



USHST Training Working Group

POSITION PAPER

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Safety Through Helicopter Simulation

Recommendations by the Training Working Group

for actions to improve the use of helicopter simulators and enhance safety.

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SAFETY THROUGH HELICOPTER SIMULATION

INTRODUCTION

At the opening of the 2014 Heli-Expo Trade Show, sponsored by the Helicopter Association International (HAI), the National Transportation Safety Board (NTSB) issued a safety alert entitled, “Safety Through Helicopter Simulators.” On the face of it, such an event is not surprising. Many interesting articles are released around this time every year, and safety is always an area of concern in the helicopter industry, so what exactly makes this particular document special? Let’s explore some of the circumstances regarding the importance of this issue.

AIM

The aim of this Position Paper is to highlight the current state of the US Helicopter simulation and training industry and make recommendations to increase the use of helicopter simulators with the purpose of improving safety.

DEFINITION OF TERMS

Aviation simulators go by many names, including full flight simulators, flight training devices, AATDs, BATDs, etc. Each type of device may have different uses, certifications, and regulations. For purposes of clarity, this paper uses the generic term Flight Simulation Training Device (FSTD). This term includes all the different types of devices. For more information regarding the various types, please refer to Appendix A.

BACKGROUND

The NTSB is the government agency charged with investigating accidents that occur within the US transportation system. Their accident investigations are designed to identify primary and secondary cause factors with the goal of improving safety. In addition, the NTSB makes recommendations where they identify policies and procedures that could be changed to improve safety and prevent future accidents. The NTSB does not have enforcement power and cannot actually change regulations or public policy. That task is left to government agencies such as the FAA. When the NTSB notices a trend, or several accidents with related cause factors, they may issue a safety alert that calls attention to a particular issue along with safety recommendations to mitigate risk. Such is the case with safety alert SA-031. See Appendix B for a link to this Safety Alert.

There is ample evidence that helicopter pilots face significant risk in flight and are sometimes found to be insufficiently trained at handling certain problems that may occur while in flight. The NTSB clearly states that many of these issues can be resolved or at the very least improved by the use of helicopter simulation.

ROOT CAUSES

The first interesting fact about this safety alert is its title, “Safety Through Helicopter Simulators.” Notice that it does not say “flight simulators”, but rather, uses the word “helicopter” specifically. This is not a safety alert to say all pilots should use simulators for training, but an alert to helicopter owners, operators, and pilots that there is a problem that could be fixed by using “helicopter” simulators. Flight simulators in general are a good tool for training. They are much more common in fixed-wing training at all levels of instruction, and recognized as a significant contributor to safety. This suggests that the lower accident rate in fixed-wing may be related in part to more comprehensive training. The NTSB is pointing their finger directly at the helicopter industry with this safety alert.

The NTSB points out that the problems include improperly performed emergency procedures leading to accidents, training scenarios in the real aircraft limited in scope due to safety considerations, and the difficulty

(in the actual aircraft) of trying to recreate the element of surprise and the realistic, complex scenarios that pilots may face. Certainly, no helicopter pilot wishes to go out and actually crash during a training flight, but all helicopter pilots want to be ready to cope with emergencies that may arise. Years ago, the only place to conduct high risk simulated emergencies was in the actual aircraft. Today, there is a better way.

The NTSB examines three major accidents that illustrate the lack of quality training and how that lack of training impacts safety. The first accident involved an emergency medical helicopter on a patient transfer that crashed just short of the airport from fuel starvation killing all four occupants. There were many factors that led to this accident, including taking off with insufficient fuel, pilot distraction and training deficiencies. The NTSB attributes this accident directly to a lack of training in entering autorotation from a cruise profile and the subsequent failure to maintain rotor RPM. The point is made that practicing the proper control movements and maintaining rotor rpm may have allowed this pilot to successfully complete the maneuver and could have possibly saved the lives of four people.

The second accident involved loss of situational awareness during a night flight while the pilots were on night vision goggles that resulted in a collision with the ground causing three fatalities. In this case, the pilot had received training in the aircraft under NVGs but the training was limited to populated areas during periods of high moon illumination. Unfortunately, the conditions at the remote accident site were not so favorable at the time of the crash. This pilot could have benefitted greatly from training received in a simulator that could vary the illumination from both the moon and populated areas.

The third accident cited was a result of an inadvertent entry into the clouds. The pilot, who was instrument rated, experienced spatial disorientation resulting in flight into terrain causing three fatalities. Helicopter pilots, even if they are instrument rated (not required for a commercial pilot), often have no recent instrument experience, and often operate aircraft not equipped for instrument flight. Encountering IMC conditions is a challenging emergency situation that requires proficiency and decisive action to avoid serious consequences.

