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ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Report – 200506614
Final

Uncommanded nose-up pitch
Cessnock, NSW
7 December 2005
Kawasaki Heavy Industries BK117 B-2
VH-IME

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Abstract

At about 1315 hours Eastern Daylight-saving Time on 7 December 2005, a Kawasaki Heavy Industries BK 117 B-2 (BK 117 B-2) helicopter, registered VH-IME, was being operated on a medical flight at 7,000 ft above mean sea level, in moderate to severe turbulence and in visual meteorological conditions (VMC), when the helicopter sustained an uncommanded nose-up pitch of 40° to 45°. The pilot attempted to counter the nose-up pitch by applying full forward cyclic control, but without effect. The pilot then lowered the collective control, producing a nose-down pitching moment, before recovery to normal level flight could be achieved. The Mast Moment advisory light illuminated and the pilot continued the flight to the destination at reduced airspeed.

An investigation by the co-designers and manufacturer of the helicopter identified an incorrect collective pitch setting that reduced the longitudinal cyclic control authority available to the pilot. That reduced authority restricted the pilot's ability to recover the nose-up pitch.

A number of safety actions resulted from this investigation, including:

- advice to the operator from the helicopter's manufacturer to re-set the helicopter's collective pitch setting in accordance with the BK 117 C-1 model helicopter maintenance manual
- amendment of the BK 117 B-2 maintenance manual to include the relevant collective pitch setting procedure from the BK 117 C-1 manual
- the issue of Safety Recommendation R20050014, which recommended that the Civil Aviation Safety Authority (CASA) should alert Australian operators of the collective pitch setting discrepancy in BK 117 B-2 helicopters
- an interim alert was provided to Australian operators of the BK 117 B-2 helicopter by CASA to amend their operation of the BK 117 B-2 pending advice from the helicopter's manufacturer.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations. Accordingly, the ATSB also conducts investigations and studies of the transport system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and, where applicable, relevant international agreements. The object of a safety investigation is to determine the circumstances to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety issues, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau is pleased to report positive safety action in its final reports rather than make formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety issue may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources to carry out a full cost-benefit analysis of each safety recommendation. The cost of a recommendation must be balanced against its benefits to safety, and transport safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example, the relevant regulatory authority in aviation, marine or rail in consultation with the industry).

FACTUAL INFORMATION

At about 1315 hours Eastern Daylight-saving Time on 7 December 2005, a Kawasaki Heavy Industries BK 117 B-2 (BK 117 B-2) helicopter, registered VH-IME, was being operated on a medical flight at 7,000 ft above mean sea level, in moderate to severe turbulence and in visual meteorological conditions (VMC), when the helicopter sustained an uncommanded nose-up pitch of 40° to 45°. The pilot attempted to counter the nose-up pitch by applying full forward cyclic control, but without effect. The pilot then lowered the collective control, producing a nose-down pitching moment, before recovery to normal level flight could be achieved. The Mast Moment advisory light illuminated[1] and the pilot continued the flight to the destination at reduced airspeed.

The pilot reported that, immediately prior to the nose-up pitch, the helicopter's indicated airspeed was about 120 kts, and the outside air temperature was 20° C. He indicated that the torque[2] setting was about 68 % and within the helicopter's published limits at that time, and that he felt the position of the cyclic control may have been further forward than normal.

The helicopter's estimated all up weight (AUW) was 3,200 kg and its Velocity Never Exceed[3] was estimated to be 125.5 kts. The Eurocopter Deutschland GmbH[4] (ECD) Flight Safety Department advised that that speed should have only been possible in the BK 117 B-2 helicopter when in a descent.

The pilot reported that he flew through severe turbulence just prior to the incident, but that he felt no abnormal vibrations prior to the nose-up pitch. He also stated that, during an after-flight crew de-brief, one crew member reported that the helicopter rolled right after the nose-up pitch. The pilot could not recall that roll.

The incident was subsequently investigated by an ECD test pilot and engineer, in consultation with representatives of the helicopter's Japanese manufacturer. That investigation revealed that the published procedure for setting autorotation rotor RPM in the BK 117 B-2 maintenance manual did not include for aircraft operations at high gross weight, and that the application of that procedure in the incident helicopter had resulted in an inappropriately high collective pitch setting.

