National Transportation Safety Board
Office of Research and Engineering
Washington, D.C. 20594

Performance Study

Specialist Report
Marie Moler

A. ACCIDENT

Location:	Frisco, Colorado
Date:	July 3, 2015
Time:	1339 MDT
Airplane:	Airbus AS350 B3E, N390LG
NTSB Number:	CEN15MA290

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On July 3, 2015, at 1339 mountain daylight time (MDT), an Airbus Helicopter Inc. (formerly American Eurocopter) AS350 B3e helicopter, N390LG, impacted the upper west parking lot approximately 360 feet southwest of the Summit Medical Center helipad (91CO), Frisco, Colorado. A post-impact fire ensued. Visual meteorological conditions prevailed at the time of the accident. The helicopter was registered to and operated by Air Methods Corporation and the flight was conducted under the provisions of 14 Code of Federal Regulations Part 135 on a company flight plan. The airline transport rated pilot was fatally injured and two flight nurses were seriously injured. The public relations flight was en route to Gypsum, Colorado.

PERFORMANCE STUDY

Weather Observation

The weather conditions reported by KCCU AWOS at Copper Mountain in Red Cliff Pass, Colorado for 1335 MDT were winds from 280° at 19 kts, gusts to 24 kts, ten miles visibility with scattered clouds. KCCU is at an elevation of 12,073 feet and is 6.5 NM from the Summit Medical Center helipad, elevation 9042 feet. The Meteorological Report explains the complexities of the mountain-influenced weather in the area of Frisco, Colorado at the time of the accident [1].

Helipad Security Video

Data for the performance study came from security camera footage of the Flight for Life helipad. The camera recorded an average of 12 frames per second and recorded the helicopter's takeoff and the motion of a windsock at the site. Figure 1 shows a frame of video from the camera just before the aircraft took off. The wind sock is marked in yellow.

Figure 1. Aircraft prior to take-off.

Figure 2 shows an overhead view of the helipad. The roof-line of the building behind the helicopter is along a heading of 57º. The helicopter initially seemed to be aligned with the building. The wind sock position indicates the wind was coming from the aircraft's left, though the exact speed and direction of the wind was difficult to determine.

