Training/Instructional	Basic Training	Aircraft Preflight Procedures
Maintenance	Instructions for Continued Airworthiness (ICA)	Evaluate adequacy of published ICA
Maintenance	Records Management	Establish Mx records systems, enhance retention requirements
Safety Management	Risk Assessment/ Management	Mission Specific Risk Management Program
Training/Instructional	Basic Training	Enhanced Aircraft Systems Training

5. **Accident Narratives**. These narratives identify accidents where the system component, and other mechanical issues/concerns are involved. These narratives include at least two from each of the following System Component Failure (SCF) sub-occurrence categories: engine, helicopter, mission equipment, and unconfirmed or perceived.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	SCF- Helicopter
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
During cruise flight the pilot lost control of the helicopter and an uncontrolled forced landing was made onto the top of a two-story industrial warehouse. The pylon mounted actuator support assembly had separated from the transmission case. The support assembly, attachment hardware, and portions of the transmission case were sent to the NTSB Materials Laboratory for analysis. According to the NTSB Materials Laboratory Factual Report, "... all of the studs showed progressive fatigue cracking from multiple origins." The report stated, "All but one stud fracture ... showed progression from diametrically opposed sides, typical of reversed bending fatigue loads." The report stated that all of the stud and dowel holes in the actuator support were, "... elongated on opposite sides from contact with the respective dowel or stud." The report further stated, "In addition to the elongation of the holes, the faying surfaces of the support and the transmission case were severely worn from relative movement. The directions of indicated movements and wear correspond to the axis of elongation of the respective support holes." The lead mechanic for the helicopter reported that one of the dowel pins was found during routine maintenance approximately one year prior to the accident date and the maintenance staff did not determine the identify the source of the dowel pin.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The loss of clamp-up force between the transmission case and the pylon mounted actuator support assembly which resulted in fatigue failure of the threaded studs and dowel pins, the failure of the flight control system, helicopter control not being possible after the flight control failure, and the inadequate maintenance procedures by the company maintenance personnel.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	SCF- Helicopter

Airport Proximity: Off Aprt/Airstrip	Distance From Landing Facility:

Accident Information Summary-
Approximately 7 minutes after takeoff, the pilot of the helicopter heard a "loud snap," and experienced a 5 to 10 degree right yaw. This occurred a second time, 5 to 8 seconds later. The pilot declared an emergency and elected to make a precautionary landing. During the approach, he experienced a third snap sound and yaw movement. The helicopter was at an airspeed below 20 knots, and about 8 to 10 feet above the ground, when the pilot heard a bang, and felt ground contact. The helicopter rolled to the left, and the main rotor blades contacted the ground. Examination of the helicopter confirmed drive train continuity to the main and tail rotor drive shafts. A ground scar, consistent with tail rotor ground contact, was observed about 60 feet from the main wreckage. The tail rotor gearbox, drive shaft and blade assembly were located about 250 feet from the main wreckage. Examination of the tail rotor gearbox and adjacent components did not reveal any preexisting damage; however, it also did not reveal any indications of rotational damage. Examination of the override clutch assembly, which drove both the main XMSN and the tail rotor system, revealed preexisting damage that occurred at an undeterminable time before the accident. The accident helicopter was involved in a previous hard landing accident about 13 months, and 87 hours of operation prior, during which, it had a tail rotor strike, and a fractured tail rotor drive shaft. The override clutch assembly was not removed for inspection after that accident; nor was it specifically required to be removed and inspected per the manufacturer's maintenance guidelines for "Special Inspection for Sudden Stoppage, Main and/or Tail Rotor Blade Strikes."

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. A partial failure of the override clutch assembly. A contributing factor to the accident was the manufacturer's inadequate inspection procedures of the override clutch assembly following a tail rotor strike.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	SCF- Engine

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The helicopter CFI was conducting an introductory flight instruction lesson under Title 14, CFR part 91 with a prospective student. A witness, about 1 mi. south of the accident site, estimated that the helicopter was about 1,000 feet above the ground as it passed over him. Shortly after, he heard a "pop", and the helicopter started a shallow, controlled turn to the left, followed by two or three more popping sounds. The helicopter began a rapid descent, and started spinning counter-clockwise. As the helicopter's descent rate increased, the main rotor blades stopped turning, and the helicopter entered a vertical descent. The witness no longer heard engine sounds during the accident helicopter's vertical descent. The helicopter crashed in a residential area, and came to rest between two houses. The helicopter sustained damage consistent with a high speed, fuselage level, vertical impact. Post-accident inspection of the engine core and airframe disclosed no evidence of any pre-impact anomalies. Impact damage prevented testing of the carburetor and ignition wiring harness assemblies. A review of the accident pilot's historical training records revealed a series of failed check rides and overall substandard performance. The NTSB IIC interviewed both previous and prospective employers, which disclosed that the accident pilot had either been dismissed or not hired due to his lack of academic and/or flight skills.

The NTSB determines the probable cause(s) of this accident as follows. A loss of engine power during cruise flight for an undetermined reason, and the pilot's failure to maintain rotor rpm, which resulted in an uncontrolled descent and collision with terrain.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	SCF- Engines/Power

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

While flying along a mountain ridgeline to make a water drop on a wild fire, the helicopter lost power in one engine and collided with terrain as the pilot turned downslope toward a landing area. Ground crews watching the helicopter make its drop run observed smoke emanating from the right engine, then the helicopter made a left descending turn and impacted the downsloping mountainous terrain. A trailing pilot saw the helicopter about 150 feet above the ridgeline, then it made a sudden left descending turn. He did not see the pilot jettison either the water or the bucket. A teardown inspection and metallurgical examination of the No. 1 and No. 2 power sections was conducted. The examination of the No. 1 power section CT disc revealed that the fir tree serrations adjacent to the No.s 24 and 25 blade positions were fractured above the blade retaining rivet hole, and that the No.s 27-29 fir tree serrations were fractured at the blade roots. During the metallurgical examination, the failure of the CT disc was attributed to cyclic stress rupture due to extended and repeated operation of the engine at, near, or above its temperature/power limits. Dimensional measurements of the blades showed growth and deformation to the disk in the areas of the fractures. There were no material, manufacture, or design deficiencies identified during the metallurgical examination of the CT disc. The examination of the No. 2 power section revealed that the intermediate drive shaft fractured in a counterclockwise direction due to sudden stoppage of the left engine while it was at a high power level. Due to the degree of destruction and lack of dispatch records, the investigation was not able to accurately determine the operating weight of the helicopter at the time of the accident; however, for the 9,500-foot density altitude, it is believed that the helicopter's weight with the water load was at a point that resulted in marginal single engine capability at best. The accident helicopter had been modified with the installation of a water bucket and long line system. The long line and water bucket circuit breakers, and the emergency electrical release, were connected to the nonessential bus. This system was installed on a Form 337 field approval. According to the helicopter manufacturer, the electrical system is designed so that if one generator and/or engine failed both of the nonessential buses would automatically drop offline. Thus the emergency electrical release of the water bucket and long line would have been rendered inoperable in the event of a generator and/or engine failure. An override switch on the electrical panel can restore power to the nonessential buses; however, based on the event timeline reported by the witnesses, it is unlikely that the pilot could have restored power to the nonessential busses in time to prevent a collision with the ground.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. Failure of the compressor turbine disc due to cyclic fatigue brought about by repeated operation near or above the engines' temperature/power limits by company personnel over an extended period of time. Factors in the accident were: 1) the high density altitude, mountainous terrain, and the helicopter's resulting marginal single engine performance capability; 2) the design, fabrication, and installation of the emergency external load release system, which had the power supply wired to the nonessential bus that would automatically drop offline during an engine or generator failure; and 3) the pilot's resulting inability to electrically release the water load, bucket, or line while dealing with the engine failure.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	SCF- Mission Equipment
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter was engaged in an animal capture program. The pilot said that the net-gunner had deployed a net over a deer, when he felt the helicopter began to "shake violently." He said that the helicopter was approximately 10 feet off the ground; he landed it with 10 to 15 knots of forward speed. After sliding approximately 10 feet, the pilot heard a loud bang, and the aircraft rolled right and forward. The helicopter came to rest on its left side with its right landing skid broken. Post accident examination of the helicopter's main rotor blades revealed that one blade had leading edge damage that corresponded in size to a missing net weight.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The foreign object damage to a main rotor blade, while maneuvering.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	SCF- Mission Equipment
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter was transporting empty fruit bins via cargo hook. The bins were lifted from a flatbed trailer, about 4 feet from a ground crewmember, a 9-year hook-up veteran. After the fifth lift, the ground crewmember attempted to run to, and help a truck driver of another trailer. Although he had a hard hat with a combination ear muffs/radio receiver and microphone, the ground crewmember did not advise the pilot of his intentions, and ran under the track flown during the previous four loads. As the helicopter flew over the ground crewmember, the cargo hook opened, uncommanded by the pilot, and the bins fell about 8 feet onto the ground crewmember. The cargo hook system had been removed from another helicopter, and that helicopter had previously had it installed at a completion center. The hook release cable was installed; however, the correct part was similar and was approximately 1 inch longer, and would have allowed enough slack to normally preclude any tension on the cargo hook manual release mechanism. After discovering the different part numbers, the operator found that another of his helicopters had the shorter release cable, and he changed it to the longer one as well.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The completion center's installation of the incorrect (shorter) release cable, and the ground crewmember's improper movement under the flight path during a bin transfer.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	SCF- Not Confirmed or Perceived
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter pilot said, "...(5) Preflighted, got in, shut doors, seat belts on, headset on, started, warmed up then picked up to a 3 [foot] hover. Everything was in the green and looked normal. I then rotated 180 [degrees] to transition out, stopped, everything looked normal. (6) I then added full power, lower cyclic and slightly raised collective to start moving [forward]. As we climbed to about 15-17 [feet], we heard a coughing sound, then silent. Engine quit, I tried to get it back on the ground as flat and level as possible. You can not auto[rotate] at 17 [feet]." A post-accident examination of the helicopter and accident site was conducted. The helicopter was found facing in a northerly direction in an open, flat, unobstructed field. There were buildings to the south of the field. No anomalies were found with respect to the helicopter. The winds were reported to be from 200 degrees at 17 knots gusting to 22 knots with a peak wind of 210 degrees at 26 knots.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows; The inadequate autorotation and disregarded wind information by the pilot. Factors were the gusting tailwind and the loss of engine power for undetermined reasons.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	SCF- Not Confirmed or Perceived
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot said he was cruising at 8,500 feet msl (mean sea level) and at a correct airspeed when he experienced a "slight yaw oscillation." He decided to make a precautionary landing and initiated a descent. The oscillations increased to about one yaw per second. Before reaching the selected landing site, the "low-rotor RPM horn/light activated. When the pilot lowered the collective control to recover, he got an engine and rotor overspeed indication of 110 per cent. The pilot made a 180-degree turn and autorotated from 800 feet agl. The helicopter landed on rocky terrain, surrounded by pinon and juniper trees. Main and tail rotor and tail rotor blades struck the trees, separating the tail rotor blades and gearbox from the tail boom. According to the helicopter manufacturer, nothing was found that would explain the oscillations described by the pilot, or why the low-rotor RPM horn/light activated.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows; An airframe vibration for reasons undetermined, resulting in the pilot performing a precautionary landing, and obstacle clearance not possible.

Chapter 6
Object Strike

1. **Short explanation and introduction. [HFH Ch. 11; AOM]** This occurrence category relates to an aircraft or aircraft component striking an object during any mode of flight. An object strike with a helicopter is different than with airplanes in most ways, as the flight environment is usually very different. Both airframes flies similarly in cruise flight situations and sometimes similarly in takeoff and landing profiles.

   Helicopters will frequently find themselves near the edges of space, which is to say movable or immovable objects that tend to create sudden stoppage of objects in motion. This environment encompasses a large percentage of where helicopters operate. It is then logical that training and operations management instill the importance of following procedures for cockpit management, to include situational awareness and communication.

