US Joint Helicopter Safety Analysis Team

Interim Safety Recommendations

to the

International Helicopter Safety Team

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US JHSAT Interim Safety Recommendations:

Recommendations:

1. – Promote the adoption of Safety Management Systems in the helicopter community.

2. – More consistent and comprehensive NTSB involvement and investigation needed in helicopter accidents.

3. – Reestablish the collection of worldwide helicopter fleet hour data as previously performed by the FAA.

4. – Establish a helicopter safety website to disseminate important information

5. – Use proximity detection equipment in helicopters.

6. – Use flight recording devices and cockpit image recording systems in helicopters.

7. – Develop a strategy to improve pilot Aeronautical Decision Making.

(NB: this listing is not intended to indicate prioritization)

Background:

The US Joint Helicopter Safety Analysis Team (US JHSAT) team is in the process of analyzing 195 accidents from the year 2000 NTSB dataset. Our plan is to issue a full set of safety recommendations derived from these accidents by the first quarter of 2007.

In a parallel effort, the US JHSAT has also developed several interim recommendations to submit to the IHST. These recommendations are based on observations to date by the team while analyzing the NTSB data and a consolidation of safety recommendations from a body of existing helicopter safety reports [(1)].

As an interim measure these recommendations afford the opportunity to make better informed decisions about the general scope of the US JHSIT's work, the team's membership and to start work on developing a basic implementation process prior to receipt of the US JHSAT year 2000 accident recommendations.

General recommendations from the US JHSAT

The US JHSAT recommends the following based on its observations to date while analyzing NTSB data.

Recommendation N°. 1. - That the IHST develop a strategy to promote the adoption of Safety Management Systems (SMS) use across the helicopter community. We are all aware that the major worldwide aviation regulatory and industry members are moving toward use of SMS. The helicopter industry should be adopting strategies to align with this shift in the aviation industry. The goals established by the IHST for an 80% reduction in accidents by 2017 are very aggressive. Adoption of SMS methods will help attain this goal by encouraging participation of all stakeholders, open exchange of safety critical data and more rapid response to existing and emerging safety threats. This requires a top down approach and engagement with the type design holders, regulators, operators, maintenance facilities, trainers, etc. To date, many of the accidents analyzed by the JHSAT might not have happened if a strong SMS function were in place. A large portion of the accidents lack information of imbedded of systems safety methods in training, SOPs, and human factor considerations that ultimately lead to deficiencies in aeronautical decision making.

The JHSIT should consider how to implement this approach across the full spectrum of operational organizations from the small single person operators to large corporate entities.

Additionally, in the process of analyzing the NTSB data, the JHSAT has determined that two key pieces of a robust systems approach need significant improvement.

Recommendation N°. 2. - We have determined that only 17% of helicopter accidents are actually investigated by the NTSB by going to the accident site.

Thorough, well documented root cause level investigations are a necessary system safety feedback element. Too many accidents documented in the NTSB database have minimal detail due to a "limited" investigation. Many are reprints of FAA or local official findings. The IHST should petition the NTSB to adequately staff and fund their organization to provide better information such that all helicopter accidents receive a full and thorough on-site investigation. The lack of information is also the product of inadequate data recording in helicopters. Moving the industry toward widespread use of data and/or cockpit recording devices will greatly enhance the ability of the industry to understand and mitigate hazardous conditions that lead to accidents. The JHSAT also recommends that the JHSIT consider developing material that can be integrated into the NTSB's training

curricula to increase crash investigators awareness of weak spots in their investigation methods and how the accident data could be used if it were more comprehensive.

Recommendation N$^{o.}$ 3. - No detailed helicopter fleet hour data is available. The FAA accumulated this data until 1996.