NTSB SAFETY ALERT RECOMMENDATIONS

Based on the results of these three accidents, the NTSB provided the following recommendations:

1. Through simulator training, operators can provide pilots with valuable tools to ensure proficiency in emergency procedures, including autorotations, use of night vision goggles, recognition of degraded visual conditions, and recovery from unusual attitudes.
2. Consistent, standardized, simulator training will help prepare pilots for the unexpected and will decrease the risk of an accident.
3. Simulators can be a helpful tool for operators to provide training on the following:
 - Autorotations during any phase of flight, which reinforces the immediate responses required during actual emergencies.
 - Scenario-based training tailored to the mission including NVG missions in low-light situations and site-specific training that considers obstacles and terrain.
 - Degraded visual conditions, safe decision-making skills, and inadvertent IMC encounters.

WHY HELICOPTER SIMULATORS?

The common theme of the safety alert is that the specific type of training that would have helped these pilots better cope with the emergencies they encountered could only be found in a simulator. Remember, it is not that the pilots did not do enough training in the aircraft, but that they could not practice in the aircraft what they needed to learn in order to avoid an accident.

So, why doesn't the helicopter industry use more simulators in training? Here are just a few reasons often mentioned:

Objection: Helicopter simulators are expensive.

Response: True, but so are real helicopters, especially to maintain and repair after a crash. Much of the cost related to helicopter simulators can be explained by the complex technology in areas of visual systems and aerodynamic modeling. The acquisition and use of a helicopter FSTD can be justified in several ways, including better training, the chance to practice and review outside of the aircraft, availability day or night or good weather or bad, and credit for some tasks that would otherwise have to be performed in the aircraft at a much higher risk and cost. Frequently instructors manage to prevent full-fledged accidents from occurring during training, but that often comes at the costs of over-torques, over-speeds, and other exceedances. FSTDs help mitigate these expenses while greatly reducing the risk to the occupants at the same time.

Objection: FSTDs are only valuable when training crews for medium and heavy twins with complicated avionics systems.

Response: Let's ponder this one? Has anyone looked at the glass cockpits appearing in today's smaller single engine reciprocating and turbine helicopters? Are they complicated? For that matter, an FSTD with older-style analog instruments is the perfect place to begin learning instrument scans in both VFR and IFR training.

Objection: Helicopter simulators must have motion.

Response: Most training tasks do not require motion to be effective. In fact a non-motion device is an excellent training tool for learning basic flight skills and hovering tasks. As a matter of fact, especially for those pilots building a basic skill level, motion can be a distractor and cause student pilots to concentrate on the "feel" rather than the important place, the horizon and the visual view.

Objection: The simulator does not fly like the aircraft.

Response: Depending on the level of certification, manufacturers and the government go to great pains to be sure the flight modeling is accurate. In modern FSTDs, actual flight data is gathered from the aircraft and then matched to the device. There is little chance that it is not representative of the aircraft. The problem is more likely pilot skill, and that means the ability to use the cues present in the FSTD, and adjust to controls, sensitivity, etc just as if one were flying a new type aircraft. It is interesting that those pilots with less aircraft experience are generally better able to adapt early in simulators.

Objection: I cannot get training credit for flying the simulator.

Response: Training and checking credits are important; they serve to provide incentive to use simulation training by lowering the overall cost of training. We have started to move in the right direction with the latest changes to the AATD credits announced by the FAA for IFR training in April 2016, but what about VFR credits too? The more FSTDs are used, the better the training result. However, if we say that the only important training in a simulator is the creditable training, we are really missing the point. In the accident cited by the NTSB, the point is that these accidents could not be practiced safely in the aircraft, whether or not they are "creditable." As another example, you will not get credit for studying the checklist and emergency procedures either, or the time spent in the hangar figuring out control linkages and preflight inspections. Remember, the FAA requirements for licensing and currency are minimum standards, and just because a pilot is "legal", he may not be proficient. Maintaining proficiency is a serious problem for many general aviation helicopter pilots because of the expense and availability of aircraft. Most graduating private pilots have 10-20 hours more than the minimum 40 hours of experience required. Effective scenario based training and practice in an FTSD can significantly reduce unnecessary risk and save substantial time needed in preparation for the final check ride.

Many emergency scenarios can be successfully demonstrated and practiced in these devices, which would likely be very dangerous to accomplish in the actual helicopter. Practice in an FSTD until a pilot performs a particular segment of a procedure or action correctly, before attempting to do the same complex tasks in an aircraft, is an acceptable and desirable practice. Learning to fly a helicopter involves practicing many tasks, not all of which have to be initially trained in the aircraft.

