PHOTO ROB CLEMENT

Understanding AVIATION ACCIDENTS

By R.G. "Ron" Hanks

How 2006 compares statistically, & implications for 2007

The end of each fiscal year (Sept. 30—Oct. 1) is a time when those of us in the wildland fire aviation field tally aviation accidents and incidents for the year. At the U.S. Forest Service (USFS) Aviation Risk Management Center, located at the National Interagency Fire Center (NIFC) in Boise, Idaho, we monitor aircraft mishaps, coordinate the investigations that inevitably follow and track corrective actions as part of a comprehensive prevention program. It's not necessarily rocket science, but the stakes are high and positive results at the end of the year translate to lives saved.

Therefore, I wondered if it was an ominous sign for fiscal year 2007 when on Oct. 1, 2006, a phone call once again brought news of a serious aircraft accident. This time, two pilots had miraculously escaped injury amid the destruction of their Type I helitanker.

Although I was relieved there was no loss of life, such calls are still disappointing because they represent a failure in the system. We take great care to protect and defend our people, yet at times it seems our efforts are easily undone by an uncaring universe bent on the destruction of our mere-mortal plans. I often wish for a crystal ball.

Of course, we cannot accurately predict the exact number of accidents that will occur in 2007. Instead, we rely upon historical data and trends to indicate what to monitor more closely in relation to the level of activity (the number of hours flown).

With four serious aviation accidents, 2006 was slightly better than the statistical "average" year for the number of aircraft accidents. Unfortunately, six people died in two of those accidents, a number that's higher than average. Perhaps most importantly, by either measure, we fell short of the zero-accident and zero-fatality goal we continually strive to achieve.

Taking a closer look at these numbers, and the factors that led to the incidents, is a part of the System Safety technique the USFS is using to move us closer to achieving that goal.

How Does Wildland Fire Compare?

By themselves, the numbers of accidents and fatalities do not tell the whole story. Accident *rates* are a more useful tool than raw numbers for analyzing trends. The standard measure for aviation accident data is the number of accidents per 100,000 flight hours per year. In 2006, USFS aircraft flew a total of 89,648 hours; during that time, we experienced four accidents. Simple division gives us an accident rate of 4.46 per 100,000 flight hours for the year; 2.23 per 100,000 for fatal accidents.

When we compare these numbers with the 10-year average for the period between 1997 and 2006, we find that last year's flight hours are about 9 percent higher than the average of 78,910. The 2006 accident rate is lower than the average of 5.56, but the fatal accident rate is nearly twice the average of 1.64. We must ask: Do the numbers indicate catastrophic failure of accident-prevention efforts and aviation-resources management, or are there other factors that affect our perspective?

One source of comparison can be found in the Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation's 2006 Nall Report, the nation's foremost annual review of general aviation (GA) accident statistics. GA comprises the majority of civil aviation activity in the United States; the statistics are based upon National Transportation Safety Board (NTSB) investigations of accidents. The information is intended to help the

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media, the public and the aviation community better understand the factors involved in aviation mishaps.

The most current data shows the GA accident rate is declining over time, even while the number of flight hours escalates. The 10-year accident rate stands at 6.2 per 100,000 hours, while fatal accidents occur at a rate of 1.4.

Another source of comparison: the Federal Aviation Safety Report recently released by the General Services Administration (GSA). Fourteen executive branch agencies report aviation accident data to GSA's Aviation Mishap Information System. In 2006, the total flight hours reported was 419,569, with 17 reported accidents, resulting in an accident rate of 4.05 and a fatal accident rate of 1.9.

To summarize, the USFS average accident rate of 5.56 is lower than the GA average of 6.22 but higher than the average federal agency rate of 4.05. (These statistics are displayed in the sidebar on p. 27.)

What Can Accident Trends Tell Us?

Causes of aircraft accidents are typically divided into three major groups:

- Human Factors: accidents that arise from the improper action of the flight crew or support personnel. This category accounts for approximately 80 percent of aviation accidents.
- Mechanical/Maintenance (M/M): accidents that arise from failure of a mechanical component or human errors in maintenance. M/M failures account for approximately 10 percent of all accidents.
- Other/Unknown: accidents that include causes such pilot incapacitation, as well as accidents of undetermined cause. These account for the remaining 10 percent of accidents.

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This helicopter experienced engine failure and a rotor strike during an emergency landing in Montana.

Review of the aircraft types involved in USFS accidents shows the highest rate occurs in helicopters (7.46), with airtankers second (5.30) and other fixed-wing aircraft third (3.23). Helicopters represent 46 percent of the total aviation aircraft used on fires, while fixed-wing aircraft represent 35 percent, USFS fleet 11 percent and airtankers 8 percent. So, one might wonder why airtankers have the second-highest accident rate when they are used the least on wildland fires.

The logical explanation lies in the nature of the aviation missions for which these aircraft are used. Helicopter and airtanker missions typically expose our personnel to flight operations near ground level in high elevations during periods of peak summer temperatures. The high number of accidents among these types of aircraft reveals a dimension in accident causes crucial to our prevention efforts: high exposure to mission-related hazards and risk.

The most recent analysis of accident data tells us a lot about when and where to expect accidents. A review of 20 years of data indicates most accidents occur during the heat of afternoon in mid-August, in flights below 500 feet above ground level (AGL). About 90 percent of USFS flight time is directly related to firefighting, and often requires maneuvers that are low, slow and below 500 feet AGL. In this environment, initial-attack forces are likely to experience additional hazards, such as reduced visibility in smoke, turbulence caused by heat or thunderstorms, high-density altitudes in mountainous terrain that reduce the performance of their aircraft, obstacles such as cell towers and power lines, and other aircraft traffic.