The macro level grouping currently supplied by FAA is inadequate. An effective safety system needs to have data sufficient to measure characteristics and trend results of specific fleets. Fleet hour data is essential for normalizing such characteristics and trends. Non-normalized data is easily misinterpreted. Therefore, the JHSAT recommends that the JHSIT develop a strategy to facilitate the accumulation of annual fleet hour data on a worldwide basis. Such effort has already started by Bell helicopter but needs international regulatory support and input.

The JHSAT recommends the following based on review of existing helicopter safety reports:

Recommendation N$^{o.}$ 4. - Helicopter Safety website

Several helicopter safety studies have recommended some way of providing safety feedback to the industry. Indeed, many industry professionals have no idea what the most prevalent causes of accidents even are. Pilots would be surprised to hear that running out of fuel is one of the most common and preventable accident causes. Or that getting interrupted during a preflight and inadvertently missing one step in the preflight process has been and will continue to be dangerous and sometimes deadly. Knowledge of these problems and their consequences might wake up the industry to the fact that no one is immune, and that following proper procedures and implementing other solutions can save money and lives.

The IHST is in the process of getting permission to take over the helicopter safety website, "safecopter", developed at NASA. Safecopter was intended to be a clearing house for helicopter specific safety information, and includes mission-related information, accident and incident statistics, a library of safety articles, lists of safety equipment, links to other safety-related sites, maintenance and training information and periodic columns of various articles and updates from safety professionals.

The IHST has a great opportunity to remake the safecopter website into an even more useful website for the helicopter industry. Updating safecopter is an easy and inexpensive way to raise awareness of safety issues, both problems and solutions, within the industry.

The JHSAT recommends that the JHSIT evaluate the type and structure of information, develop strategies to maximize the sites exposure to the helicopter community and determine how to keep the site current.

See https://safecopter.arc.nasa.gov for the existing website, still posted through NASA.

Recommendation N°. 5. - Proximity Detection Equipment for Helicopters

Previous studies performed by contractors revealed that there were a significant number of accidents resulting from collision with terrain or with objects. Most of the reports differentiated between a collision with terrain event and a collision with object event in that the collision with object event usually involved impacting an object with the MR or TR, resulting in an accident. The initial accident analysis accomplished by the JHSAT identified numerous events where pilots allowed the aircraft to impact objects on the ground, close to the ground, or attached to the ground. The analyses, and reviewed reports, indicate that the majority of the object collision events occurred in single-engine piston rotorcraft operated in close proximity to objects (Ag operations, confined space operations.). In particular, wires were singled out due to the difficulty in seeing them. There were events in more complex rotorcraft usually related to helipads and objects or confined space such as maneuvering like that encountered in some EMS operations.

The recommendations from the previous studies included the need for proximity awareness cues or warnings for the pilots. Currently, the types of proximity detection equipment available to helicopters are:

Helicopter Terrain Avoidance Warning Systems (HTAWS) to address more commonly understood collision with the ground accidents (usually in a cruise or approach mode).

Wire detection systems (radar, EM detection)

Radio altimeters (confined to what is directly below helicopter or within direct line of sight of sensor)

Hover systems employing RADALT, Doppler radar or other means to measure lateral drift (The RADALT being the proximity detector, height above the ground)

Currently, TAWS are widely used in the commercial fixed wing sector and have proven to be highly effective in reducing Controlled Flight into Terrain (CFIT) events. Avionics manufacturers have recently developed Helicopter Terrain Avoidance Warning Systems (HTAWS) that are designed specifically for the helicopter community. These systems are currently being installed on some "high end" rotorcraft. Additionally, a RTCA committee is currently working to establish Minimum Operational Performance Standards (MOPS) for helicopter terrain avoidance warning systems. Given the potential benefits of deploying these systems into the helicopter community and the need to address the unique operational challenges presented by helicopters, the JHSAT recommends that these systems and standards be given additional consideration as an important

piece of an overall plan to enhance helicopter operational proximity detection. HTAWS could effectively address terrain issues, however, our analyses to date do continue to show the larger need is for systems that address object collisions in environments where the HTAWS would be "inactive", i.e., hover in confined space, approach/takeoff to helipads, repositioning in confined space or operating in object rich environments.

