EUROCOPTER
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As a result of the Coordinators Call on 01-25-12, the NTSB requested that Eurocopter respond to the following questions based on; available Eurocopter experience, existing data form models, and engineering judgment. There was no expectation or requested for Eurocopter to perform any; bench tests, ground tests, exhaustive engineering/flight simulation of the accident event, or flight tests in response to any item in this request.

Firstly, Eurocopter would like to remind the investigation team of the previously provided information concerning the characteristics of this attachment/coupling. Eurocopter confirmed that such loss of this coupling has never occurred within the entire Eurocopter Fleet up to the time of the subject accident. Taking into account the similar design of the control rod to servo control input lever coupling on other Eurocopter models, more than 150 million operating flight hours have occurred without such an event. Furthermore similar screw/bolt couplings are used in other locations throughout the aircraft flight control system (such design of screws/bolts are widely used on the flight control system of the EC fleet). Additionally, Eurocopter uses the same hardware on heavier helicopters with significantly higher flight loads.

In addition, for this particular coupling, a safety factor of at least 300 times the flight load transmitted to the front servo control input control rod during normal operation exists as required by FAR 27 § 397. That confirms that, by design, by calculation and by experience, such hardware is perfectly adapted to what it is designed for.

1. What is the minimum event parameter set (parameter type, source, and sample rate) required to support a meaningful Eurocopter engineering simulation match of an in-flight accident/incident event for a "healthy" helicopter (accident make and model)?

A sample rate of at least 1 Hz with positional data, basic inertial parameters such as pitch, roll, and yaw, and images or other means to determine flight control inputs could be utilized to support a meaningful engineering simulation of the accident flight and sequence leading up to impact. A system such as the Appareo Vision 1000 flight data monitoring system, which is now installed as standard equipment on new AS350's delivered by American Eurocopter, would provide this data.

In the case of the subject accident, there is insufficient data to create a relevant and accurate simulation of the accident sequence. The reaction of the aircraft and pilot following the loss input rod connection to the fore-aft servo control input lever is very difficult to predict as it depends on several variables such as, but not limited to the following:

- The flight profile and load acting on the servo control at the time of the loss of connection; the direction of the servo ether extending or retracting. If the input lever was in the extending mode you could expect the servo control to extend until it reached its fully extended position with a speed as high as the initial amplitude of the spool valve; however, it is also possible that dependent on the force and the vibration of the input lever, it could also go down by gravity after a certain period of time too. If the input lever was in the retracting mode you could expect the servo control to retract until it has reached its fully retracted position. In either case, the aircraft would be acting in an uncontrolled manner.

- The possibility that the input rod remained in position (or partial position) for a period of time after the hardware became disconnected, either by friction between the yoke and the rod end bearing or by the presence of the anti-ice protection cover

- Pilot reaction and control inputs following the disconnection

2. Can EC perform a systems (flight controls) analysis based on radar flight path of the expected effect of the missing bolt? Specifically, if the subject bolt departed from its design location during constant altitude, constant heading, cruise flight, how would the helicopter motion initially be affected in each axis (assume no pilot correcting or compensating control inputs occurred for a Eurocopter-defined, finite time period)?

Again, it is not possible to provide a meaningful analysis/simulation of the accident sequence due to too many unknown variables (i.e. flight profile and load on the servo control at the time of the loss of connection).

However, if we consider the aerodynamic aspect, during cruise flight the servo input lever is set on a slight retracting position in order to counteract a tension flight load applied on the front servo control. So if the disconnection occurs during this phase and if we consider a slight and progressive increasing of tension flight load applied on the front servo control, the pitch up reaction of the aircraft is not inconsistent.

2a. Identify other potential systems failures that could result in the same flight profile. e.g. actuator failure of some manner, control jam, etc.

Potentially some other disconnection in the mechanical flight control system. However, there were no pre-impact disconnects identified in the flight control system during the onsite examination other than the fore/aft main rotor servo control input.

A main rotor servo slide valve seizure could theoretically result in an extreme servo input/position; however, in more than 18,000,000 flight hours on the AS350 fleet, a main rotor servo slide valve seizure has never been reported. Furthermore, there is an emergency procedure for such an event. If properly executed, the aircraft could regain full control and land safely with a hydraulics-off run on landing.

3. To what degree, if any, could the helicopter transponder-based altitude information recorded in the radar data be contaminated by helicopter dynamic maneuvers (for example, linked to vehicle response to departure of the subject bolt from its design location)?