2. **Accident Occurrence**. In the table below, object strike data were compiled from the three sub-occurrence categories of takeoff or landing, low altitude missions, and object strike.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Situational Awareness	External Environment Awareness	Aircraft position and hazards
Safety Systems & Equipment	Safety Systems & Equipment (level 2)	Intolerance to wire strike
Pilot Judgment & Actions	Flight Profile	Pilot's flight profile unsafe – Altitude
Pilot Situational Awareness	External Environment Awareness	Low flight near wires
Mission Risk	Terrain/Obstacles	Mission involves flying near hazards, obstacles, wires
Pilot Judgment & Actions	Landing Procedures	Selection of inappropriate landing site
Pilot Judgment & Actions	Human Factors - Pilot/Aircraft Interface	Diverted attention, distraction
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or manoeuvre
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Pilot Judgment & Actions	Human Factors - Pilot/Aircraft Interface	Perceptual judgment errors
Ground Duties	Mission/ Flight Planning	Inadequate consideration of weather/wind
Pilot Judgment &	Human Factors - Pilot's	Willful disregard for rules and SOPs

Actions	Decision	

3. **Standard Problem Statement**. An object strike occurred in 16% of the 523 accidents analyzed. In the JHSAT's Top 20 SPSs across all 523 accidents, the SPSs applicable to object strike distributes itself in the following areas:

Rank	SPS LVL 1	SPS LVL 3
3	Pilot Judgment & Actions	Pilot control/handling deficiencies
8	Pilot Judgment & Actions	Pilot's flight profile unsafe – Altitude
10	Ground Duties	Inadequate consideration of weather/wind
16	Pilot Judgment & Actions	Willful disregard for rules and SOPs
20	Pilot Judgment & Actions	Diverted Attention

4. **Intervention Recommendation**. In the table below, object strike data were compiled from the three sub-occurrence categories of takeoff or landing, low altitude missions, and object strike.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Systems & Equipment	Situational Awareness Enhancers	Install proximity detection system
Safety Management	Risk Assessment/ Management	Personal Risk Management Program (IMSAFE)
Systems & Equipment	Post Incident Survivability	Install WSPS
Safety Management	Risk Assessment/ Management	Mission Specific Risk Management Program
Safety Management	Risk Assessment/ Management	Use Operational Risk Management Program (Inflight)
Systems & Equipment	Situational Awareness Enhancers	Wire detection system for low alt ops
Training/Instructional	Safety Training	Training emphasis for maintaining awareness of cues critical to safe flight
Safety Management	Flight ops management	Establish mission specific SOP and flight ops oversight program

5. **Accident Narratives**. The narratives discussed below are comprised of three separate sub-occurrence categories within a strike: takeoff or landing, low altitude missions, or a general object strike.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Strike- takeoff or landing

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
The hospital helicopter pad security video camera showed the helicopter had flown into the wind during the approach to hovering over the helicopter pad. A hover turn was used to place the left side of the helicopter nearest to the patient ramp. The helicopter then landed on the pad. The shadow of the windsock seen on the video recording indicated the wind was from the direction aft of the helicopter when the helicopter landed on the pad. The helicopter started to lift off the helicopter pad when the tailrotor struck the helicopter pad light that was below the tailrotor. The aft portion of the helicopter's skids were still on the deck of the helicopter pad, or very nearly still on the deck of the helicopter pad, when the tailrotor struck the lighting fixture. The helicopter yawed to right about 30 degrees and the weight of the helicopter settled back down on the helicopter's skid. The main rotor and tail rotor blades came to a complete stop about 10 seconds after the tailrotor hit the light fixture. The top of the light fixture measured about 19 inches in height.

The surface weather observation recorded at a local airport at 1109 cdt indicated the winds were 020 degrees at 10 knots. The surface weather observation recorded nearby at 1153 cdt indicated the winds were 010 degrees at 12 knots gusting to 17 knots.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. the pilot's inadequate preflight and improper vertical takeoff and not obtaining clearance from helicopter pad light. Factors included the tailwind takeoff and the helipad light.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Strike- takeoff or landing
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot of the helicopter was looking for a group of people to be picked up at a designated point. Flying over the location, he realized that they had not yet arrived, so he decided to land at an alternate location and await their arrival. He had landed at the alternate location previously but not on the day of the accident. He said the visibility was good, but there were no shadows due to the overcast. The approach was normal, and the pilot used a small pine tree to the right front quarter of the helicopter as a reference point. As the helicopter touched down, the pilot heard a loud noise and the helicopter yawed. Believing there had been a mechanical failure, the pilot lowered the collective control and closed the throttle. Post-accident inspection revealed there had not been a mechanical failure. Rather, the pilot had not seen the snow covered slope to the left front quarter of the helicopter. The main rotor blades struck the surface of the ground and the helicopter settled into deep snow. The transmission separated from its mounts, the main rotor blades were destroyed, and the tail boom was severed.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to maintain adequate lateral and vertical clearance during landing. Factors were the clouds and snow-covered high terrain.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	Strike- low altitude missions
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot reported that while en route to a field for the aerial application, he was distracted by a radio call from another pilot. The pilot looked down at a map to verify a field location, and when he looked back up, he did not see the power lines that he knew were along his flight path and had flown over on previous flights. After colliding with those power lines, the helicopter pitched nearly straight up, leveled slightly, then fell to the ground in a tail low attitude. A post-crash fire consumed the helicopter. The pilot reported that there were water drops on the windshield, which was dirty, and the sky was overcast, reducing his visibility substantially.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadequate visual lookout, and his failure to maintain adequate clearance from the power lines. The pilot's diverted attention, a dirty windshield, power lines, and light rain were factors.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	Strike - low altitude missions
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter had been contracted by the State to relocate moose to an area where they would be less hazardous to traffic. After the helicopter herded a moose off a frozen reservoir and back towards the shoreline, the pilot turned and flew into five power lines. The helicopter nosed over, and fell 80 feet in a near-inverted attitude to the surface of the frozen reservoir. It broke through the ice, sank, and then floated back to the surface. A portion of the tail boom remained entangled in the wires. Witnesses said the visibility was 1 mile in fog. An examination of the wreckage revealed no anomalies.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadequate visual lookout, resulting in an inflight collision with powerlines. Contributing factors were the fog and the powerlines.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	Object Strike
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The non-instrument rated private pilots did not obtain a weather briefing or file a flight plan for the night cross-country flight. During dark night conditions, a witness observed the helicopter descending from the clouds following a highway. The helicopter appeared to be at a height just above a 285-foot tall radio tower. Approximately 5 miles south of the radio tower, the helicopter struck an electrical pole, impacted terrain, and came to rest adjacent to an oil pump jack. A weather study revealed that the accident site was in an area of low ceilings and restricted visibility. During examination of the helicopter, no anomalies were found with the engine or airframe that would have precluded normal flight operations.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadvertent flight into instrument meteorological conditions and failure to maintain obstacle clearance. Contributing factors were the pilot's failure to obtain an updated preflight weather briefing and the dark night conditions.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	Object Strike

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The helicopter collided with a tree as it flew over a mountain ridgeline. The helicopter was under contract to the U.S. Forest Service. The pilot was requested to fly a relief Fire Lookout to a lookout tower 4 nautical miles (nm) and a 2,844 feet elevation gain away. There were several forest fires in the area and visibility in the lower valley was approximately 1 nm. The relief Fire Lookout, who was dropped off, said that as the helicopter flew up the ridge, visibility got much better. He said that there were two PAX on board, to assist in off-loading and on-loading equipment, supplies, and refuse from the two open-top external cargo baskets secured to the helicopter's skid gear. Cargo was secured in the cargo baskets by multiple bungee cords. The return flight would have been flown directly into the late afternoon sun. There were no witnesses to the accident. Cargo and paint chips were found near a freshly downed and up rooted snag (a dead, defoliated conifer) located on the ridgetop. The snag was estimated to have been 90' tall. Further down the mountain side was a tail rotor paddle which had separated at its cuff. The burned wreckage of the helicopter was found on a forest service road, approximately 2,000' down the mountain and 1,230' elevation loss from the initial downed snag. Post-accident examination of the engine revealed that the power turbine's blades were sheared from their disc, which indicated an over speed event, which would occur with a main rotor blade strike/sudden-stoppage event, and the subsequent compromised engine to main rotor power train. 11 of the containers from one cargo basket had 3 to 9 inch slashes in them from the tail rotor. Interviews were conducted with four Helitack crew members who were assigned to the helicopter. They said the pilot did like to do "showy" flying at times, but would always ask the passengers if they were comfortable. He would "buzz" a ridge every now and then, and perform a maneuver he called the "sleigh ride." One of the Helitack crew members said that a "sleigh ride was where you top a ridge then drop the collective, drop the nose a bit....it was a common maneuver for him." No preimpact engine or airframe anomalies, which might have affected the helicopter's performance, were identified.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's intentional low altitude flight and his failure to maintain an adequate altitude to clear the trees.

Chapter 7
Visibility

1. **Short explanation and introduction. [PHAK Ch. 14; FAR Pt 91; FM 3-04.203 Ch 3, 4, 5]** Issues with visibility and low-level helicopter flight have been around since the beginning. From the very first commercial rescue in the Long Island sound on November 29, 1945.

   Helicopter rescues have continued, as has low-level operations and at times in exceedingly poor visibility conditions. FAA regulations also support low-level operations by allowing pilots to operate in marginal VFR conditions. Perhaps the most general logic used in the acceptance of such operations is the sheer fact that a helicopter can stop in space and safely land to the surface. The challenge has been and will continue to be, the appropriate application of Aeronautical Decision-Making (ADM).

   Low visibility conditions do not consider the experience level of the pilot. The environment is not concerned with how quickly a helicopter can maneuver into a clear area and safely touch down. Many pilots operate in limited visibility with great success, and this can be attributed to many things like experience, operational procedure, crew coordination, and/or special mission equipment. Detailed study of accident data will indicate that continuing VFR flight into IMC conditions often ends with catastrophic consequences.

   Technological advancements for helicopters operating at low level and in limited visibility will continue to improve. In just the last 10 years, some helicopters have been fitted with Helicopter Terrain Avoidance Warning Systems (HTAWS) that portray the surrounding terrain in two and three dimensions. Thermal imagery can enhance the HTAWS system even more. Perhaps one of the most important human factors study is to be made in the near future will be determining the influence of the glass cockpit and additional safety systems impact on a pilot or flight crew in low visibility conditions.

   It is likely that pilots will continue to measure the risk of operating in limited visibility. Therefore, how they do this is even more important than in the past as the stakes are much higher. Complex aircraft with complex systems simply cost more, and combined with the unpopularity of fatalities, the insurance industry, government regulators, and public, these mission profiles will continue to receive increased scrutiny.

2. **Accident Occurrence**. Visibility was cited as an occurrence In 56 of the 523 accidents (11%) analyzed by the JHSAT Visibility accidents were grouped into several different categories. This is due to the various environmental situations by which aircrews in flight are exposed to. These categories are fog/glare, flat light, glassy water, inadvertent IMC, night/darkness, sun/glare, white-out/brown-out and are inclusive to the table below. Accidents with visibility as a contributing occurrence category occurred more often during the enroute phase of flight than

during other phases, such as takeoff, landing, or approach. Inadvertent Instrument Meteorological Conditions (IIMC) has routinely been the number one killer.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Ground Duties	Mission/Flight Planning	Inadequate consideration of weather/wind
Pilot Situational Awareness	Visibility/Weather	Reduced visibility-darkness, night
Pilot Situational Awareness	Visibility/Weather	Reduced visibility--fog, rain, snow, smoke
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Pilot decision making
Pilot Judgment & Actions	Flight Profile	Pilot's flight profile unsafe – Altitude
Pilot Situational Awareness	External Environment Awareness	Aircraft position and hazards
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Willful disregard for rules and SOPs
Pilot Judgment & Actions	Flight Profile	Pilot's flight profile unsafe for conditions
Pilot Judgment & Actions	Human Factors - Pilot/Aircraft Interface	Perceptual judgment errors
Safety Management	Management	Management policies/oversight inadequate

3. **Standard Problem Statement**. The table below highlights the fact that visibility accidents are widespread and appear more frequently on the Top 20 Standard Problem Statements found by the JHSAT analysis. A cursory review of these statements identifies the seriousness of human action.

Rank	SPS LVL 1	SPS LVL 3
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver
6	Pilot Situation Awareness	Aircraft position and hazards
8	Pilot Judgment & Actions	Pilot's flight profile unsafe – Altitude
9	Pilot Judgment & Actions	Pilot decision making
10	Ground Duties	Inadequate consideration of weather/wind
15	Safety Management	Management policies/oversight inadequate
16	Pilot Judgment & Actions	Willful disregard for rules and SOPs

4. **Intervention Recommendation**. The categories below include; fog/glare, flat light, glassy water, inadvertent IMC, night/darkness, sun/glare, white-out/brown-out and are inclusive to the table below. A combination of aeronautical knowledge enhancing decision-making is essential for intervention. Affordable technology may be a challenge today, but resolve itself as it does, though perhaps the best possible intervention when combined with training. Answering the question of what does an accident really cost sometimes help companies decide to commit resources to enhance situational awareness with technology.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/Instructional	Advanced Maneuver Training	Inadvertent IMC Training
Systems & Equipment	Situational Awareness Enhancers	Install EVS/SVS/NVG
Training/Instructional	Safety Training	Risk assessment/management training
Safety Management	Risk Assessment/ Management	Use Operational Risk Management Program (Inflight)
Training/Instructional	Safety Training	Training emphasis for maintaining awareness of cues critical to safe flight
Safety Management	SOP - Ops Mgt	Establish risk assessment program that addresses the potential for VFR into adverse Wx and night flight ops
Safety Management	Risk Assessment/ Management	Establish/Improve Company Risk Management Program
Safety Management	Flight ops management	Improved supervisory and operational oversight

5. **Accident Narratives**. The key to understanding the significance of visibility accidents is that the highest level of injuries range from the serious to fatal category.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Visibility - Flat Light
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- The commercial helicopter pilot was flying one passenger on an on-demand, Title 14, CFR Part 135 air taxi flight to a remote site in an area surrounded by snow-covered, flat, featureless terrain. Low fog, reduced visibility, and flat light conditions reduced his ability to discern a horizon or terrain. He said visibility deteriorated to about 1-2 miles, and was unable to discern any topographic features on the snow-covered terrain, and elected to make a precautionary landing to wait for better visibility. After about 10 minutes, he decided to continue flight. After takeoff, flat light conditions again reduced ability to recognize topographical features on the snow-covered terrain. He reported that in attempting to establish a stable hover, and erroneously believing that the acft was not moving, the right skid struck the snow-covered terrain. The acft rolled right, the main rotor blades struck the ground, and the helicopter rolled onto its right side. The acft sustained substantial damage to the fuselage, tail boom assembly, and the main and T/R drive systems. The pilot reported that there were no pre-accident mechanical anomalies with the helicopter.