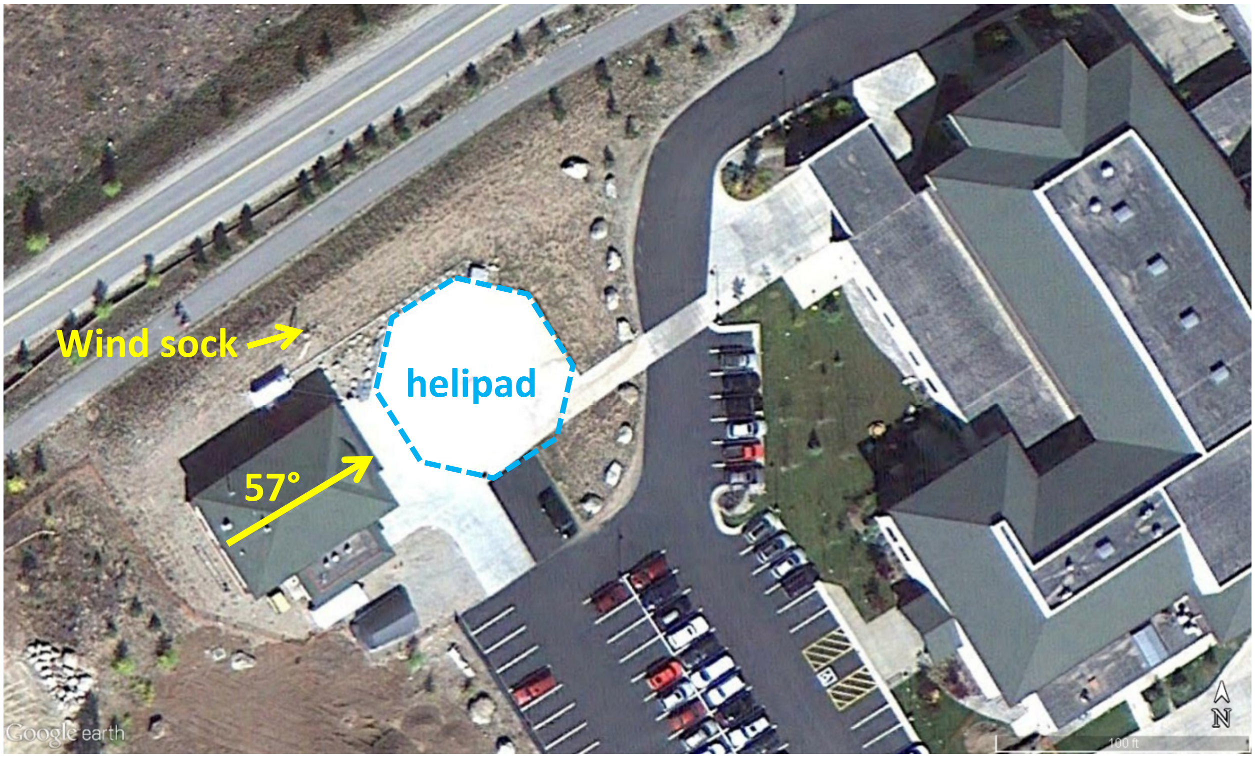

Figure 2. Overhead view of helipad.

The image of the helicopter remains steady until the aircraft, without an appreciable change in altitude, begins to yaw to the left. Figure 3 shows the complete helicopter take-off sequence from first movement until just out of the video frame. The Video Study estimated the average yaw rate for the first eight seconds after takeoff was 22 deg/s and it increased to 45 deg/s as the aircraft gained altitude. The aircraft's estimated vertical speed shortly after takeoff was 5.6 ft/s [2].

Figure 3. Helicopter take-off sequence.

The aircraft climbed while rotating to the left until out of the frame of the video. Approximately 23 seconds later the helicopter can be seen descending in the top left corner of the camera frame. The aircraft subsequently impacted the parking lot surface and caught on fire.

The parking lot the helicopter crashed in was approximately 350 ft to the southwest of the helipad (see Figure 4) and was covered by another video camera. The video from that camera was also evaluated in the Video Study. In the study, the aircraft was described as “undergoing 3D translation and rotation with the rotor spinning” as it impacted the ground.

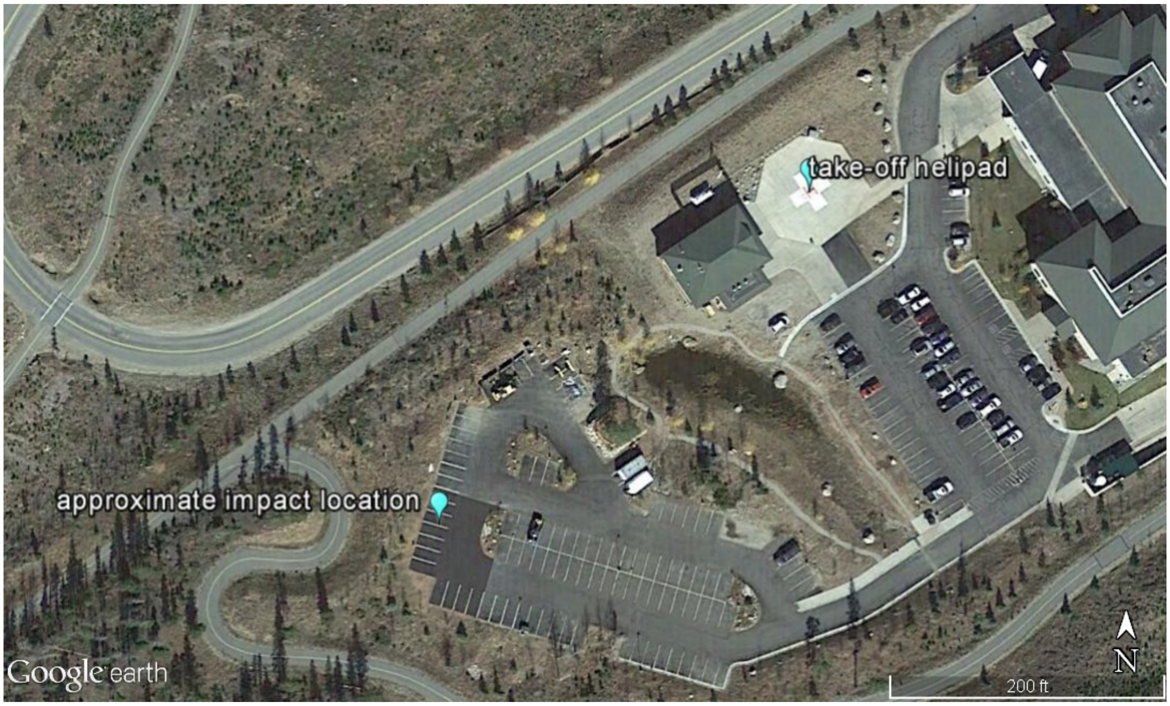

Figure 4. Helicopter take-off helipad and approximate impact location.