It is possible for an unusual attitude to compromise the integrity of the altitude information being reported to the transponder at varying degrees during the accident sequence. Please confirm the radar sites reported altitude based on information from transponder as opposed to independent location/altitude information based on radar return.

4. Does a "healthy" helicopter flown using Eurocopter-recommended procedures and techniques within the nominal flight envelope have the performance capability to match the significant characteristics of the recorded accident flight path through radar-based time?

This analysis is based on the data recorded by the radar and such analysis does not take into account possible radar discrepancies.

a. 16:29:40 PST? (cruise segment prior to climb)

Yes.

b. 16:29:51 to 16:30:00 PST? (climb/heading change)

Yes, according to a preliminary performance calculation based on mass of 1,950 kg, DA of 3,500 ft., and temperature of 12 degrees Celsius, the maximum rate of climb at max continuous power (86% torque) would be 2,000 FPM; the climb performance at 16:30:00 is consistent with a 1971 FPM climb at 60 kts.

c. 16:30:00 to 16:30:15 PST? (initial descent)

The initial descent from 4,100 to 3,200 feet around 16:30:15 is not impossible, but totally outside the normal flight envelope. As a reference point, the rate of descent in a steady state autorotation would be approximately 1,850 FPM; the rate of descent reached around this time was more than 4,000 FPM. Such maneuver would be considered as a severe acrobatic maneuver outside of the normal flight envelope.

d. 16:30:18 to 16:30:41 PST? (constant altitude segment prior to final descent)

Yes

e. 16:30:41 PST? (final descent)

The rate of descent depicted during this segment is also not impossible, but would also be considered as a severe acrobatic maneuver outside the normal flight envelope.

Please provide reasoning and technical support for your answer of "yes", "no", or "cannot be determined" for each flight path time segment above.

5. Given the available physical evidence, radar data, helicopter simulation models, control system models, and Eurocopter experience, during what time window(s) (PST or Reference) during the accident flight did/could the subject bolt depart from its design location? If the operational evidence and context is ignored, which bolt departure time is most probable and why?

Based on the lack of information available and number unknown variables, it is not possible to determine when the subject bolt departed from its design location. However, it does appear, based on the radar data, that the aircraft departed normal, controlled flight around 16:29:46 PST.

6. Request that EC perform a vibration/departure case analysis for the bolt/nut/cotter pin. Conditions to be analyzed in various combinations include normal and properly installed bolt, nut, pin associated with one or more of following conditions: Missing cotter pin Nut with compromised locking capability, Nut improperly torqued

This test has not been accomplished and EC does not see presently how to proceed to perform some vibration tests which should be representative of the normal operation of this coupling

a. Bolt/nut/pin within spec and properly installed

A normal Installation of airworthy parts in accordance with the Eurocopter Maintenance Manual would exhibit no anomalies.

b. Airworthy bolt/nut, properly torqued; no cotter pin

According to AC 43.13-1B, 7-38 and the relevant Eurocopter Maintenance Manual, cotter pins should not be reused. However, the purposes of cotter pins are to; secure, and further avoid the unscrewing of a nut in case of an untightening from its axial moment on a bolt. According to certification requirements found in FAR 27.607, any removable fastener whose loss could jeopardize the safe operation of the helicopter must incorporate two separate locking devices. Thus; if the first locking device, which keeps the clevis bolt from its lateral movement, is the self-locking fiber nut (an integral plastic bushing as auxiliary safety device within its construction), the second one is the cotter pin. If there was no cotter pin behind an airworthy self-locking nut, and the nut alone is correctly torqued: there would be no limitation for a normal operation.

c. Airworthy bolt/nut, improperly torqued; proper cotter pin

As explained previously, even with a compromised tightening torque the efficiency of both locking system (nylon and cotter pin) will not limit the ability of this coupling to operate properly.

d. Airworthy bolt; degraded nylon nut, improperly torqued; proper cotter pin

If both nut's locking efficiency and tightening torque were compromised, but with a cotter pin suitably installed, the efficiency of this remaining locking device will not limit the ability of the coupling to operate correctly.

e. Airworthy bolt; degraded nylon nut, improperly torqued; no cotter pin

This installation scenario would result in a loss of the nut after a 'short period of time', which would depend on several factors such as the natural fit of the bolt, the center of gravity and position of the bolt, the level and frequency of the vibration to the system from the aircraft, the number of inputs applied to the mechanical system; and finally, the degraded properties of the nut's nylon self-locking system.