Objection: I cannot find a helicopter simulator locally.

Response: Depending on location, it can be difficult to locate suitable helicopter simulators. However, more and more are entering the marketplace and their capability is much improved. The emphasis on helicopter simulators in the helicopter world up until recently has been on high fidelity medium and heavy twins used by commercial aircrews for initial and recurrent training. Ab-initio flight schools may not have a device at all, or it may be such a low fidelity level that it is not suitable for serious training. If you are interested in learning to fly a helicopter, the availability of simulation for your training should be a factor in which school you select. If you are the owner or chief pilot of a training organization, having a simulator provides your potential graduates with complete, top-notch training.

To be fair, it is only recently that technology has advanced to the point where realistic helicopter simulation is possible and affordable. Most helicopter missions are conducted during the day, in visual meteorological conditions (VMC), over challenging terrain, and far from the airport. This means that the helicopter FSTD must have a high quality visual system that provides a high resolution wide and deep field of view to allow the helicopter pilot to train in conditions that simulate the “real world.” After all, training in a FSTD that is not realistic isn’t really very good training at all. In the past, these limitations have caused the helicopter FSTD to be assigned the more mundane task of teaching basic instrument tasks, certainly something that can be taught in a simulator, but not the only thing and *not the most important thing*.

MATCHING TRAINING REQUIREMENTS AND SAFETY NEEDS

What is the most important thing? The point made in the NTSB Safety Alert is that scenario based training is key to developing decision-making skills and this training can be tailored to specific missions, considering weather, location, obstacles and terrain. Scenario based training fills in the gaps from traditional training in the helicopter. In the helicopter, we make believe we have just flown into the clouds and then put on glasses or a hood and try to complete some sort of maneuver. In the simulator, we fly into the clouds while conducting some sort of mission with no warning, no hood, and no one else to fly the aircraft. Training in the helicopter, we “simulate” an engine failure, and normally complete the maneuver at a safe height above the ground. Training in the simulator, we have an actual engine failure, accompanied by all of the correct alarms and instrument indications, and we go all the way to the ground, the goal being to complete the maneuver successfully. Which seems more realistic and more valuable? These scenarios educate the pilot to the importance of hazard identification and risk management and develop situational awareness to take forward as higher order thinking skills in actual flight.

DIRECTION FOR THE FUTURE

So, simulators make sense for helicopter training. What kind of FSTD should be used, how much does it cost, and what is the difference from brand to brand, or level to level? Are they expensive, and what can they do exactly? Can they substitute for actual aircraft training? What kind of training credits can be given? What kind of checking credits are available?

The fundamental question to ask when incorporating a simulator in a training program is what are the training tasks to accomplish? A simulator is a training tool, and analyzing the training tasks is the most important step in determining the right tool for the right job. As an example, if your goal is to teach instrument flying tasks, then a

simulator equipped with the appropriate instrumentation and a rudimentary visual system would be sufficient. If, however, you also wish to train VFR tasks such as hovering, confined area operations, and slope landings, then you will also need a much more capable visual system in addition to the properly equipped instrument panel. If the training goal is to teach pilots the difference between normal and abnormal vibrations in flight, then some sort of vibration system will be necessary.

Another way to select a proper device is to look at the various levels involved in government certification. The table presented in Appendix A lists the various levels of simulation devices for the FAA, EASA, and ICAO. These levels are designed to accommodate varying types of training by combining features that the government agencies feel are important to the training experience. As you can see by the table, there are several differing opinions on how these levels should be defined. The FAA and EASA offer nine levels (but not defined the same), and ICAO offers only five levels. The inspector doing the qualification will make an objective evaluation of the simulator, and a subjective evaluation of the suitability to conduct certain training tasks. In the statement of qualification issued by the FAA, the tasks that are considered suitable for the device are listed. It is important to note that simulators do not have to be approved or qualified by the appropriate national aviation authority unless they are to be used in creditable training or training to proficiency.