Wind and Loss of Tail Rotor Effectiveness

Loss of tail rotor effectiveness (LTE) occurs when the tail rotor cannot provide enough anti-torque to counter the aircraft's natural tendency to yaw towards the advancing main rotor blade. The design of the aircraft, wind direction and magnitude, gross weight, and airspeed can be contributing factors to the onset of LTE. This section will discuss the effects of wind on LTE. Airflow relative to the helicopter can cause three different types of LTE: main rotor disk vortex interference, tail rotor vortex ring state, and weathercock stability [3]. For a helicopter with a clockwise main rotor rotation like the accident craft, winds of 10 to 30 kts from 45° to 75° right of the aircraft's heading can blow the main rotor vortices directly into the tail rotor. Winds from 30° to 150° can cause tail rotor vortex ring states that result in unsteady flow into the tail rotor. Tail rotor vortex ring states can be compensated for, but require continuous and rapid pedal (which controls the tail rotor pitch) movements. Weathercock stability is when a tail wind induces the aircraft to turn its nose into the wind.

The windsock in the video, the KCCU METARS report, and the meteorological chairman's group report all report winds from the aircraft's left (~270° compared to the aircraft heading), so the wind direction was not consistent with any of the identified sources of loss of tail rotor effectiveness.

Wind and Available Tail Rotor Effectiveness

The main rotor of an Airbus helicopter turns in a clockwise direction and imparts a left yaw on the aircraft. A wind from the aircraft's left would exacerbate this left yaw tendency and require more right pedal to keep the aircraft's heading constant. The FlightLab helicopter simulation tool[1] was used to model the pedal required to hold the aircraft steady for different wind magnitudes and azimuths. The simulations were of an AS350 with a gross weight of 4,720 lbs at an elevation of 9,042 ft on a 73°F day to match the accident event. The simulation was run in ground effect (< 15 feet above ground) for wind magnitudes of 5, 10, 15, 20, 25, 30, 35, and 40 kts at every 20° of azimuth (see Figure 5). Pedal input was reported in percentages: 0% for full left pedal, 50% for neutral/no input, and 100% for full right pedal. The result was that wind directly from the aircraft's left side required the greatest amount of right pedal to hold the aircraft's heading constant. For 15 kts of wind 67.5% pedal (right pedal depressed about 1/3rd) was needed to maintain heading. For 35 kts just less than 80% pedal was required (right pedal depressed 2/3rds of the way).