The NTSB determines the probable cause(s) of this accident as follows. The pilot's continued flight into adverse weather conditions, and his spatial disorientation and loss of control during a subsequent landing attempt. Factors associated with the accident are flat light and whiteout conditions, fog, and snow-covered terrain.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	Visibility - Inadvertent IMC
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The turbine powered helicopter was on a 29 nautical mile night flight over a city. Two law enforcement officers, located about two blocks northeast of the accident site, reported observing the helicopter "flying at a very low altitude" northbound. The officers walked around the building to a parking lot where they met another officer. All three officers heard the helicopter fly over the parking lot in a southwest direction. The officers looked for the helicopter, but they could not see it due to the poor visibility. When the helicopter came into view, it was "banked to the right" traveling in a westerly direction. The helicopter continued in a downward direction, and then a "huge fireball" was observed. The helicopter struck wires, a power pole and an above ground gas meter. An electrical transformer exploded, and the helicopter was consumed by the ensuing fire. The destination airport had IFR weather conditions at the time of departure. Witnesses estimated that at the time of the accident, there was an overcast ceiling of about 300-400 feet. No record was found of any preflight weather briefing obtained by the pilot. No pre-impact anomalies were observed during an examination of the airframe and engine.

The NTSB determines the probable cause(s) of this accident as follows: the pilot's failure to maintain obstacle clearance while maneuvering, which resulted in an in-flight collision with objects. Contributing factors were the dark night and low ceilings.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Visibility - Sun/Glare
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot collided with wires and impacted terrain while maneuvering during a morning aerial application flight. The pilot indicated that the accident could have been prevented had he performed a better reconnaissance of the area, avoided distractions, and approached the wires with the sun at his back.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadequate visual lookout while maneuvering in proximity to wires. A contributing factor was the sun glare, which reduced the wire's conspicuity.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Visibility - Fog/Glare
Airport Proximity: Off	Distance From Landing Facility:	

Accident Information Summary-
While en route to pick up a passenger for VFR revenue flight, the pilot encountered fog. She diverted from her intended destination and landed in a field. When her passenger arrived, darkness had fallen, and dense fog formed. The pilot and passenger boarded the helicopter. A witness watched as the helicopter climbed vertically to a height just above the trees to its left and utility lines to its front, and hovered for a few seconds. While hovering, the landing light of the helicopter cycled on and off two times. The helicopter then pitched nose down and accelerated forward. Instead of climbing, the helicopter accelerated forward in a shallow descent until impacting the ground. The witness described that the conditions of darkness and fog prevented him from making his way to the accident scene without the aid of a light. Several witnesses described similar conditions around the time of the accident. Forecasted and actual recorded weather conditions in the area around the time of the accident were consistent with witness observations. The ceiling/visibility conditions were significantly worse than minimum values required by company operations specifications. Further review of the operations specifications revealed the pilot was required to report any itinerary changes to the operator. No evidence was found to indicate pilot notifying operator of initial deviation/landing in the field, or intent to depart from field after sunset. Additionally, during post-accident interviews the operator couldn't clearly articulate its actual method for determining whether an aircraft was overdue, since no one individual was charged with that specific duty for operations after normal business hours. Examination of the wreckage revealed no evidence of any pre-impact mechanical malfunctions.

The NTSB determines the probable cause(s) of this accident as follows. The pilot's improper decision to depart under visual flight rules into night instrument meteorological conditions. Contributing to the accident was the fog and the dark night conditions.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	Visibility - night/darkness
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The non-instrument rated pilot departed on a night cross-country flight with no record of a weather briefing. Although visual meteorological conditions prevailed, witnesses along the route of flight reported isolated areas of fog and low clouds were present. The terrain was rolling tree-covered hills with no ground lighting. Two witnesses in a vehicle saw a momentary glow behind a ridge covered by a low cloud. A tree with freshly skinned bark located near the top of a ridge was found 670 feet prior to where the main wreckage was found. The debris trail between the tree and main wreckage included components from the battery located in the nose of the helicopter, side doors, windshield plexiglas, part of the trailing edge of one main rotor blade, and part of one tail rotor blade. The helicopter burned at impact. No evidence of a mechanical failure or malfunction was found with the helicopter or engine. The pilot's total flight experience was estimated at about 386 hours with 60 hours in make and model.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. the pilot's improper weather evaluation, and his failure to maintain terrain clearance while operating over unlighted terrain at night. Factors were the isolated areas of fog, and night conditions.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Visibility - glassy water
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter sustained substantial damage on impact with water while maneuvering over a glassy lake. The pilot stated, the Lake selected for low altitude water/shoreline footage. Did high recon, no observed boat traffic in conflict with flight path over water at approx 40 to 50 ft. Commenced descent profile of 80 mph and 600 [fpm]. The descent was to continue until treetop level then terminate descent and cruise over water for length of lake. Flight path was S to N with planned airspeed of 60 - 80 mph, then climb out. Reached target altitude confirmed with left and right shoreline sight picture, raised collective with [simultaneous] forward cyclic to commence over water cruise. Engine appeared non-responsive to power demand. Descent was not arrested. Added additional collective; no response to power demand. Leveled aircraft and impacted water with forward velocity. The left front seat PAX stated, "the pilot did not give us any preflight safety briefing or instructions. The pilot did not demonstrate or explain how to use the seatbelts or how to egress from the helicopter in case of an emergency. Shortly after takeoff, I noticed we were flying very low over the lake. Suddenly the helicopter abruptly dove nose down first crashing into the lake. The helicopter quickly began to sink into the water. I could not unbuckle the safety harness strap. My clothing was getting very heavy and began to swallow water uncontrollably I thought I was going to die. I continued to successfully unsuccessfully struggle with the safety harness. Finally, somehow I was able to wiggle out of the buckled safety harness." Wind was calm, sky condition clear, and the temperature was 20° C. An unseen investigation of the recovered wreckage revealed no pre-impact of anomalies. A study of an onboard video revealed sounds consistent with functioning engine and rotor system. Both rear passengers were not wearing their seatbelts.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot not maintaining altitude/clearance when he maneuvered above the glassy lake. A factor to the accident was the glassy lake condition.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	Visibility - white-out/brown-out

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The commercial certificated pilot was transporting two medical crewmembers under Title 14, CFR Part 91, to a prearranged LZ to meet ambulance and fire dept. personnel caring for a patient. The flight was conducted during dark night conditions. The accident helicopter had predetermined LZ locations stored in its onboard GPS system. The stored landing sites had been previously inspected for obstruction clearance and overall suitability. After arriving overhead of apparent sod-covered field, the pilot used an externally mounted searchlight to aid in seeing ground and obstructions during approach. As the helicopter approached open field and transitioned to a hover, the pilot encountered blowing, dry sand and dust created by the helicopter's main rotor downwash, reducing visibility. He stated he lost all visual reference with ground, and while attempting to regain a visual reference, the helicopter's main rotor struck a large tree, and the fuselage began to rotate. The helicopter's tail boom assembly subsequently struck the tree, and the helicopter impacted terrain. The helicopter sustained substantial damage to the main rotor drive system, tail boom assembly, and fuselage. A post-accident inspection of the landing site disclosed the sod had recently been removed from field, leaving a dry, sand-covered field. The pilot reported that there were no pre-accident mechanical anomalies with the helicopter.

The NTSB determines the probable cause(s) of this accident as follows. Pilot failure to maintain clearance from objects while hovering IGE, resulting in an in-flight collision with a tree. Factors associated with the accident were loose, sand-covered terrain, and the operator's failure to ensure that the pilot was provided with current, off-airport landing site condition information.

Chapter 8
Abnormal Runway Contact

1. **Short explanation and introduction**. **[HFH Ch. 11]** This type of accident comprises 8% by Occurrence category. DEFINITION. Abnormal Runway Contact (ARC) is defined as landings that result in collapsed or spread gear, main rotor blade contact with the airframe, or tailboom damage. These accidents are not limited to abnormal contact with a prepared runway, but include unprepared surfaces as well.

   Abnormal Runway Contact (ARC) events occurred in forty (7%) of the 523 accident reports analyzed in the Compendium Report. A detailed look identifies that nine accidents resulted from the improper execution of a practice autorotation landing.

   The JHSAT team reviewed demographics and included the mission being flown at the time of the accident, and each accident was operating under Part 91, General Aviation Rules and CFIs were at the controls with either a student pilot or a passenger with minimal flight experience.
   Pilot flight times were also reviewed. The team determined that the total time were in the 1400 – 1700 total time flight hour range, with 900 – 1200 time as the Instructor. Both accidents had passengers on board and no flight time was reported for either occupant; however, the industry component listed in accidents was identified as flight academies. Total rotorcraft time in Make/Model ranged from 900 – 1200 hours.

2. **Accident Occurrence**. Abnormal Runway Contact is a result as opposed to the cause of an accident, and as such has many potential relationships with other occurrence categories that are discussed in detail in other sections of this report. After reviewing the data, the JHSAT concluded that Pilot Judgment & Actions was the most frequently cited problem in Abnormal Runway Contact accidents. Improper decisions on the ground and in-flight by the pilot and others resulted in these types of accidents.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Landing Procedures	Autorotation – Practice
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Pilot Judgment & Actions	Procedure Implementation	Inappropriate Energy/power management

3. **Standard Problem Statement**. Abnormal Runway Contact (ARC) was noted as an occurrence category 8% (40 out of 523) accidents. The consistent Level 1 SPS was Pilot Judgment & Actions, cited as a problem in 100% of the 40 accidents where ARC contributed. Additionally, Post-crash Survival/Safety Equipment was listed due to one accident involving a CFI not using the installed shoulder harness. It is important to note that the accidents in this occurrence evolved from one or more areas.

Rank	SPS LVL 1	SPS LVL 3
3	Pilot Judgment & Actions	Pilot control/handling deficiencies
6	Pilot Situation Awareness	Aircraft position and hazards
7	Pilot Judgment & Actions	Inappropriate Energy/power management
9	Pilot Judgment & Actions	Pilot decision making

4. **Intervention Recommendation**. Intervention categories to prevent future occurrences of ARC accidents include Safety Training, Basic Training and Flight OPS Management.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/ Instructional	Advanced Maneuver Training	Simulator Training - Advanced Maneuvers
Training/ Instructional	Advanced Maneuver Training	Autorotation Training Program
Training/ Instructional	CFI Training	CFI judgment and decision making training to follow student more closely

5. **Accident Narratives**. These accident reports come from a diverse population of locations and flight modes and illustrate the complexity of this accident area.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABNORMAL RUNWAY CONTACT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
During a practice power recovery autorotation, the private single engine land rated, helicopter student pilot performed a full autorotation when the engine lost all power. During the ensuing power off landing to an open soft field, the helicopter tipped forward, the main rotor struck and severed the tail boom, and the helicopter rolled on its right side. An examination of the engine provided no evidence of pre-impact failure or malfunction.