Wire detection is also an issue during low level flight. There are currently systems on the market that can warn the pilot of wire presence and some that will provide location. Some of these systems use electro magnetic emissions from energized wires to provide aural (and/or visual) cues to the pilot of wire presence. Others use laser or radar transceivers to locate wires and alert the pilot. There is a system available that is external to the aircraft that is used in Europe using radar mounted on power line towers. This system detects an aircraft's proximity and speed then transmits an aural warning to the aircraft on all frequencies coupled with flashing strobe lights on the towers.

There currently is no marketed proximity warning device that will warn a pilot if they're about to strike their tail rotor or main rotor blade into an object. Likewise, other than a RADALT, there is no system on the market that will keep the pilot form impacting an object below the aircraft if the pilot does not see the object. There are rearview cameras now STC'd for installation on aircraft that allow the pilot to see what is aft of the aircraft. This type of system has been installed on transport category rotorcraft but is new enough that there is no service history to use to assess its effectiveness.

There needs to be a research and development effort to bring proximity detection systems to market in order to assist the pilot in keeping track of their rotorcraft's pieces parts relative to objects on the ground or attached to the ground.

<u>Recommendation N$^{o.}$ 6. - Flight Recording Devices and Cockpit Image Recording Systems for Helicopters</u>

Currently, the FAA does not required CVR/FDR installation for light aircraft and most helicopters. In the commercial world Cockpit Voice Recorders (CVR) and Flight Data Recorders (FDR) serve as critical aids in understanding airline accidents and incidents. Understanding helicopter accidents with a high degree of confidence is often impossible given the lack of utilization of recording devices. Additionally, due to the FAA's Technical Standard Order (TSO) requirements for

crash survivability, traditional recording devices have been priced out of most helicopter markets.

Technological advances, in some cases, have also hindered the ability to understand causal and contributing factors of helicopter accidents:

> New cockpit configurations utilizing digital displays and LED illumination have reduced the ability of investigators to perform time honored assessments of passive indicators such as needle slap, bulb filament deformation and analog gauge positions at impact.
>
> Increased use of composite material construction, which is susceptible to fire, masks or destroys post crash evidence; mature post crash analysis methods of composites have not yet been developed.

The JHSAT recommends that new technologies be adopted to increase information available to accident investigators. Advances in miniaturization in digital storage, non-volatile memory (NVM), digital imaging and GPS systems have allowed for development of mini-flight data recorders which are relatively inexpensive. In today's market, cost varies from $1000 to $5,000 as opposed to $50,000 to $150,000 for traditional TSO compliant equipment. The IHST/JHSIT should promote work between industry and the FAA to develop recording standards and work to ensure that installation of these devices is not hampered by over burdensome government or industry requirements (i.e., TSO requirements which drive cost/complexity to unacceptable levels). Experience with several manufacturers' products over the last five years has demonstrated an approximate 97% data recovery capability from non-hardened NVM devices.

A variety of recording devices should be considered, the spectrum of operational and cost environments will need to be optimized with the various technologies:

1. GPS Positional Flight Recorders-no aircraft interface.
2. Performance Monitoring Devices-recovers aircraft information.
3. Cockpit Image Recording Systems – digital imaging

Adoption of these technologies could also have beneficial implications in day to day operations. All three types of units have the added capability of acting as mini flight data recorders and are capable of being used as training devices, where flash card memory can be removed and the flight can be "re-flown" on a computer. Performance Monitoring Devices can also record up to several thousand hours of aircraft time and could act as electronic aircraft and engine logbooks. All of the devices are useful for the aircraft owner, to enable monitoring of aircraft utilization

and the pilot performance. The devices should not be accessible from the cockpit, thus prohibiting the pilot from turning them off or disabling them.