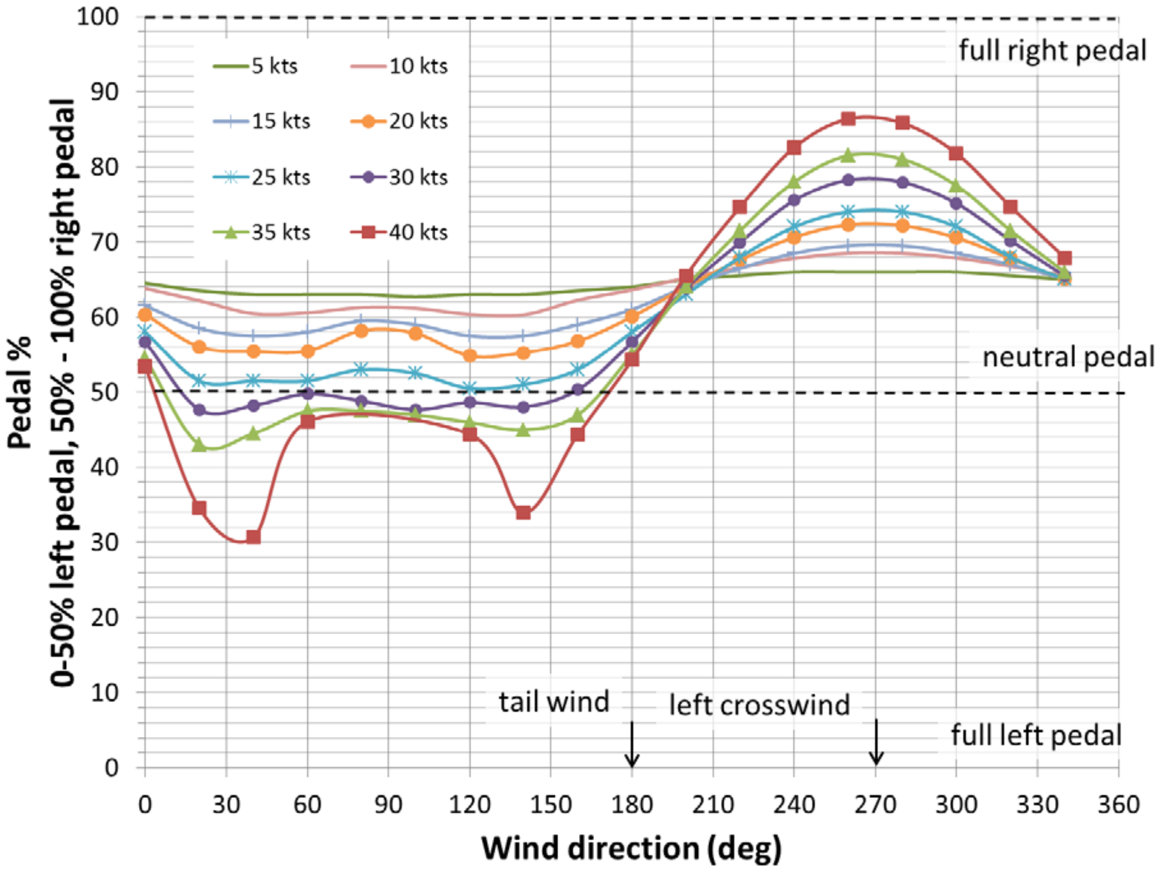

Figure 5. FlightLab simulation of AS350 helicopter. The figure shows pedal input for the aircraft to hold a steady 0° heading in varying winds in ground effect.

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[1] FlightLab is a library of flight dynamic models of rotorcraft components and full helicopter models that can be used to simulate various flight conditions. Models are constructed using physics-based sub-component models and airframe-specific data developed from sources outside the manufacturer. FlightLab is a product of Advanced Rotorcraft Technology; for more information, see ART's website at www.flightlab.com.

Airbus Helicopter also performed a simulation of the AS 350 B3e for different wind speeds and azimuths for the specific condition of the day of the accident (Figure 6). In no wind, 78% pedal is needed to hold the aircraft on a steady heading while in ground effect. In a 15 kts left crosswind, 83% pedal was needed to hold the aircraft on a steady heading. The Airbus simulation showed the aircraft had adequate tail rotor authority through the pedals to maintain its heading in a 30 kts crosswind. The results shown in Figure 6 are from a computer simulation of the aircraft and should not be considered definitive performance data.