The NTSB determines the probable cause(s) of this accident as follows. The pilot misjudged the run on landing during a full autorotation. Factors were a total loss of power for unknown reasons and soft terrain.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	ABNORMAL RUNWAY CONTACT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- Shortly after liftoff to a 10-foot hover, the certified flight instructor (CFI) transferred control of the helicopter to the student pilot. The student then 'jerked' back on the cyclic and the tail rotor struck the ground before the CFI could regain control. As the helicopter 'spun' to the right, the CFI attempted to reduce the throttle and lower the collective. The helicopter came to rest on its left side and both occupants evacuated. The helicopter sustained structural damage to the tail boom, cabin, and main rotor system. The instructional flight was the second for the student pilot who had 2 hours of total flight time.
The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The student pilot's abrupt control input, which resulted in a tail rotor blade strike. Factors were the CFI's delay in taking remedial action and the student pilot's lack of total experience.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABNORMAL RUNWAY CONTACT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- While hovering out of ground effect, the helicopter had a hydraulic system failure. The pilot shutoff the hydraulic accumulator pressure 5 seconds after the warning horn sounded. According to the onboard cameraman the helicopter began to spin. The pilot stabilized the helicopter, and reported to other news helicopters filming the night time event, that she had lost hydraulic pressure and was experiencing control problems. Another pilot suggested that the pilot consider two airports within 5 miles. The pilot elected to return to the home base, about 15 miles away. The pilot reported en route to escorting helicopters that her right leg was 'killing her.' A hover landing was attempted, and a loss of control resulted in spinning out of control to the ground. Postaccident examination revealed a failed hydraulic pump drive pulley bearing and subsequent drive belt failure. According to the rotorcraft flight manual, 'The pressure stored in the accumulators allows sufficient time to reach the 'refuge' area with hydraulic servo-assistance.' According to manufacturer representatives, that time is between 30 and 45 seconds, depending on control inputs. The pilot action is to 'Calmly reduce collective pitch and adjust the airspeed to between 40 and 60 knots in level flight. Cut off the hydraulic pressure, using collective lever pushbutton.' According FAA medical data, the pilot's last reported weight was 108 pounds and a height of 61 inches. According to pilots who are experienced in this model, body size and strength are important issues in handling this type of emergency. The manufacturer representative stated that it is an emergency, and the pilot should land as soon as practical. It was also stated that the accident pilot had recently completed the factory-training course successfully.
The National Transportation Safety Board determines the probable cause(s) of this accident as follows. the pilot's failure to land as soon as practical and to utilize the available accumulator pressure to transition from hover to flight. Contributing to the accident was the pilot's physical stature and strength, and the inadequate and incomplete emergency training and flight manual information.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	ABNORMAL RUNWAY CONTACT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- The helicopter pilot took off about 0415 from a chemical loading site, made a left turn, and departed to spray a field. Subsequently the wreckage was located 1/2 mile west of the field. The helicopter collided with level farm terrain while in a descent. The horizontal and vertical stabilizers and tail rotor assembly appeared to be undamaged. The main rotor mast had rotated about 45 degrees forward, and symmetrical upward crushing of the cabin area occurred. A post-accident examination of the helicopter was conducted.
The anti-torque control system examination revealed a tail rotor pitch change shaft's castellated shear nut stripped from the rotor end of the shaft. The threads were still intact on the shaft but missing from the nut. The shaft cotter pin hole retained the sheared portions of the cotter pin. The shearing force came from an unknown source. An ongoing wear imprint from the shaft end, into the castle nut, was noted by the lab report. Nut damage to the interior of the pitch change cap was also found during the wreckage examination.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. the partial failure of the tail rotor pitch change control rod that resulted in an attempted run-on landing in dark night conditions.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABNORMAL RUNWAY CONTACT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- The pilot was conducting low level wildlife surveillance. He stated that the atmosphere was humid. When the helicopter was refueled, he noticed that the carburetor had accumulated condensation from the humid air. The pilot departed and after 5 minutes of flight, he noticed that the carburetor air temperature gauge was reading in the lower one third of the yellow caution range. When he adjusted the carburetor heat control lever, the engine lost power. The pilot made an autorotation to an open area. The helicopter landed hard, the main rotor blade contacted and severed the tail boom, and the extended gear legs collapsed.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's misjudgment of the flare, which resulted in a hard landing. Contributing factors were weather conditions conducive to carburetor icing, the pilot's delay in applying carburetor heat, and his inattention to the carburetor air temperature gauge.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABNORMAL RUNWAY CONTACT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- The pilot approached the remote snow covered mountain site into the wind. During the descent at about 50 feet, the wind increased and shifted. The helicopter began to descend rapidly, and the pilot increased power in an attempt to arrest the rate of descent. Shortly thereafter, the low rotor rpm horn sounded and the helicopter touched down just past the normal landing site with sufficient force and forward speed to prevent him from holding it on the landing site. The pilot applied forward cyclic in an attempt to prevent the helicopter from falling off a 30 foot drop. Due to the low rotor rpm and the inability to maintain altitude, the pilot elected to land the helicopter in a large open snowfield. During the landing, the helicopter settled in the snow and the main rotors contacted the ground. The helicopter subsequently rolled over. The weather at the accident site was reported as high overcast. The wind direction was not indicated, however, the wind velocity was reported at 15-20 knots. No mechanical failures or malfunctions were reported.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to maintain aircraft control. Snow covered terrain, high and variable wind conditions, and failure of attaining the proper touchdown point were factors.

Chapter 9

Fuel

1. **Short explanation and introduction. [HFH Ch. 4; AOM]** These accidents consist of conditions when inadequate or unsuitable fuel resulted in a subsequent power loss and failed autorotation. The types of fuel problems analyzed consist of; fuel exhaustion, fuel starvation, fuel contamination, and carburetor icing.

   Fuel exhaustion, where the supply is completely depleted in flight, leads to a total engine power loss and usually coincides with the lack of pilot awareness to the status of the fuel supply. Fuel starvation occurs when the supply of fuel to the engine is interrupted and liked fuel exhaustion, leads to total loss of engine power. Fuel contamination exists when a contaminant interrupt fuel flow and the continued functioning of the engine. Carburetor icing occurs in reciprocating engines that operate in ambient with low temperature and higher humidity, causing icing condition in and around the carburetor system.

   In this area of flight operations, it is clear that situational awareness is essential to preventing these fuel related accidents. The complacency of a higher time pilots has shown to be a contributing factor in the statistics surrounding the analysis of the situation.

2. **Accident Occurrence**. Each accident involves the interruption or prevention of fuel delivery. This led to engine power loss, followed by unsuccessful forced autorotation landings.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Ground Duties	Mission/Flight Planning	Incorrect fuel planning/calculations
Pilot Situational Awareness	Internal Aircraft Awareness	Unaware of low fuel status leading to fuel starvation/exhaustion
Ground Duties	Aircraft Preflight	Performance of Aircraft Preflight procedures inadequate
Pilot Judgment & Actions	Procedure Implementation	Lack of Inflight fuel quantity monitoring

3. **Standard Problem Statement**. Fuel related accidents accounted for 8% of the 523 total accidents in the analysis. Unsuccessful autorotations after losing engine power due to fuel issues were a significant portion of these accidents.

Rank	SPS LVL 1	SPS LVL 3
1	Pilot Judgment & Actions	Autorotation – Forced
11	Ground Duties	Performance of Aircraft Preflight

4. **Intervention Recommendation**. The table below clearly represents the fact that Training and Instruction are safety factors in fuel related accidents. This should be combined with safety management and system improvements.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/Instructional	Advanced Maneuver Training	Autorotation Training Program
Systems & Equipment	Cockpit Indication/Warning	Fuel System improvements
Training/Instructional	Basic Training	Enhanced Mission Planning Training
Safety Management	Risk Assessment/Management	Personal Risk Management Program (IMSAFE)
Systems & Equipment	Cockpit Indication/Warning	Automate carb anti-ice function, early warning alert function

5. **Accident Narratives**. The types of fuel problems analyzed consist of; fuel exhaustion, fuel starvation, fuel contamination, and carburetor icing.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	FUEL - Contamination
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter was in cruise flight over the Gulf of Mexico when it began to vibrate and shudder. The pilot lowered the collective control to initiate an autorotation and the engine lost power. During the ensuing autorotation, the helicopter's floats were deployed. The pilot attempted to decelerate the helicopter; however, the controls became stiff, and subsequently, the helicopter hit the water hard. Examination of the helicopter's fuel system revealed that the fuel nozzle inlet screen was collapsed and the screen was 80 to 90% contaminated with a brown material with a polymeric-like to varnish-like appearance. The screen was examined by a laboratory, and it was determined that DIEGME, a fuel additive used as an icing inhibitor, was present on the screen. The helicopter's operating environment is such that salt water could have been introduced into the fuel system. The presence of water and fuel would allow bacteria to grow. The combination of bacterial growth, DIEGME, and water resulted in the formation of an "apple-jelly" type material, which then adhered to the fuel system components (fuel nozzle screen). The blockage and collapse of the fuel nozzle screen resulted in an interruption of fuel flow, and the subsequent loss of engine power.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. fuel contamination due to the combination of DIEGME, water, and bacterial growth, which resulted in formation of an apple-jelly type material that blocked the fuel nozzle screen and led to a loss of engine power.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	FUEL - Exhaustion

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
The airline transport certificated pilot, with four passengers, departed on a Title 14, CFR Part 91, local area revenue sightseeing flight in a skid-equipped helicopter. According to the operator's chief pilot, the accident pilot reported that while in cruise flight, the fuel pump warning light illuminated, and he began a precautionary landing approach to a vacant parking lot. While on final approach to the parking lot, the pilot said the "engine flamed out." The pilot initiated an autorotation, but the helicopter landed hard. The helicopter's landing gear cross-tubes were deformed, the pilot's windscreen was broken, and the fuselage received structural damage. An FAA inspector reported that an examination of the helicopter revealed that it had flown 1.5 hours before the accident. The helicopter's fuel gauge, annunciator system, fuel pump, and fuel system, functioned normally. A pressure check of the fuel lines revealed no leakage. The inspector indicated that the fuel tank contained about 40 ounces of fuel. The inspector reported that during his examination of the helicopter, no mechanical malfunction was found.

The NTSB determines the probable cause(s) of this accident as follows. The pilot's failure to refuel the helicopter prior to the accident flight, which resulted in a loss of engine power during cruise flight, and a hard landing.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	FUEL - Carburetor Icing

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
The pilot stated he was in cruise flight at 700 feet over a residential area when the helicopter experienced a reported loss of engine and rotor rpm. The pilot did not activate the carburetor heat as required by the pilot operating handbook. The pilot lowered the collective pitch and increased throttle with negative results. He initiated a forced landing to a field but realized he would not be able to reach it. He made a forced landing to a residential carport. The right skid slipped through the roof, the aircraft rolled over on its right side and the main rotor blades collided with the roof. Examination of the airframe and flight controls revealed no evidence of a pre-crash mechanical failure or malfunction. The engine assembly was removed and mounted in a dynamometer test cell. The engine was started and produced engine power.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to use carburetor heat as required by the Pilot's Operating Handbook resulting in a loss of engine and rotor rpm, forced landing to none suitable terrain (residence), and subsequent roll over.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	FUEL - Starvation

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The twin-engine helicopter departed on a positioning flight to pick up a medical patient. While in cruise flight, at 2,000', both engines experienced a total loss of power. The pilot attempted to autorotate to a field; however, the helicopter impacted trees and came to rest on its right side. The pilot reported that he did not notice any warning lights immediately before or during the loss of engine power events. However, it was noted during a post-accident examination of the helicopter that the pilot instrument light and console light variable resistor control was in the ON position. This control dims the MC and annunciator panel lights for night operations. The NTSB IIC noted that the master caution and annunciator lights were not visible in daylight with the pilot and console variable resistor control in the ON position. Although the two fuel transfer pump switches were found in the ON (normal operating) position, examination of the fuel system provided evidence that the dual engine power loss was the result of fuel starvation due to these switches not being ON during the majority of the flight. The fuel supply lines to the engines were found empty, a nominal amount of fuel was found in the fuel filters, and the fuel quantity indicator displayed 4, 0, and 15 gallons of fuel in the #1 supply, #2 supply, and forward main fuel tanks, respectively. The function of the fuel transfer pumps is to transfer fuel from the forward main tank to the two supply tanks. The fuel transfer pumps were operated during the post-accident examination by turning on their respective switches and it was noted that fuel began to flow into the supply tanks. Additionally, it was noted that the fuel transfer pump caution lights (which are illuminated when the pumps are off) extinguished when the pumps were turned on. The engines were placed in a test cell and both operated with no anomalies noted. The normal operating checklist calls, in part, for the pilot to set the instrument lights as required, test the annunciator panel for operation, and turn on the transfer pumps after engine start.

The NTSB determines the probable cause(s) of this accident as follows. the pilot's failure to follow the checklist and turn on the fuel transfer pumps, which resulted in fuel starvation and a dual loss of engine power while in cruise flight.

Chapter 10
Landing Zone (LZ)

1. **Short explanation and introduction**. **[HFH Ch. 10; AOM; FM 3-04.203 Ch 5]** Accidents in a landing zone occur on or near the ground at or near the intended touchdown point. These LZ's are separated into different areas that the better associate to a phase of flight or area of operation. These include approach to an LZ, maneuvering within the LZ, and ground handling in the LZ. Further, the associated sub-occurrence categories include prepared surfaces and unprepared surfaces.

   Landing zone areas away from airport, heliport, or other prepared surfaces intended for the use of helicopter operations vastly outnumber those prepared and surveyed locations. Landing in these areas which can often times be confined, require a different level of awareness to pilots and air crew operating in and around them. Throughout early training as a helicopter pilot, we learn to deal with space in a different way than when in a low-level and confined environment. Airport's runways and taxiways give the new pilots almost a sense of security. The most confined environment they generally operate in our parking close to hangers, in between helicopters at a parking space or like environment. Helipads are similar in that the surrounding areas can be fairly open and free of obstruction or closer to that low-level environment where obstacles are closely located near available touchdown points. When a pilot graduates from an airport or open environment to a confined area in a low-level environment, there are more edges of space to contend with. Situational awareness must combine with training and procedural action to give the pilot the best decision-making tools available for safe operations.

   It is important for a pilot operating in an unprepared environment to understand the conditions of that environment. This is to say that the behavior of weather conditions, vegetation, terrain, Size–Distance Relationships or association, peripheral vision, and the ability to "wear the helicopter". Throughout training a pilot must develop a sense of awareness for the size of the aircraft as it relates to tight spaces. Much as a basketball player can put a ball through a hoop without touching the rim, the helicopter pilot must fit an aircraft into a landing zone in the same manner (safely of course), but if you will, out of the corner of their eyes, or behind their back. This requires a higher level of coordination.

   Like a symphony, selecting appropriate landing sites are directly tied to every event that must occur before touching down. Surrounding each of those events are hazards and other considerations that absolutely must be made.

2. **Accident Occurrence**. The JHSAT used the Landing Zone occurrence category in 7% (39 out of 523) of accidents analyzed. Clearly, the problems in landing zone accidents derive from Pilot Judgment & Actions, as well as Safety Management decisions.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Landing Procedures	Selection of inappropriate landing site
Pilot Judgment & Actions	Landing Procedures	Landing site reconnaissance
Pilot Situational Awareness	External Environment Awareness	Aircraft position and hazards
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver

3. **Standard Problem Statement**. Is important to note that the Standard Problem Statements shown below comprise the highest percentage of LZ accident occurrences. It is also significant that in each of the problem statements in the table below, the pilot decision-making is integral.