Such factors create challenging environments requiring high proficiency and near athletic stamina to perform well. Enter the average aviator, each with their individual weaknesses that are exacerbated by fatigue, inadequate food, disrupted sleep cycles, dehydration and susceptibility to stress, disease and distraction. When these conditions are accepted as a normal part of the job, it is understandable and even predictable that humans will make mistakes.

Human errors appear statistically as groupings of similar types of accidents occurring in similar conditions, and even appear to be common with certain models of aircraft. One such trend in helicopters is accidents in "hot, high and heavy" (HHH) conditions.

A 2003 study showed approximately 18 percent of all USFS helicopter accidents occur in HHH environments as the result of the pilot's loss of control of the aircraft following a loss of tail-rotor effectiveness or settling with power. These accidents are most common in helicopters manufactured prior to the more rigorous certification required in the 1990s under Federal Aviation Regulations (FAR) Part 27. The only other accident grouping that comes close statistically is main- and tail-rotor strikes occurring in trees or wires. In both failures, human error is the cause, and the accident is both predictable and preventable.

The single most disturbing causal trend in fixed-wing operations accidents is an event called "controlled flight into terrain" (CFIT). It occurs when an airworthy aircraft is flown, under control of a qualified pilot, into terrain with inadequate pilot awareness of the impending collision. According to the Federal Aviation Administration (FAA), CFIT accidents account for 17 percent of all GA accidents. Among USFS aircraft, CFIT plays a large role in fixed-wing and airtanker accidents: Although the airtanker accident rate declined during the past 10 years, CFIT accounts for approximately 43 percent of all airtanker accidents. Again, CFIT is most typically caused by human errors.

Accident Comparison between U.S. Aviation Communities (5-year average rates)

Air Carrier—Scheduled Airlines	0.61
Commuter—Scheduled Airlines	1.57
Air Taxi—On Demand	2.25
Federal Executive Agencies (Ave)	4.05
USFS	5.56
General Aviation	6.22
Army (all classes aviation)	9.95

Making 2007 Safer

The USFS believes no resource or structure is worth the loss of human life. We acknowledge the wildland firefighting environment is dangerous because its complexity may make events

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This single-engine airtanker (SEAT) crashed in Nevada during an initial-attack drop in high winds. This crash is an example of "controlled flight into terrain" (CFIT), which occurs when an airworthy aircraft is flown into terrain with inadequate pilot awareness of the impending collision. CFIT accounts for approximately 43 percent of all USFS airtanker accidents.

and circumstances difficult or impossible to foresee. We will aggressively and continuously manage risks toward a goal of zero accidents, serious injuries and fatalities.

How will we do this? Through a comprehensive accident-prevention program focused on protection of human life, implementation of a comprehensive risk-management program and commitment to the goal of zero accidents. Based upon the numbers, is there any indication that we can reach the goal of zero accidents? In theory, we can. But in the most practical sense, we can't sustain a zero accident rate over time without having a significant and negative effect on the firefighting mission.

The effectiveness of aviation resources is directly proportional to how quickly and accurately they can be delivered. Aviation operations must take advantage of speed and accuracy without sacrificing safety. In the wildland firefighting arena, timeliness is everything. The sooner we get to a newly started fire, the less damage and destruction it will produce. Aircraft are a key component in this equation, delivering firefighters and supporting line personnel with water or retardant during rapid initial attack.

In the real world, we continuously compromise between risk-taking and benefit, and we must assess whether the mission can be accomplished with the minimum exposure to risk while aggressively mitigating known hazards. It's a full-time job not for the faint of heart.

To do this, the USFS has initiated an effort to apply System Safety techniques to the firefighting aviation mission. Following the FAA lead in this area, we pattern our program after the success demonstrated within the airline industry. System Safety techniques are now included in the operators' contracts (FAR 135/137) that comprise the bulk of our aircraft fleet.

System Safety works like this: We organize a team of subject matter experts from the agency and the commercial sector to analyze USFS flight operations. The team is tasked with identifying the systems or context required for a specific aviation mission. For example, airtanker mission considerations would include aircraft, flight crews, payload, tanker-base operations, aerial supervision, etc. The team then identifies existing hazards within each system, given historical data on USFS accidents and incident causes such as CFIT, mid-air collision, loss of communications, etc. Each hazard is assessed for its level of risk based upon the frequency and severity of the event and then given a mitigation to reduce or eliminate it.

Once the risk assessment team completes the assigned program assessment, the report is forwarded with recommendations to the Aviation Operations headquarters at the NIFC. Operations then develops an action plan to carry out high-priority hazard-mitigation items to bring the hazards within acceptable levels, thereby reducing risk-taking behaviors. The final step takes place in the Aviation Risk Management Center, where we monitor the completion of the action plan and evaluate how successful we are in terms of incidents, accidents and lost-time injuries. Subsequent plans are continuously amended for improvement.

A major strength of System Safety: it allows us to measure our successes along with failures. No Fortune 500 company bases its business plan solely on its failure rate. By evaluating risk-management and prevention actions, we have a proactive system to measure our performance.

High Expectations

The System Safety project is evolving in concert with changing doctrine in the USFS. This well-orchestrated program is conducted on an agency-wide basis, with the highest expectations of its leaders: cultural change from top to bottom, with an end result of changed behaviors that achieve positive outcomes. By changing risk-taking behavior, improving leadership and encouraging better decision making, the agency intends to achieve greater efficiency and improve the working environment. In short, I believe the System Safety process will lead us toward achieving the elusive zero accident rate, translating directly to saving more firefighter lives.

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