To summarize, technology can be a double edged sword relative to understanding helicopter accidents. Some traditional tools used by investigators have been compromised; however, other technological advances should be used to develop recording devices for all helicopters, new and old. Significant work will be required to develop standards, correctly adopt technology to the needs of varied operations and meet the cost constraints of smaller operations. The benefits will be many, ranging from more complete understanding of accidents, especially fatal accidents, where no survivors are available, and the potential to use recording devices as simplified HUMS/HOMP devices.

Recommendation N$^{o.}$ 7. - Aeronautical Decision Making (ADM)

From the start of aviation, the most common cause of all civil and military helicopter accidents worldwide has been the human. This accident casual percentage varies from 65% to 85% depending on the type of helicopter, the type of operation being conducted, the operational environment/location, organizational safety culture, the specific pilot himself, etc.

Failure of the aircraft itself occurs relatively infrequently and these problems in the fielded fleet are usually corrected quickly by the manufacturers, regulatory agencies, and operators. Improving the human error component is far more complex to assess, correct and validate.

Pilots can be view as being at the end of a long line of design, training and infrastructure decisions. Latent failures in training, SOPs, maintenance, design, etc., can ultimately manifest themselves as an unexpected critical decision-making scenario being placed on the pilot. Studies of root causes of helicopter pilot errors have revealed many interesting and useful insights but the common root cause is related to poor judgment (also referred to as Aeronautical Decision Making (ADM) and Pilot Decision Making (PDM)). Since the vast majority of helicopter accidents are single pilot, ADM for single pilots is should be considered a priority. ADM is also related to Cockpit Resource Management (CRM) used when the aircraft has two pilots. CRM has evolved to Crew Resource Management which further involved all crew members onboard and their relationship to the pilots. CRM is evolving to include ground personnel and others not onboard the aircraft that can assist the pilot.

Studies of the use of ADM and CRM in training for military and civil aircraft have shown a significant impact in reducing accident rates. US military services using

CRM have shown accident rate reductions of 28% to 81% for their airplanes and helicopters. US civil helicopters use of ADM have shown accident rate reductions of 36% to 54%. There is no single best approach to ADM training as different approaches to ADM training have proven successful.

It is recommended that ADM training be done is several areas from initial training, recurrence training, etc. A Company's Safety Management System should include ADM training and be an integral part of the company-specific safety process. For multiple pilot/crewmember operations, CRM should also be included.

Further, mission-specific ADM/CRM training is recommended as different types of operations have different human/organizational issues. Location/environment of operations are critical and specialized ADM/CRM must address these issues.

ADM/CRM should be included in training using simulators and fixed-based training devices (FTD).

The JHSAT recommends that the JHSIT develop a strategy to develop, target and apply ADM training across the operational community.

(1) LEGEND of REPORTS

1. U.S. Civil Rotorcraft Accidents, 1963 Through 1997 (Harris, et al)
2. Analysis of US Civil Rotorcraft Accidents from 1990 to 1996 and Implications for a Safety Program – 2001 (Iseler, et al)
3. ASRS Rotorcraft Incident Study - 1998 (Hart, et al)
4. HAAT – 1998, (Hart ,et al)
5. A Safety Review and Risk Assessment in Air Medical Transport – 2002 (Blumen, et al)
6. Military Aviation Safety – 2002 (Bolkcom, et al)
7. Safety Performance of Helicopter Operations in the Oil & Gas Industry – 2000 (OGP)
8. Lessons Learned from Transportation Safety Board Investigations of Helicopter Accidents – 2004 (Morley and MacDonald, TSB Canada)
9. The History of Helicopter Safety - 2005 (Fox)

Revision History:

Initial issue – November 30, 2006

Rev 1 – February 21, 2007, adopted revised language relative to HTAWS under recommendation 5. Added language to more clearly indicate that this is a product of the US JHSAT.