Rank	SPS LVL 1	SPS LVL 3
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver
3	Pilot Judgment & Actions	Pilot control/handling deficiencies
6	Pilot Situation Awareness	Aircraft position and hazards
14	Pilot Judgment & Actions	Selection of inappropriate landing site

4. **Intervention Recommendation**. In all cases, Safety Management Systems are a top priority in reducing risk at landing zone areas. Standard operating procedures worked hand-in-hand with SMS programs to ensure safety at off-site locations. Operational management is a key area in this industry that needs work. These interventions include the top categories for both prepared and unprepared LZ's.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Safety Management	SOP - Ops Pilot	Training and recognition on suitable landing site selection
Systems & Equipment	Situational Awareness Enhancers	Install proximity detection system
Safety Management	Risk Assessment/ Management	Use Operational Risk Management Program (Inflight)
Training/Instructional	Basic Training	Ground Hazard Awareness/Proximity Training
Safety Management	SOP - Ops Mgt	Establish SOP for selection of off airport or remote LZ
Training/Instructional	Safety Training	Training emphasis for maintaining awareness of cues critical to safe flight
Training/Instructional	Advanced Maneuver Training	Dynamic Rollover Training

Training/Instructional	Advanced Maneuver Training	Simulator Training - Advanced Maneuvers

5. Accident Narratives. These accidents are associated with LZ operation;

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LANDING ZONE - Prepared
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
During the practice 180-degree autorotation landing, the helicopter touched down hard, the main rotor severed the tail boom, and the helicopter rolled on its side. The first pilot reported that, during four of six prior autorotations performed by the second pilot, it was necessary for the him to assume control of the helicopter and make power recoveries due to high landing flares, improper airspeed, and improper rotor rpm. During the seventh autorotation, the landing approach that resulted in the accident, the first pilot stated that the second pilot first let the main rotor rpm get too high, then too low, and then let airspeed get low. The first pilot again took control and applied engine power, but this time, as the ground approached more rapidly than before due to recovery from a low airspeed and low rpm condition, the second pilot "began to scream" and interfered with the first pilot's control by pulling up on the collective. The first pilot could not overpower him, the rotor rpm decayed further, and a hard landing resulted. The first pilot reported there were no mechanical problems with the helicopter. The second pilot reported that, as he initiated the final autorotation, the first pilot said "hold on, hold on," and the second pilot thought he was again taking the controls and relinquished them to him. As the helicopter continued the descent, the first pilot continued to say "hold on, hold on," and the second pilot became worried because the ground approached rapidly and the low rpm horn had been on for several seconds. When the second pilot realized they were going to crash and the first pilot wasn't doing anything to arrest the situation, he (the second pilot) took the controls and tried to flare and pulled full up collective to cushion the landing.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot-in-command's inadequate supervision of the second pilot and delay taking control of the aircraft and implementing remedial action. A factor in the accident was the second pilot's interference with the pilot-in-command's operation of the collective flight control.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LANDING ZONE - Prepared
Airport Proximity: Off	Distance From Landing Facility:	

Accident Information Summary-
The certificated commercial helicopter pilot was landing on an elevated landing platform. After landing, as the throttle was retarded to the flight idle position, the helicopter began to shake violently, and tip backwards. The pilot opened the throttle in an attempt to restore rotor rpm, but the helicopter continued to tip backwards, and the tail rotor blades struck the ground. The helicopter sustained substantial to the tail rotor gearbox assembly, and vertical fin. According to a FAA operations inspector, the pilot stated to him that after she had an opportunity to think about the events surrounding the accident, she felt that she had landed the helicopter with the rear skid cross-tube over the aft edge of the elevated platform.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to attain a proper touchdown point.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LANDING ZONE – Un-Prepared
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The commercial helicopter pilot terminated the night approach to a 6 to 8-foot hover, with 'trees and 2 post-box's to the right and a large ditch to the left.' The pilot hovered the helicopter sideways to the left to move away from the trees. He then started a left pedal turn to face EMS units located behind the helicopter. He had turned the helicopter approximately 120 degrees, 'when I moved backwards' and struck the trees with the tail rotor. He immediately stopped the turn and moved the helicopter forward before losing tail rotor control. As the helicopter began to spin, he 'lowered the collective and landed hard.' The tail rotor drive shaft forward of the 45 degree gearbox was sheared.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's failure to maintain obstacle clearance while hovering the helicopter. A contributing factor was the dark night light conditions.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LANDING ZONE – Un-Prepared
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot reported that the tail rotor contacted water during landing. The pilot reported that he was landing near a "decorative pond" at a country club when the accident occurred. He said that he flew over the landing area and did not notice any obstructions. He reported that unknown to him at the time, there were ducks along the bank of the pond. The ducks flew up into the windscreen at which time he pulled back on the cyclic and the tail rotor contacted the water. The pilot reported that he then entered an autorotation, touching down on the bank of the pond.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot inadvertently pulled back on the cyclic when birds flew into the windscreen. A factor associated with the accident were the birds.

Chapter 11
Fire

1. **Short explanation and introduction**. **[AOM]** In this study, the fire occurs in two categories: non-impact, and post-impact. Survivability in a fire sequence is essential, but most accident data reflected thermal trauma as a huge threat.

2. **Accident Occurrence**. There were 32 of 523 accidents (6%) that included an occurrence category of fire. Most were fatal or serious regarding injury level. While approximately 6% of the accidents included a fire, they contributed to 48% of all fatalities.

SPS Level 1	SPS Level 2	SPS Level 3
Post-Crash Survival	Crashworthiness	Post-crash fire
Maintenance	Performance of MX Duties	Failure to perform proper maintenance procedure
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Willful disregard for rules and SOPs
Safety Management	Safety Program	Insufficient employee performance monitoring
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Safety Systems & Equipment	Safety Systems & Equipment (level 2)	Intolerance to wire strike

3. **Standard Problem Statement**. A number of the JHSAT's top 20 SPSs are connected to the occurrence category of fire and appear to hint that human failure was a primary contributor.

Rank	SPS LVL 1	SPS LVL 3
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver
4	Maintenance	Failure to perform proper maintenance procedure
16	Pilot Judgment & Actions	Willful disregard for rules and SOPs
18	Training/Instructional	Post-Crash Fire

4. **Intervention Recommendation**

IR Lvl 1	IR Lvl 2	IR Lvl 3
Systems & Equipment	Post Incident Survivability	Crash resistant fuel systems
Safety Management	Risk Assessment/ Mgt	Personal Risk Management Program (IMSAFE)
Safety Management	Safety Culture	Establish risk assessment program to eliminate culture of non-compliance
Safety Management	Risk Assesmnt/ Mgt	Establish/Improve Company Risk Mgt Program
Systems & Equipment	Post Incident Survivability	Install WSPS
Systems & Equipment	Situational Awareness	Install proximity detection system
Training/ Instructional	Adv Maneuver Tng	Emergency Procedures Training

5. **Accident Narratives.** Fires may occur on the ground or in the air. These accidents attempt to illustrate the examples of airborne fire and post impact fire.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	FIRE – Non-Impact
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
About 5 minutes before landing at a hospital, the main rotor gearbox (MGB) oil pressure warning light illuminated. The pilot continued to the hospital, landed, and performed an immediate engine shutdown. A mechanic disconnected the wiring to the MGB oil pressure switch and the light went out. The mechanic stated he believed the oil pressure switch had failed and he asked the pilot to run the acft, hover the acft, and if everything was normal, to fly it back to the base hospital. The pilot did the run and hover, and then departed the hospital. The acft crashed about 1 minute later. Witnesses stated they heard the acft approach the crash site at a low altitude and making a slow thumping noise. Examination of the MGB showed the oil pump idler gear had seized in the oil pump due to undetermined reasons and the oil pump drive shaft had failed due to overstress. The teeth on the engine input gears, intermediate gears, and MGB drive gear in the MGB combining gearbox had failed due to high-temperature overstress, which was the result of oil starvation. The acft was not equipped with a MGB oil pressure indicator. The maintenance procedure for trouble shooting an illuminated MGB oil pressure warning light is to first check the electrical circuit, and if this does not correct the problem, to change the oil pressure switch. The mechanic stated he did not have the maintenance manuals with him while working on the helicopter. The MGB had been installed in the acft after overhaul, 3 days and 4 flight hours before the accident.

The NTSB determines the probable cause(s) of this accident as follows. The mechanics failure to comply with manufacturers instructions for correction of a illuminated main rotor gearbox oil pressure warning light resulting in the helicopter being dispatched on a ferry flight with a failed main rotor gearbox oil pump, failure of the main rotor gearbox combining gearbox gears due to oil starvation, loss of main rotor RPM, and the helicopter colliding with trees and the ground during an uncontrolled descent.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	FIRE – Post Impact
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter had been used for fiber optic cable installation support operations earlier that day. The helicopter landed next to a company fuel truck at a job site approximately 20 miles south-southeast of the airport, and approximately 12 miles west-southwest of the accident site. There the helicopter was refueled. The pilot told the driver he and his passenger were returning to the Regional Airport. Shortly after it departed, an oilfield worker, investigating the source of a smoke plume, found the burning wreckage of the helicopter and notified authorities. A severed static line was found nearby. The utility company estimated the height of the static line, at the point where it was severed, to be 39 feet. The power lines were estimated to be 35 feet above the ground. A toxicological screen revealed the presence of tetrahydrocannabinol (marijuana) and tetrahydrocannabinol carboxylic acid (primary inactive metabolite of marijuana) in blood, lung, and bile.

The NTSB determines the probable cause(s) of this accident as follows. The pilot's intentional low level flying, and failure to maintain clearance with the static wire. A factor was his physical impairment by a contraindicated drug controlled substance.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	FIRE - Non-Impact
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
An engine fire warning light illuminated in the cockpit and the pilot observed smoke coming from the acft. He pulled the fire extinguisher handle on the number 2 engine and made a rapid descent to the airport. The pilot dropped the long line and landed without further incident. A post-landing examination of the acft revealed that the external surfaces of the Number 2 engine were covered in soot. A hole, which appeared to originate inside the engine, was observed on the gas generator case at the 5 o'clock position (aft looking forward). Post accident disassembly and inspection was performed on the number 2 engine. During the teardown, investigators found foreign debris, consistent in appearance to a stator vane, lodged in a diffuser pipe. The diffuser pipe, which directs compressor discharge air to the combustion area, was located at approximately the 5 o'clock position (aft looking forward). Further inspection revealed a fractured stator vane in the compressor second stage stator assembly. Due to impact and heat damage to the stator vane fracture surface, the cause of cracking could not be determined. Manufacturer investigators, in the presence of FAA inspectors, concluded the following. "The perforation of the gas generator case was most likely caused by a disturbance of compressed air flow from the diffuser pipes. The restriction in airflow caused by the lodged stator vane limited the flow of combustion liner cooling air, resulting in a localized increase in temperature and subsequent burning through the combustion liner and the gas generator case." The engine teardown and inspection revealed no other significant anomalies.

The NTSB determines the probable cause(s) of this accident as follows. Failure of compressor second stage stator vane for undetermined reasons while maneuvering.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	FIRE - Post Impact

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The helicopter was damaged when it impacted the ground and burned while hovering. The helicopter was piloted by a certified flight instructor (CFI) and dual student. The student was the holder of a private pilot certificate with a helicopter rating. In a written report, the dual student said that he raised the helicopter up to a hover and rotated 90 degrees with the helicopter facing downwind. He said that the helicopter seemed somewhat unstable in the gusty tailwind. He said that the helicopter came up in the front and then he felt a vibration in the tail. He said that the helicopter turned and the left skid impacted the ground and the helicopter rolled onto its left side. In a written report, the CFI said that, after a rudder turn when the helicopter was facing downwind, the student, "...very abruptly pitched the nose up reacting to the wind behind him. The abrupt pitch attitude allowed the tail to strike the ground." The CFI said that the aircraft was uncontrollable at that point and ultimately rolled onto its left side. A weather reporting station located about 9 miles and 157 degrees from the accident site recorded the winds as 10 knots gusting to 18 knots from 230 degrees at 1553. No anomalies were found with respect to the helicopter and none were reported.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The dual student pilot's failure to maintain control of the helicopter, his failure to maintain altitude/clearance from the terrain, and the inadequate supervision by the flight instructor. A factor was the gusty wind condition.

Chapter 12
External Load

1. **Short explanation and introduction**. **[HFH Ch. 10;FAR Pt 133; AOM]** External load or long line of operations with a helicopter or another advanced level operation. The FAA requires specific training for this type of operation. Any associated external load training, documentation, or operation requires attention to detail and increased situational awareness.

   Understanding the capabilities and limitations of the aircraft as it is associated to the environment of operation for an extra load, is absolutely essential. This requires not only detailed preparation but also a healthy understanding of the pilots' own personal limitations and capabilities.

2. **Accident Occurrence**. The JHSAT used the external load occurrence category in 5% of the accidents they analyzed. As shown by the detail in SPS Level 3, it is clear that mission specific planning and training must accompany proper equipment and operations.

SPS Level 1	SPS Level 2	SPS Level 3
Mission Risk	Terrain/Obstacles	Mission involves flight over unsuitable emergency landing terrain
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Part/System Failure	Mission Specific Equipment	Mission specific equipment - civil
Mission Risk	Aircraft Intensive	Mission involves repeated heavy lift
Mission Risk	Pilot Intensive	Mission requires low/slow flight

3. **Standard Problem Statement**. For accidents where the external load occurrence category was used, only one SPS with falls into the JHSAT's list of Top 20. Many of the accident SPS for external load are spread through many areas. This highlights the complexity of external load operations.