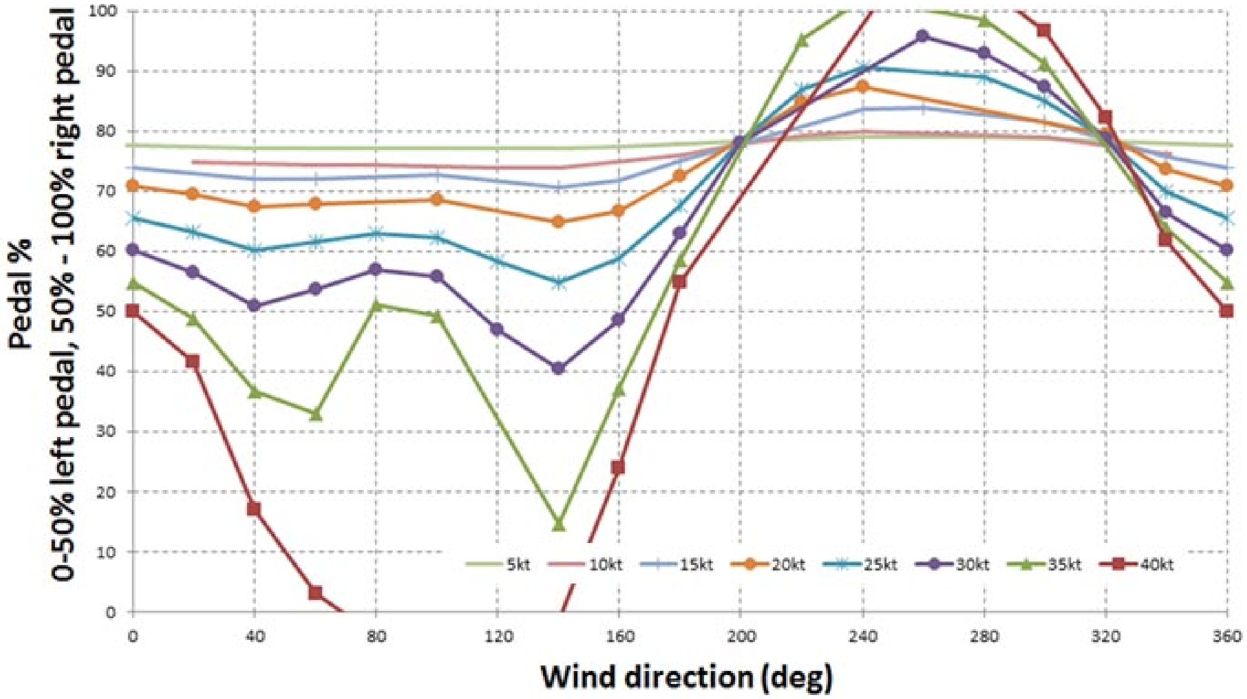

Figure 6. Airbus simulation of AS350 helicopter. Shows pedal input for aircraft to hold a steady 0° heading in varying winds.

Both simulations agreed that at the accident altitude, temperature, and aircraft weight, there should be enough tail rotor authority to counteract the yaw imparted by a left crosswind of up to 30 kts.

Calculated Yaw Rates

The Video Study [2] of the aircraft's take-off estimated that the aircraft's average yaw rate was 22 deg/s for the first eight seconds of flight. The yaw rate was increasing and for the final four seconds, the average yaw rate was 45 deg/s.

Airbus simulated the left yaw rate that would develop when the necessary pedal was released by different percentages (10%, 15%, 20%, 25%, and 30%). The simulation was for a 15 kts left crosswind and the accident configuration, which as discussed earlier required 83% pedal to hold a steady heading. In Figure 7, the pedal input was released the prescribed amount at the one (1) second mark. Four seconds after the reduction in pedal the yaw rates were approximately 50 deg/s (10% reduction in pedal), 75 deg/s (15% reduction), 95 deg/s (20% reduction), 110 deg/s (25% reduction), and 125 deg/s (30% reduction in pedal input). Note this simulation may overestimate the yaw rate because it uses a simplified model and does not account for the aerodynamic effects of the tail fin at given angles, the interaction between the tail fin and tail rotor at a given yaw rate, inertial factors, the dampening effects of the tail boom, or wind effects during rotation.