Here, in the United States, if training is being conducted under Part 61, the regulations state that the simulator must be approved by the Administrator (14 CFR §61.4). Such approval may be issued in a letter for a BATD/AATD device, or a statement of qualification for a level 4 and higher device. For training conducted under Parts 135 and 141, a Principal Operations Inspector (POI) approves the use of a specific qualified simulator for specific training tasks under a specific training syllabus. The same thing happens under Part 142 (Training Centers) except that this approver is called a Training Center Program Manager or TCPM. Although there is substantial guidance for FAA personnel regarding what type of simulators may be used for what types of training and/or training to proficiency (checking) in the airplane world, the same cannot be said for helicopters. Currently, official FAA guidance supporting simulator training and checking credits is limited (see Flight Standards Information Management FAA Order 8900.1, Volume 3, Chapter 19, Section 6, Paragraph 3-1251(D) for example) and this constrains simulator usage in approved training programs under 14 CFR Part 135 or Part 141. As to what credits may be approved, each case is considered separately and is dependent upon the inspector's evaluation. Hopefully, the FAA will, in the future, develop a standard, cohesive, and well thought out approach to using helicopter simulation and promoting helicopter safety. It seems clear this is an idea whose time has come.

CONCLUSION

Simulation training is not just for pilots that fly airliners or transport category helicopters. Every helicopter pilot needs training specific to the mission and the challenges of operating safely. All helicopter pilots, regardless of the type aircraft he or she flies, face challenges including inadvertent IMC, degraded visual conditions, controlled flight into terrain, obstacle awareness and avoidance...the list goes on. For some pilots, that list might include operating under night vision goggles, utilizing a FLIR camera and a high-intensity spotlight, or pinnacle landings conducted at high altitude. Every mission is demanding and presents a safety risk. Simulator training adds another dimension to the total training package and should be sought out whenever possible. Training in the real aircraft is not always better, nor is it all that is required to be a well-trained, safe and prepared pilot.

RECOMMENDATIONS

It is recommended that:

1. There is a direct link between the use of simulators in training and improved safety. At every opportunity, the FAA, USHST, and other helicopter organizations should encourage increased use of helicopter simulators in all areas of training.
2. Increased credits for training and checking will encourage the use of helicopter simulators. The FAA should conduct a full review of guidance and oversight for helicopter simulation usage in the US. The

goal of this review is to improve standardization, give greater single point oversight, and allow as much training and checking credit as possible.

3. Greater credits be awarded to lower fidelity helicopter simulators (AATD and above) for training other than instrument flying practice (ADM, Emergency handling including IIMC, Procedures etc).
4. USHST should issue guidance and bulletins related to the use of helicopter simulators in training for both Part 61 and Part 141 operators that addresses training syllabi and proper use of the simulator by instructors.

Appendices:

- A. Comparison of Helicopter FSTD Levels (FAA, EASA and ICAO).**
- B. References and Links.**

Appendix A

Comparison of Helicopter FSTD Levels (FAA, EASA, and ICAO)

FAA	EASA	ICAO	Comments
BATD AATD AFS-800	FNPT I	Type I	EASA -Flight, Navigation, and Procedures Trainer FAA – Basic or Advanced Aviation Training Device FAA AFS-800 approves BATD and AATD devices, all others are approved by the National Simulator Program Manager (NSPM) AFS-205
FTD 4 AFS-205			Part Task trainer only – does not simulate an aircraft, only a system
FTD 5 AFS-205	FNPT II FTD 1	Type II	EASA and ICAO require visual system. FAA does not.
FTD 6 AFS-205	FTD 2		Requires flight data and specific cockpit. Does not require low speed (hover, etc) data. Visual system is optional for FAA.
FTD 7 AFS-205	FTD 3	Type III	Requires both low and high speed flight data and high level visual system. FAA and ICAO require vibration system.
FFS A AFS-205	FFS A		Level A is not used in FAA. Very few in EASA.
FFS B AFS-205	FFS B	Type IV	Requires motion, flight data and specific cockpit, Low speed flight data is not required by FAA and EASA, but is required by ICAO.
FFS C AFS-205	FFS C	Type IV or V	Requires motion, both low and high speed flight data and specific cockpit.
FFS D AFS-205	FFS D	Type V	Requires motion, both low and high speed flight data, and specific cockpit. Also required technical data for sound and vibration.

Appendix B

REFERENCES AND LINKS

NTSB Safety Alert SA-031

https://www.nts.gov/doclib/safetyalerts/SA_031.pdf

FAA Part 60 (Appendix C for helicopter full flight simulators, Appendix D for Flight Training Devices)

http://www.faa.gov/about/initiatives/nsp/media/consolidated_version.pdf

Explanation of EASA levels for helicopter simulators:

<http://easa.europa.eu/essi/ehest/wp-content/uploads/2013/07/HE-6-Advantages-of-simulators-in-Helicopter-Flight-Training-final.pdf>

ICAO 9625 Volume 2 Presentation (document is available for sale through ICAO)

<http://www.ihst.org/portals/54/ihss/training/Simulation%20and%20FTD%20Challenges.pdf>