Rank	SPS LVL 1	SPS LVL 3
1	Pilot Judgment & Actions	Autorotation – Forced

4. **Intervention Recommendation**.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/ Instructional	Safety Training	Mission specific risk assessment training - external load
Training/ Instructional	Advanced Maneuver Training	Emergency Procedures Training
Safety Management	Risk Assessment/ Management	Mission Specific Risk Management Program

5. **Accident Narratives.** These are exemplary of accident profiles within the long-line community.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	External Load
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
While in level flight approximately 120 feet above ground level, carrying an external load of logs, the main rotor mast separated from the helicopter.The fuselage descended into a tree covered slope and broke into three sections. The pilot received serious injuries. Laboratory examination of the main rotor mast provided evidence the mast failed in fatigue at the lower ring groove of the damper splines where burrs were left during machining of the part. Retirement requirements for the mast were 15,000 flight hours or 300,000 RIN (retirement index number).The mast had 5,644.4 hours with the last overhaul being done at 3,660.8 hours. The FAA calculated the RIN number to be 291,065.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. Failure of the main rotor mast due to fatigue that resulted from inadequate quality assurance during the manufacturing process.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	External Load
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter is configured with an external horizontal platform mounted adjacent to the left loading door, between the fuselage and the skids, for use during in-flight transfer of a lineman from aircraft to structure during inspections of high tension transmission line supports. The exact procedures for the in-flight lineman transfer call for the helicopter-to-structure static electricity grounding cable to be clamped to the structure prior to the actual transfer. By design, the ground cable clamping is the very first procedural task and the unclamping is the very last procedural task. When the pilot sees the cable and clamp returned to its holding pouch on the platform, that is his cue to back the helicopter away from the structure. In this particular occurrence, the procedural tasks got out of sequence, and when the pilot saw the ground cable and clamp in its pouch, he backed the rotorcraft away. The lineman, still tethered to the rotorcraft, was pulled off the structure, and the lineman's choice of safety tether attachment point on the rotorcraft gave way under his weight, causing the fatal fall.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The lineman's failure to use the designed attachment point for securing his safety harness to the helicopter, resulting in overload and failure of the component he did attach to. A factor in the accident was the lineman's failure to follow exact sequential procedures for performing the in-flight transfer from rotorcraft to structure, resulting in his being dragged off the structure by the retreating rotorcraft.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	External Load

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
The helicopter snorkel snagged on a dip tank and the pilot-in-command (PIC) lost control of the helicopter during a retardant dropping mission. The tank and the snorkel screen fitting both contained 90-degree edges, which allowed them to catch on one another, once they came into contact. These abrupt edges may have increased the likelihood of a snagged condition during flight. The PIC was positioning the helicopter into a second tank and the snorkel became caught on the tank. The PIC applied power and shortly thereafter, the helicopter impacted the ground on its right side. Normal procedures following a caught snorkel are to slowly maneuver the helicopter until the snag becomes free. The PIC had reported 1,620 hours of pilot-in-command (PIC) time in helicopters on his application.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot-in-command's improper remedial action, which resulted in a loss of helicopter control. Contributing factors were the retardant tank and snorkel designs.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	External Load

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
The commercial certificated helicopter pilot was transporting an external sling load and a passenger from a remote off-airport site on a Title 14, CFR Part 135 on-demand air taxi flight. He stated that after lifting a relatively light load on a short sling line, he transitioned to cruise flight. Shortly after entering cruise flight, he said he inadvertently allowed the cargo and sling line to strike the tail rotor blades. The cargo/cable disabled the tail rotor, and the pilot was unable to maintain control of the helicopter. The helicopter subsequently collided with terrain during the ensuing forced landing. The pilot indicated that there were no pre-impact mechanical problems with the helicopter.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's improper rigging of the external sling load, which allowed the suspended load/cargo cable to entangle and disable the tail rotor control, resulting in a loss of control during cruise and an in-flight collision with terrain.

Chapter 13
Abrupt Maneuvers

1. **Short explanation and introduction**. **[HFH Ch. 10, 11; AOM]** Abrupt maneuver accidents are those where the pilot imparts a rapid movement of the controls that causes the aircraft to assume an abnormal attitude. These rapid control movements definitively contributed to the accident. This can be caused from an evasive maneuver. In analyzing this category, abrupt maneuver accidents do not occur at a hover.

2. **Accident Occurrence**. Most all of the accidents occurred in VMC. Most of the accident incurred minor or no injuries. The industry segments were mostly split between Commercial or Training/Instruction.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action
Pilot Situational Awareness	External Environment Awareness	Aircraft position and hazards
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Ground Duties	Mission/Flight Planning	Inadequate consideration of weather/wind

3. **Standard Problem Statement**. As can be seen in the problem statements below, nearly all of these concerns reside in the Top 10 problem areas.

Rank	SPS LVL 1	SPS LVL 3
1	Pilot Judgment & Actions	Autorotation – Forced
3	Pilot Judgment & Actions	Pilot control/handling deficiencies
6	Pilot Situation Awareness	Aircraft position and hazards
10	Ground Duties	Inadequate consideration of weather/wind
12	Pilot Judgment & Actions	Inadequate and untimely CFI action to correct student action

4. **Intervention Recommendation**. It is clear in the intervention analysis that both training and safety management play a large part of the success in preventing abrupt maneuver accidents.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Safety Management	Risk Assessment/ Management	Establish/Improve Company Risk Management Program
Training/Instructional	Basic Training	Enhanced Aircraft Performance & Limitations Training
Training/Instructional	CFI Training	CFI judgment and decision making training to follow student more closely
Safety Management	Risk Assessment/ Management	Personal Risk Management Program (IMSAFE)

5. **Accident Narratives.** These accident narratives point out the complete and poor pilot involvement in decision-making.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABRUPT MANUEVERS
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot stated that the helicopter was brought to a hover and began acceleration down runway 19 for the takeoff. At approximately 100 feet above the ground, while at 100 kts, with no visible warning, he entered clouds but the runway was still visible underneath. He started to abort and began a level deceleration. Immediately afterwards he lowered the collective, and the paramedic in the front seat said " Rotor RPM" and he looked inside to see what was happening. When he looked back outside the helicopter, about a second later, his first visible reference was trees and bushes rapidly approaching. He pulled max torque and within 1 or 2 seconds the helicopter landed level and hard, just off the side at the very end of the runway. The helicopter bounced into the air after the impact. He brought the helicopter to a hover and noted the helicopter was dangerously close to bushes and trees. He maneuvered the helicopter away from the tree line toward the runway and landed at the helipad. After landing, the right rear of the helicopter was noted lower than normal. Everyone onboard exited the helicopter without assistance. The operator stated that there were no mechanical failures or malfunctions with the helicopter or any of its systems prior to the accident. The Federal Aviation Administration inspector who responded to the accident stated that the landing skids were splayed outwards with the apparent appearance of a hard landing. Damage to the helicopter was noted to the bottom of the enclosure surrounding the tail rotor blade.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The pilot's failure to maintain main rotor rpm and proper descent rate resulting in a hard landing. A related factor in this accident was inadvertent encounter with clouds.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABRUPT MANUEVERS
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The student pilot was practicing hover autorotation maneuvers. Three hover autorotations had been conducted jointly, with both the student and the flight instructor on the flight controls. The fourth attempt was to be done with only the student holding the flight controls. According to the instructor, when he reduced the throttle to initiate the practice hover autorotation, the student lowered the collective so abruptly that he could not prevent a hard landing. After landing, the helicopter rolled onto its side.
The National Transportation Safety Board determines the probable cause(s) of this accident as follows: The student's improper procedure during a practice emergency that exceeded the instructor's reaction capability

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	ABRUPT MANUEVERS
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot reported that while conducting deer capture operations, and during a low altitude tail-low flare maneuver, the helicopter's tail rotor blades struck a rock outcropping while maneuvering around a knoll, resulting in the helicopter rotating 270 degrees to the right before contacting the ground and rolling over onto its left side. There was no post crash fire and the pilot reported no mechanical anomalies with the helicopter prior to or during the flight.
The NTSB determines the probable cause(s) of this accident as follows: The pilot's failure to maintain clearance from mountainous terrain while maneuvering. Mountainous terrain was a factor.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	ABRUPT MANUEVERS
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter collided with terrain during an uncontrolled descent about 4 miles during an air tour. The helicopter was destroyed by impact forces and a postcrash fire. The pilot and five passengers were killed, and the remaining passenger sustained serious injuries. The flight originated from the company terminal as a tour with a planned stop at a landing site. The helicopter departed the landing site and stopped at a company fueling facility. The helicopter departed the fueling facility and was en route to the company terminal when the accident occurred. Visual meteorological conditions prevailed, and a visual flight rules flight plan was filed.
The NTSB determines the probable cause(s) of this accident as follows: The pilot's in-flight decision to maneuver the helicopter in a flight regime, and in a high density altitude environment, in which the aircraft's performance capability was marginal, resulting in a high rate of descent from which recovery was not possible. Factors contributing to the accident were high density altitude and the pilot's decision to maneuver the helicopter in proximity to precipitous terrain, which effectively limited any remedial options available.

Chapter 14
Controlled Flight Into Terrain

1. **Short explanation and introduction**. **[HFH Ch. 10, 11, 14; AC 61-134]** This accident category occurs in a flight where an aircraft is flown or allowed to fly into an obstacle (natural or man-made objects). Natural objects can be terrain features (mountains, hills, rocks, fields, or bodies of water).

2. **Accident Occurrence**. CFIT was cited as an occurrence category in 16 of 523 (3%) accidents. There were 72 unique SPSs at Level 3 used by the JHSAT for accidents where CFIT was a contributing occurrence category.

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Pilot Judgment & Actions	Flight Profile	Pilot's flight profile unsafe – Altitude
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Pilot decision making
Ground Duties	Mission/Flight Planning	Inadequate consideration of weather/wind
Pilot Judgment & Actions	Human Factors - Pilot/Aircraft Interface	Perceptual judgment errors
Pilot Situational Awareness	Visibility/Weather	Reduced visibility-darkness, night
Pilot Judgment & Actions	Flight Profile	Pilot's flight profile unsafe for conditions

3. **Standard Problem Statement**. CFIT accidents reside in the Top 10 problem areas.

Rank	SPS LVL 1	SPS LVL 3
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver
8	Pilot Judgment & Actions	Pilot's flight profile unsafe – Altitude
9	Pilot Judgment & Actions	Pilot decision making
10	Ground Duties	Inadequate consideration of weather/wind

4. **Intervention Recommendation**

IR Lvl 1	IR Lvl 2	IR Lvl 3
Safety Management	Risk Assessment/ Management	Establish/Improve Company Risk Mgt Program
Training/Instructional	Safety Training	Risk assessment/management training
Safety Management	Risk Assessment/ Management	Mission Specific Risk Management Program
Systems & Equipment	Situational Awareness Enhancers	Install EVS/SVS/NVG
Safety Management	SOP - Ops Mgt	Establish risk assmnt pgrm to addresses potential for VFR into adverse Wx and night flight ops

5. **Accident Narratives.** Situational awareness is essential in low level flight environments. These narratives exemplify how important it is to stay focused;

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: NONE
	Occurrence Type: Accident	CFIT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

During a local flight to pick up personnel, the helicopter was launched during a snowstorm. The weather was moderate snow, partial obscuration, 1/4-mile visibility, winds from 320 degrees at 12 knots with gusts to 20 knots, and a temperature/dew point of 28/27 degrees Fahrenheit respectively. Limitations in the flight manual require that both a particle separator and deflector be installed on the engine for flight in snow to prevent engine flame out. A deflector was not installed. During cruise flight at approximately 200 feet above ground level, the engine lost all power and the pilot performed a downwind autorotative landing. During the flare for landing, the pilot lost ground contact due to blowing snow and the helicopter picked up a right drift. During touchdown, the helicopter rolled on its side.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The company dispatching, and the pilot initiating, flight into known adverse weather with an aircraft which did not have the required anti-ice equipment installed. A factor was snow conditions.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	CFIT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

The pilot stated he keeps the helicopter at his residence. On the day of the accident he flew to his sisters house. After dinner, he departed his sisters house, which is located about 5 miles from the accident site, with the 2 passengers. They flew around the town of Tallassee, and he then entered on the downwind leg for runway 13 at Reeves Airport. He turned on base over the Tallapoosa River, and was flying to the south. He observed a glimmer and remembers seeing power lines. The next thing he remembers is being in the river. Postcrash examination of the helicopter showed it had collided with an unmarked power transmission line, which drooped below the tree level on the river banks, to a point about 75 feet about the river. The collision occurred about midpoint in the river and the wire rapped around the main rotor mast. The main rotor system separated from the helicopter and the helicopter crashed into the river about 500 feet south of the power lines. Postcrash examination of the helicopter and engine showed no evidence of precrash failure or malfunction of the helicopter structure, flight controls, or engine. Toxicology tests performed on specimens obtained from the pilot after admission to a hospital were negative for ethanol and drugs.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The failure of the pilot to maintain a safe altitude above terrain and maintain a visual lookout resulting in the helicopter colliding with power transmission lines and crashing into a river. A factor in the accident was the power transmission lines not being marked.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: MINOR
	Occurrence Type: Accident	CFIT
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