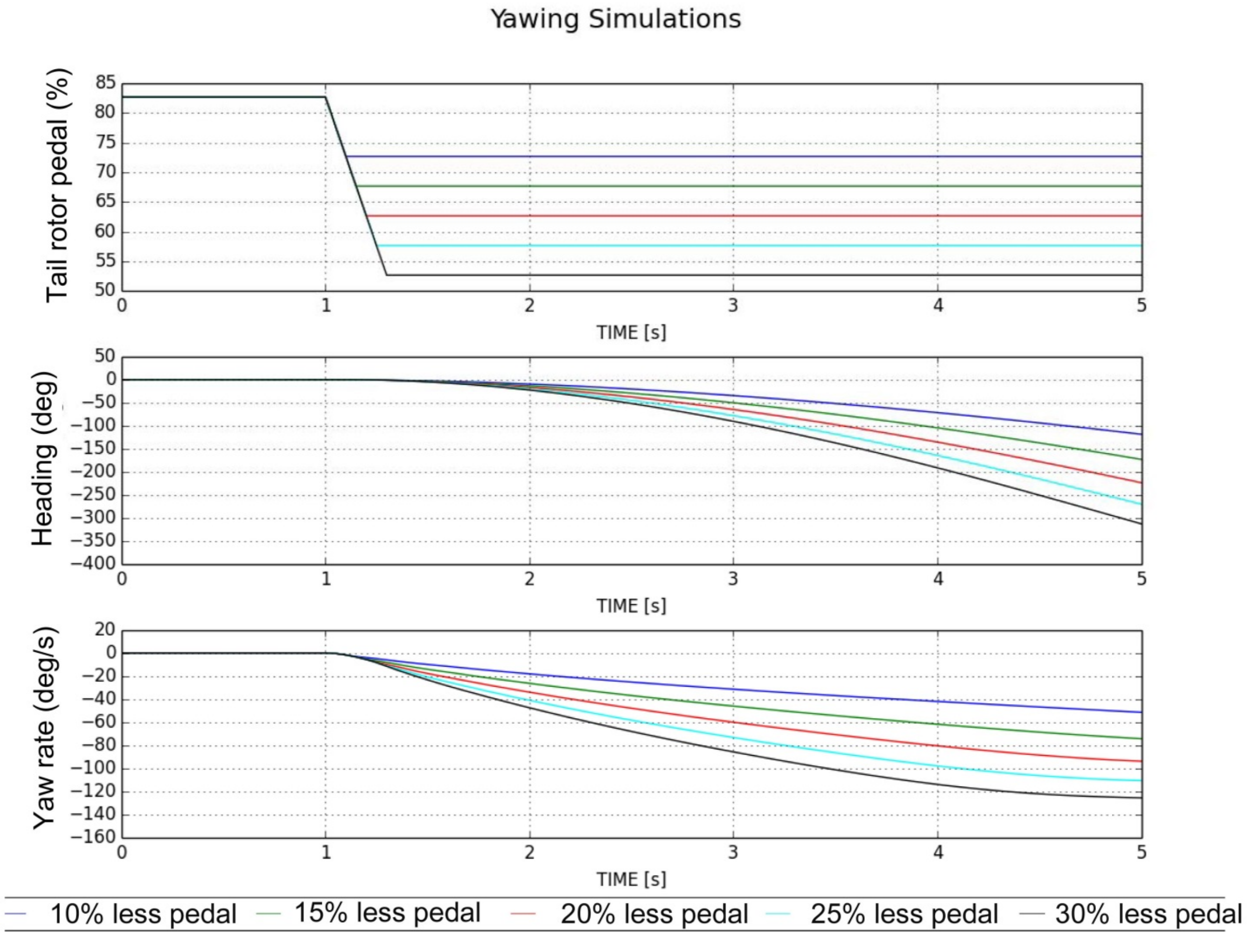

Figure 7. Airbus simulation of AS350 helicopter. Shows resultant heading change and yaw rate when 83% right pedal is reduced by 10%, 15%, 20%, 25%, and 30%.

The simulated yaw rates were higher than those for the accident flight calculated in the Video Study. For further comparison, a similar video study was performed on a different accident involving an AS350 in Albuquerque, New Mexico (CEN14FA193 [4]). The pilot, who survived the accident, reported that the pedals were jammed or locked in the neutral position and he was unable to apply any countering tail rotor torque. After approximately eight seconds the aircraft's yaw rate was over 100 deg/s and increasing. These rates were much higher than the 22 to 45 deg/s yaw rates measured for the Frisco, Colorado accident helicopter.

D. CONCLUSIONS

Simulations of the aircraft in its takeoff configuration under the environmental conditions at the time of the accident indicate that the aircraft should have had enough tail rotor authority to control left yaw with the reported winds. The winds from the aircraft's left at the time of takeoff were not consistent with any of the identified sources of loss of tail rotor effectiveness. The measured yaw rate of the accident helicopter was less than that calculated by Airbus simulations and lower than the yaw rate measured from another AS350 accident in Albuquerque, which may indicate that the accident pilot was able to input some amount of tail rotor control.

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E. REFERENCES

1. Meteorological Factual Report, Accident CEN15MA290, National Transportation Safety Board, 2016.
2. Video Study, Accident CEN15MA290, National Transportation Safety Board, 2016.
3. FAA Rotorcraft Handbook, FAA-H-8083
4. Video Study, Accident CEN14FA193, National Transportation Safety Board, 2016.