The effect of the helicopter's collective pitch stop is to limit the collective travel and, in turn, establish a maximum horizontal speed (V_H[5]) for the ambient conditions and AUW of the helicopter. The ECD Flight Safety Department advised that the helicopter's abnormally high collective pitch setting meant that the pilot would require increased forward displacement of the cyclic control in order to

1 The illumination of the Mast Moment advisory light indicated that the rotor mast had exceeded its normal limits.

2 A measure of the power provided by the helicopter's engines to overcome the resistance of the rotor blades to rotation, and maintain constant main rotor RPM.

3 Never-exceed speed that was specified by the helicopter's manufacturer.

4 Co-designed with Kawasaki Heavy Industries. The incident helicopter was manufactured by Kawasaki Heavy Industries.

5 The maximum possible sustained airspeed in level flight at the helicopter's continuous engine power rating.

maintain level flight. That would result in a reduction in the longitudinal cyclic control authority[6] that was available to the pilot.

The ECD Flight Safety Department indicated that the severe turbulence reported by the pilot could have precipitated the helicopter's nose-up pitch in this incident, and that the reduced longitudinal cyclic control authority would have restricted the pilot's ability to recover the changing pitch. Retreating blade stall[7] was considered by the ECD Flight Safety Department as an unlikely contributory factor in this instance, as it was only considered possible when the helicopter was in a descent profile.

6 The forward and aft limits of travel of the cyclic control.

7 Stall of the retreating blades at high helicopter forward speeds. Occurs when the angle of the attack of the retreating blades becomes excessive, especially towards the tip of the retreating blades.

ANALYSIS

The abnormally high collective pitch setting meant that the majority of the helicopter's forward cyclic control authority was required by the pilot to maintain level flight. The result was that, in response to the nose-up pitch, there was insufficient remaining forward cyclic control available for the pilot to recover the helicopter without also lowering the collective control. It appeared likely that the reported severe turbulence contributed to the helicopter's initial nose-up pitch.

SAFETY ACTION

Helicopter manufacturer

On 19 December 2005, the helicopter manufacturer advised the Australian Transport Safety Bureau (ATSB) that the procedure for setting the autorotation rotor RPM contained in the Kawasaki Heavy Industries BK 117 B-2 (BK 117 B-2) maintenance manual did not cover operation of the helicopter at high gross weight. In order to correct that procedure, the manufacturer advised the operator to re-set the helicopter's collective pitch setting in accordance with the relevant procedure in the BK 117 C-1[8] model helicopter's maintenance manual, which can be used to set the helicopter's autorotation rotor RPM at high gross weight.

On 20 December 2005, the helicopter manufacturer advised the ATSB that it intended amending the BK 117 B-2 maintenance manual to reflect the procedures detailed in the BK 117 C-1 manual, and that it would advise all customers who operated the BK 117 B-2 helicopter of the change to the maintenance manual. A temporary revision to the manual was subsequently issued by the manufacturer. On 20 January 2006, the maintenance manual was amended to include the procedure for setting autorotation rotor RPM in the BK 117 B-2 at high gross weight.

Australian Transport Safety Bureau

The ATSB provided an initial alert to the Civil Aviation Safety Authority (CASA) of this safety deficiency on 15 December 2005. Further information on the progress of the ATSB investigation was provided to CASA technical staff on 19 December, with notice of the likelihood of the ATSB issuing a safety recommendation provided later that day. On 21 December 2005, CASA technical staff met with ATSB investigators and, following a briefing, advised the ATSB that CASA would alert operators about this safety deficiency.

On 22 December 2005, the ATSB issued the following safety recommendation R20050014 to CASA. That recommendation stated:

> The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority alert Australian operators of the Kawasaki BK 117 B-2 helicopter to the discrepancy with respect to the procedure for adjusting the collective pitch settings in the maintenance manual.

On 22 December 2005, CASA wrote to all Australian owners and operators of the BK 117 B-2 helicopter and recommended that, pending advice from the helicopter manufacturer, operators of the BK 117 B-2 should:

- reduce exposure to conditions of high density altitude and atmospheric turbulence, especially if the aircraft is at high gross weight
- if such conditions were encountered, reduce airspeed and torque settings while hand flying the aircraft with SAS [Stability Augmentation System] mode engaged.

8 The BK117 B-2 helicopter type certificate also included the BK 117 C-1 model helicopter.

On 7 February 2006, CASA advised the ATSB that the helicopter manufacturer had provided all Australian operators of the BK 117 B-2 helicopter with the amended procedure for setting the collective pitch setting.

In response to the safety action undertaken by CASA and the helicopter manufacturer, the ATSB has classified safety recommendation R20050014 as 'Closed-accepted'.