The certified flight instructors (CFI) attempted VFR flight to his destination airport without a weather briefing. Instrument flight conditions were encountered and the pilot landed on an island. The CFI called an FAA Automated Flight Service Station and received a standard weather briefing. The forecaster informed the CFI that VFR flight was not recommended. The CFI attempted VFR flight after he thought the weather had moved through his location, and encountered instrument flight conditions. He attempted to reverse his course, became spatially disoriented, and the helicopter descended and collided with the Ocean.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The certified flight instructors disregard of an FAA weather forecast stating VFR flight not recommended resulting in VFR flight into known instrument flight conditions, loss of aircraft control due to spatial disorientation, and subsequent in-flight descent and in-flight collision with the Ocean.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	CFIT

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-

The emergency medical services (EMS) helicopter was performing a cross-country repositioning flight from a hospital back to its base during dark night conditions back over a routing that the pilot had flown 5 times that day and also earlier in the evening when they had transported a patient to the hospital. VMC predominantly prevailed along the route of flight; however, analysis of the weather reports disclosed conditions consistent with broken to overcast clouds having bases at 4,000'msl in the vicinity of the accident site. An AIRMET had been issued for the area for IFR conditions, with mountain obscuration, precipitation, mist, and fog. The helicopter was equipped with a satellite-based tracking system that reports the helicopter's GPS location to the operator's ground base while the system is in operation, and the data for the accident flight was reviewed. The route of flight proceeded toward the apex of a mountain pass, which is the main transition route from one side of a mountain range to the other, where the helicopter's base is located. The tracking data indicated that the helicopter appeared to follow a major highway in the lower portion of the pass. The highway makes a large "S" shaped path as it gains in elevation toward the top of the pass, which is about 4,200'(msl). The route along the highway is away from a well-lit major city area that has a well-defined light horizon, toward rising and dark terrain with no ground reference lights other than vehicles on the highway. Once at the top of the pass as the highway turns toward the northeast, the upper desert communities on the other side of the mountain range once again provide a well-lit and clearly defined horizon. Near the upper end of the pass, the helicopter's satellite derived flight track showed that it inexplicably diverged toward the east, away from the highway, instead of continuing to follow the highway into the upper desert valley. The helicopter collided with terrain about 0.7 nautical miles east of the highway at 4,026'msl. The accident site was located in a small ravine, near the base of a 100' tall electrical transmission tower that was located along the ravine's east ridge. During subsequent examination of the airframe structures, flight control components, and engines, no pre-impact anomalies were found that would have precluded normal operation before impact. While the operator was in the process of equipping its helicopter fleet with NVG's, the accident helicopter had not as yet been equipped with any enhanced night vision devices. The helicopter was equipped for instrument flight, including a 3-axis autopilot. The first fire department responders to the accident site reported that the area was covered by what they described as "intermittent waves" of fog that would suddenly form and then dissipate, which made it difficult to locate the wreckage.

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

The pilot's inadvertent encounter with instrument meteorological conditions and subsequent failure to maintain terrain clearance. Contributing to the accident were the dark night conditions, fog, and mountainous terrain.

Chapter 15
Ditching

1. **Short explanation and introduction**. **[HFH Ch. 5, 8; AOM]** Ditching occurs when an unintended or intended landing in water is performed in the process or after an emergency with the express expectation to abandon the aircraft. It is important to understand that manufacturer emergency procedure guidelines are critical to adhere to. Every aircraft is different and therefore may have a tendency to naturally roll one way or another. For pilots who maintain qualifications in several aircraft from different manufacturers, this knowledge is incredibly important. Conditions of the water may be such that limited time is available for decision-making and therefore must be briefed ahead of time. Specific overwater flight regulations exist for a reason.

2. **Accident Occurrence**. Most of the accidents occurred in day VMC, with experienced pilots on board.

SPS Level 1	SPS Level 2	SPS Level 3
Post-crash Survival	Crashworthiness	Vehicle sank and/or capsized
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Pilot Judgment & Actions	Flight Profile	Pilot's flight profile unsafe – Altitude
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Pilot decision making
Maintenance	Maintenance Procedures/ Management	Failure of QA or supervisory oversight

3. **Standard Problem Statement**. This analysis includes the ditching event and not what caused the decision to ditch. As an example, an engine failure causes a forced autorotation, ending in a ditching event.

Rank	SPS LVL 1	SPS LVL 3
1	Pilot Judgment & Actions	Autorotation – Forced
8	Pilot Judgment & Actions	Pilot's flight profile unsafe – Altitude
9	Pilot Judgment & Actions	Pilot decision making

4. **Intervention Recommendation**. Post crash survival is possible with appropriate measures before the event. This can include location devices, training and thorough briefings before the flights.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Training/Instructional	Advanced Maneuver Training	Autorotation Training Program
Maintenance	Instructions for Continued Airworthiness (ICA)	Follow ICA procedures with confirmation of compliance
Maintenance	QA	Better Mx QA oversight to ensure adherence to the ICA/Manual
Systems & Equipment	Post Incident Survivability	Post Incident Survivability - Other
Systems & Equipment	PAH corrective action	Design approval holder implement corrective action and mitigate field risk
Training/Instructional	Advanced Maneuver Training	LTE Training Program
Training/Instructional	Basic Training	Enhanced Aircraft Systems Training
Training/Instructional	Basic Training	Inflight Power/Energy Management Training

5. **Accident Narratives.** The pre-flight brief to an over-water flight is important from the perspective that it prepares the aircrew and passengers for the ability to correctly react to events in this area and escape.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	DITCHING
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- The helicopter departed from a helipad located on an offshore oil platform, and was 3 minutes from landing at a refueling helipad on another platform, when the pilot transmitted two distress calls indicating the helicopter was "going down." There were no witnesses to the accident; however, 9 minutes after the distress calls were heard, the helicopter was found floating inverted in 3-4 foot seas. Subsequently, the helicopter sank and was later recovered and examined. Examination of the helicopter revealed no anomalies with the airframe or flight control systems. Examination of the engine revealed that the first and second stage turbine blades were fractured due to extreme heating. One blade of the second stage tubine disk had liberated from its retention slot, and all the blade roots and retention slots of this disk exhibited permanent outboard deformation, due to a combination of centripetal forces from engine operation and excessive heat. In contrast, the blade roots and retention slots of the first stage turbine disk did not exhibit evidence of outboard deformation, most likely since they were located further away from the heat source. The rear bearing assembly (located aft of the second stage disk) was contaminated with coke. The coking suggests that oil was leaking from the engine and migrating from the rear bearing assembly. The aft side of the second stage turbine disk displayed dark stain marks in the form of streaks. A passage exists that would allow oil to flow from the rear bearing to the aft face of the second stage turbine disk. Oil that strikes the disk would flow into the hot stream of gases and auto-ignite, starting a fire. Oil migration can occur if the rear bearing scavenge and vent tubes become blocked; however, the scavenge and vent tubes were checked during the engine examination and were not found blocked.
The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The loss of engine power due to an internal engine oil leak that started an internal engine fire and the pilot's inadequate autorotation, which resulted in a hard landing. A contributing factor to the accident was the rough water condition.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: NONE
	Occurrence Type: Accident	DITCHING
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot stated that he maneuvered the helicopter to the southeast corner of Ocean Reef so the passenger, a photographer, could take photos of a house at the water's edge. The helicopter was in a steady hover over the water with the nose towards the north. The winds were from his left, from the west, at about 10 knots. There were no abnormalities noted with the helicopter's power. He increased left pedal to bring the nose of the helicopter more into the wind to smoothen it out from the effects of the winds on the tail rotor. Suddenly the helicopter started an un-commanded turn to the right. He applied full left pedal, reduced collective, and initiated forward flight. The helicopter continued the right turn. After several rotations and close to the water he initiated an auto-rotation from about 10 feet above the water. He used collective to cushion the contact with the water. The helicopter came to rest on its right side in about 7 feet of water. The passenger stated that while doing aerial photography at about 150 feet above sea level, the helicopter started spinning and spiraling down. They hit the water soon thereafter. A representative for the helicopter's manufacturer, with FAA oversight, examined the helicopter. No abnormalities were found with the helicopter's flight control system. All damage noted to the helicopter was consistent with a water impact. The FAA Aeronautical Handbook\FAA-H-8083-21-Helicopter Flying Handbook\Chapter 11-Helicopter Emergencies\Systems Malfunctions\Unanticipated Yaw\Loss of Tail Rotor Effectiveness states that an unanticipated yaw is the occurrence of an uncommanded yaw rate that does not subside of its own accord and, which, if not corrected, can result in the loss of helicopter control. This uncommanded yaw rate is referred to as loss of tail rotor effectiveness (LTE) and is not related to an equipment or maintenance malfunction and may occur in all single-rotor helicopters at airspeeds less than 30 knots. It is the result of the tail rotor not providing adequate thrust to maintain directional control, and is usually caused by either certain wind azimuths (directions) while hovering, or by an insufficient tail rotor thrust for a given power setting at higher altitudes.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The pilot's inadvertent encounter with a loss of tail rotor effectiveness during hover in a crosswind wind.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: SERIOUS
	Occurrence Type: Accident	DITCHING
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary- After about 2 hours and 54 minutes of flight, the helicopter had a loss of engine power while on final approach to an offshore oil platform. The pilot initiated an autorotation and subsequently landed hard on rough/choppy ocean water. Fuel consumption calculations, provided by the operator, showed that the helicopter could have been at or near fuel exhaustion at the time of the accident. The helicopter sank to the bottom of the ocean, thus precluding available fuel verification and examination of aircraft systems. Therefore, the reason for the loss of power could not be determined conclusively.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The loss of engine power for undetermined reasons. A factor was the lack of suitable terrain for a forced landing.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: MINOR
	Occurrence Type: Accident	DITCHING
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-

While aggressively maneuvering over the shore and ocean, below 100 feet above ground level, the helicopter experienced a total loss of engine power. The pilot entered an autorotation, and activated the float system. The helicopter impacted the water in a level attitude, but with enough forward speed to become submerged and then bounce 15 to 18 feet back into the air. The helicopter impacted the water a second time, but this time inverted. Both occupants egressed the submerged helicopter, and were rescued shortly after reaching the surface. A post-accident examination of the helicopter revealed main rotor blade damage consistent with a loss of power; however examination of the engine and powertrain were inconclusive.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows: A loss of engine power due to undetermined reasons.

Chapter 16

Aerodrome

1. **Short explanation and introduction**. **[HFH Ch. 11; FAR Pt. 91; AOM]** Aerodrome accidents are very similar to those discussed earlier in landing zones. Generally speaking, aerodrome accidents occur in prepared areas and surfaces. These include taxiways, runways, overruns, ramps etc. these accidents include approach to the landing area maneuvering, and ground handling. These accidents are separated from landing zone accidents as the analysis of the data supports it.

2. **Accident Occurrence**. The characteristics of these occurrences can include striking man-made objects or improper use of equipment. Additionally, in a landing profile, pilots may choose an improper location to land or an emergency, landing incorrectly. There are four subcategories in this area: fixed helipads, heliport/airport, mobile helipad, and platform. The occurrence and intervention tables will review these subcategories together.

SPS Level 1	SPS Level 2	SPS Level 3
Safety Management	Pilot	Disregard of known safety risk
Infrastructure	Equipment (Infrastructure)	Aerodrome/landing site related factor
Pilot Situational Awareness	External Environment Awareness	Aircraft position and hazards
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Not in possession of valid airman/medical certificate
Pilot Judgment & Actions	Procedure Implementation	Improper recognition and response to dynamic rollover
Pilot Judgment & Actions	Human Factors - Pilot/Aircraft Interface	Perceptual judgment errors
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Pilot misjudged own limitations/capabilities
Pilot Judgment & Actions	Landing Procedures	Selection of inappropriate landing site
Ground Duties	Mission/Flight Planning	Inadequate consideration of obstacles
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Safety Management	Management	Management disregard of known safety risk
Safety Management	Pilot Experience	Pilot inexperienced

3. **Standard Problem Statement**. Widespread issues existed between 41 total Level 3 SPSs assigned by the JHSAT for accidents where Aerodrome was used as an occurrence category. The following are those Level 3 SPS related to Aerodrome that are connected to the JHSAT's list of top 20 SPS.

Rank	SPS LVL 1	SPS LVL 3
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver
6	Pilot Situation Awareness	Aircraft position and hazards
10	Ground Duties	Inadequate consideration of weather/wind
14	Pilot Judgment & Actions	Selection of inappropriate landing site
17	Pilot Judgment & Actions	Improper recognition and response to dynamic rollover

4. Intervention Recommendation

IR Lvl 1	IR Lvl 2	IR Lvl 3
Infrastructure	Ground support	Ground support - Other
Systems & Equipment	Situational Awareness Enhancers	Install proximity detection system
Training/Instructional	Safety Training	Training emphasis on techniques for maintaining visual alertness
Safety Management	Risk Assessment/ Management	Personal Risk Management Program (IMSAFE)
Safety Management	Risk Assessment/ Management	Use Operational Risk Management Program (Inflight)
Safety Management	Risk Assessment/ Management	Use Operational Risk Management Program (Preflight)
Regulatory	Disciplinary action	Recommend enforcement action - certificate suspension/revocation
Safety Management	Risk Assessment/ Management	Establish/Improve Company Risk Management Program
Safety Management	Safety Culture	Periodic Safety Audit of heliport
Training/Instructional	Safety Training	ADM training

5. **Accident Narratives.** This includes a wide variation of accidents to cover the diverse environment of aerodromes.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	AERODROME - Platform
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The airline transport certificated helicopter pilot was transporting oil field personnel to an offshore oil producing platform. The pilot said that wind conditions, in conjunction with various platform mounted obstructions, required that he plan his approach to the left side of the helipad, then "side slip" to the right and over the helipad. He said that as he terminated his approach, and moved the helicopter to the right and over the helipad, the tail rotor struck a handrail that was adjacent to the helipad. The helicopter sustained substantial in-flight damage to the tail rotor blades, main rotor blades, and horizontal stabilizer. The pilot reported that wind conditions at the time of the accident were from the northeast at 25 knots.
The NTSB determines the probable cause(s) of this accident as follows: The pilot's failure to maintain adequate tail rotor clearance while maneuvering to land.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	AERODROME – Helipad/Airport
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The 430-hour commercial helicopter pilot collided with unmarked power lines while attempting to depart the uncontrolled airport on an easterly heading from the airport's parking apron. The pilot lost control of the helicopter following the collision with the power lines and the helicopter impacted the ground. A post impact fire consumed most of the helicopter. Several witnesses observed the accident and provided written statements. The uncontrolled airport features a single runway aligned 140/320 degrees, and Unicom services are available. Eye-witnesses reported that the pilot did not hover-taxi the helicopter from the parking apron onto the parallel taxiway to the runway, but instead departed the apron area on an easterly direction between two ramp light fixtures that were 35 feet tall and 150 feet apart. The 32-foot high power lines impacted by the helicopter were located outside the airport perimeter and were 220 feet from the airport parking apron. The wind at the time of the mishap was reported from 190 degrees at 10 knots, with VMC weather conditions; however, the accident occurred during the early evening at 1840. Examination of the wreckage did not reveal any anomalies. Maintenance records for the helicopter that were provided did not reveal any discrepancies. The flight logbook for the pilot was not made available to the NTSB during the course of the investigation.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The pilot's failure to maintain clearance with the power lines. Contributing factors were the dusk light condition and the pilot's non-compliance with standard taxi and takeoff procedures.

Chapter 17
Unknown/Other

1. **Short explanation and introduction**. Most of the accidents in this category are difficult to tie to one specific cause. Many involved undetermined origin though several causal factors were influential in the accidents. Some included factors that imply regulatory lapses.

2. **Accident Occurrence**. Generally, average pilot times were very low for this query.

SPS Level 1	SPS Level 2	SPS Level 3
Part/System Failure	Powerplant	Engine Component failure
Maintenance	Performance of MX Duties	Failure to perform proper maintenance procedure
Regulatory	Oversight and Regulations (Regulatory)	Inadequate government/industry standards and regulations
Pilot Judgment & Actions	Landing Procedures	Autorotation – Forced
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver

3. **Standard Problem Statement**. These accidents were divided across many industry segments. In terms of relation to the JHSATs list of Top 20 SPSs, the connections spanned the spectrum of the safety system, from problems tied to the pilot, maintenance, and the helicopter.

Rank	SPS LVL 1	SPS LVL 3
1	Pilot Judgment & Actions	Autorotation – Forced
2	Pilot Judgment & Actions	Disregarded cues that should have led to termination of current course of action or maneuver
4	Maintenance	Failure to perform proper maintenance
13	Part System Failure	Engine Component Failure

4. **Intervention Recommendation**. The table below reflects some of the intervention issues that relate to compliance with regulatory issues, and procedural issues.

IR Lvl 1	IR Lvl 2	IR Lvl 3
Maintenance	Instructions for Continued Airworthiness (ICA)	Follow ICA procedures with confirmation of compliance
Regulatory	Disciplinary action	Recommend enforcement action - certificate suspension/revocation
Training/Instructional	Basic Training	Aircraft Preflight Procedures
Regulatory	Oversight	Increased Government oversight of Operations

5. **Accident Narratives.** Accidents were chosen from the dataset that express a wide range of causal factors and illustrate just how complex accident occurrences can be;

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	UNKNOWN
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter's engine experienced a partial loss of engine power while maneuvering at 60 feet agl and a forward airspeed of approximately 10 knots. In response to the loss of engine power, the pilot 'increased power, pulled up on the collective, in order to increase airspeed.' The engine immediately began to 'coast down.' The pilot added that due to the relatively low altitude, slow airspeed, and insufficient rotor rpm available for the autorotation, the helicopter landed hard. Examination of the engine revealed that a power control (PC) line, which ran between the fuel control unit and governor, had separated. Metallurgical examination revealed that the PC line failed due to fatigue. A bend in the line was observed at the location corresponding to the base of the ferrule at the failed end, indicating that excessive force may have been used during installation of the line. It is likely that fatigue initiated due to the additional stresses placed on the tube by this bend.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The failure of the pilot to maintain rotor rpm during an autorotation, which resulted in a hard landing. A factor was the partial loss of engine power resulting from the separation of the power control line due to fatigue, as a consequence of improper installation.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	UNKNOWN
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The helicopter was being operated at greater than its maximum gross weight for takeoff. The airfield was at 6,387 feet mean sea level. The temperature at the time of the accident was 61 degrees Fahrenheit. The pilot said they lifted off and bounced across the ground trying to gain lift. The helicopter then reached a 20 foot drop at the north end of the airport. The helicopter dropped, impacted the terrain and rolled over causing the tail boom to separate, the main rotor blades to bend and fracture, the right skid to separate and the bubble canopy to come off and fragment. The pilot and passenger on board were not injured. The calculated density altitude was 7,914 feet.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's improper preflight planning and his failure to maintain control of the helicopter during takeoff. Factors contributing to the accident were the helicopter exceeding its maximum gross weight for takeoff and the high density altitude.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	UNKNOWN - OTHER

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:

Accident Information Summary-
According to the pilot, the externally slung, hydraulically operated fertilizer bucket stopped dispensing. With no ground handling crewman available, the pilot set the rotorcraft down to troubleshoot the problem. With engine rpm near maximum to run the hydraulic pump to its maximum output, the pilot climbed out of the left seat, onto the left skid to read the externally mounted hydraulic pressure gage. While egressing the cockpit, the pilot accidentally bumped the collective control to the "increase rotor pitch" position, and the rotorcraft became airborne without him aboard. The rotorcraft climbed to about 500 feet AGL, in circling flight until the loaded fertilizer bucket began swinging in ever-divergent oscillations causing rotorcraft instability and eventual main rotor-to-boom strike and crash.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The PIC's failure to follow safe operating procedures for the maintenance of the rotorcraft's external aerial application equipment, resulting in inadvertent activation of collective as he egressed the rotorcraft, causing unmanned flight, in-flight break-up, and collision with terrain.

Chapter 18
Conclusion

Nearly all of the examples in each chapter align with an Operator Note-Caution-Warning, Emergency Procedure, or safety notice from the manufacturer. This is the place to begin your full comprehension of the information provided here. If you read each example, you immediately saw the best corrective action (or reference to it) and in most cases, how easily the accident may have been prevented in the first place. Knowing what to do upon the moment something happens is the responsibility of the person at the controls. Having said that, there are times where something happens that is beyond the control of the pilot to correct. Helicopter flying is inherently dangerous, but knowing emergency procedures applicable to the situation helps to mitigate that risk.

Again, the intent of this document is to impart a more in-depth knowledge as to why and how accidents can happen and illustrate this fact with real occurrences. It can happen to you too. Risk mitigation is everybody's responsibility. Pre-flight planning, risk analysis, training, education, experience all work together to make us better and safer pilots and crew. Another well-known practice is communication between pilots. The military and airlines have practiced crew-resource management training for years. This is not impossible in a single pilot helicopter world either. Consider the crew to be anyone partaking in the mission and work through problem solving and situation recovery discussions.

Risk analysis that is an active component of pre-flight actions will not only set the conditions for a safe flight, but it can infuse that mental capacity to have the safety mindset in place throughout the flight. These actions are common sense actions that put the aircrew into the flight environment with a safety first mentality.

The bottom line is to always strive for improvement. Pilots after every flight should evaluate the flight and determine how it could have been done better. Evaluate what went well and find a way to capture the information for record to make the organization better, and yourself a better pilot. Reducing bad decision making will help drive operational costs down by not bending helicopters that are expensive to replace, and not breaking those on board.

IHST Toolkits, manuals, videos, training and other documents like this one, have a purpose. It is up to aircrew to obtain access and make this information important not just to themselves, but to their organizations.

Situational awareness is everything.

Annex A: Acronyms

AC	Aircraft
AC	Advisory Circular
AD	Airworthiness Directive
ADM	Aeronautical Decision Making
AFCS	Avionics Flight Control System
AFM	Airplane Flight Manual
AGL	Above Ground Level
ATC	Air Traffic Control
AOM	Pilot's Operating Handbook, Rotorcraft Flight Manual, Pilot Flight Manual etc.
Auto	Autorotation
CAST	Commercial Aviation Safety Team
CFI	Certified Flight Instructor
CFIT	Controlled Flight into Terrain
CRM	Crew Resource Management
CVidR	Cockpit Video Recording
CVR	Cockpit Voice Recorder
DA	Density Altitude
DGPS	Differential Global Positioning System
EASA	European Aviation Safety Agency
EGPWS	Enhanced Ground Proximity Warning System
ELT	Emergency Location Transmitter
EPIRB	Emergency Position Indication Radio Beacon
EVS	Electronic or Enhanced Vision Systems
FAA	Federal Aviation Administration
FDR	Flight Data Recorder
FLIR	Forward Looking Infrared
FOQA	Flight Operations Quality Assurance
FSF	Flight Safety Foundation
GOM	Gulf of Mexico
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GW	Gross Weight
HOGE	Hover out of ground effect
HOMP	Helicopter Operational Monitoring Program
HUMS	Health and Usage Management System
HTAWS	Helicopter Terrain Avoidance Warning System
HVR	Hover
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IHST	International Helicopter Safety Team
IMC	Instrument Meteorological Conditions
IP	Instructing Pilot
JAA	Joint Aviation Authorities
JHSAT	Joint Helicopter Safety Analysis Team
JHSIT	Joint Helicopter Safety Implementation Team
LTE	Loss of Tail Rotor Effectiveness
LZ	Landing Zone
M&M	Make and Model

MR	Main Rotor
Mx	Maintenance
NASA	National Aeronautics and Space Administration
NAVAID	Navigation Aid
NOTAM	Notice to Airmen
NR	Main Rotor RPM
NTSB	National Transportation Safety Board
NVG	Night Vision Goggles
OGE	Out of Ground Effect
OH	Overhaul
PAH	Production Approval Holder
PAX	Passengers
PIC	Pilot in Command
PINC	Procedural Intentional Non Compliance
QA	Quality Assurance
QFE	Field Level – Altimeter Setting
QNH	Mean Sea Level – Altimeter Setting
RAA	Regional Airline Association
RIN	Retirement Index Number
RR	Rolls-Royce
SAT	Safety Analysis Team
SNV	Synthetic Night Vision
SOP	Standard Operational Procedure
SPS	Standard Problem Statement
SVS	Synthetic Vision Systems
TAWS	Terrain Awareness Warning System
TBO	Time Between Overhauls
TQ	Torque
TR	Tail Rotor
TSN	Time Since New
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
Wx	Weather

Annex B : Definitions

Ability	A component of Overall Effectiveness, ability is a measure of how well a particular intervention can mitigate the cause or contributing factors of a specific accident assuming everything and everyone work as expected.
Accident	An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.
Contributing Factors	Identify factors both in the crew's environment and personal factors that help explain why an inappropriate response or latent failure occurred.
Data Driven	Decisions, results and recommendations that are supported by, rooted in, and traceable to data (accident/incident reports, FOQA data, prior studies, etc.) Expert opinions that are logical, structured and traceable to data will also be used.
Events	Describe, relative to a time mark, the actions taken or omitted by the crew, the conversations of the crew and between the crew and ATC, and the airplane maneuvers prior to the accident.
Feasibility	Current potential for implementation of the intervention strategies on a widespread basis.
Implementation	How to incorporate a given intervention strategy.
Importance	A component of Overall Effectiveness, Importance is a measure of the relative importance of a problem statement in the causal chain, the measure ranges from no effect to the cause of the accident.
Intervention Strategies	Proposed activity intended to prevent or mitigate a given safety-significant problem associated with the cause of an accident.

Overall Effectiveness	A calculated combination of Validity, Importance, Ability and Usage scores which is intended to estimate how effective an intervention is likely to be in preventing future accidents.
Problem Statements	Describe what went wrong, define a deficiency, or describe a potential reason some action occurred or did not occur. They represent inappropriate crew responses, latent failures in organizational management and/or regulatory agency oversight. They may also reflect active failures by maintenance personnel or ATC controllers. Equipment failures are also identified as problems.
Usage	A component of Overall Effectiveness, usage is a measure how confident are we that an intervention will be utilized and will perform accounting for possible limitations in the real world.
Validity	A component of Overall Effectiveness, Validity is a measure of how valid we think the Problem Statement is in this accident based on the available accident information?

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