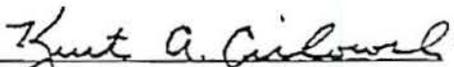


ACTION OF THE CONVENING AUTHORITY

The Addendum to the report of the Accident Investigation Board, conducted under the provisions of Air Force Instruction 51-503, that investigated the 9 April 2010 mishap in Afghanistan involving an CV-22B, T/N 06-0031, assigned to the 8th Special Operations Squadron, Hurlburt Field, FL complies with CSAF's direction on 15 November 2010 and with applicable regulatory and statutory guidance and on that basis is approved with comment.

I find the preponderance of the evidence in this report does not support a determination of engine power loss as a substantially contributing factor. I assess the indications of engine power loss hypothesized in this report do not rise to the greater weight of credible evidence, based upon the following justification: (1) no crew discussions, or computer generated voice warnings, of an aircraft malfunction were audible prior to impact; (2) the probability of an engine failure, less than two seconds prior to impact, was assessed as being highly remote; (3) Rolls-Royce determined the recovered left engine was operating at time of impact; (4) PMA-275's, the CV-22 Joint Program Office (JPO), analysis indicated "a single engine failure was unlikely;" and, (5) this Addendum's reassessment of mishap aircraft speed at initial impact as 80 knots ground speed at time of impact, with a purported, corresponding low prop-rotor RPM, fails to reconcile how engine power loss co-exists with the other nine substantially contributing factors determined by this report, at the preponderance of evidence standard.


KURT A. CICHOWSKI
Lieutenant General, USAF
Convening Authority

23 Nov 2010
Date

ADDENDUM TO
UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION
BOARD REPORT



CV-22B OSPREY, T/N 06-0031

**8TH SPECIAL OPERATIONS SQUADRON
1ST SPECIAL OPERATIONS WING
HURLBURT FIELD, FLORIDA**



ACCIDENT LOCATION: NEAR QALAT, AFGHANISTAN

DATE OF ACCIDENT: 9 APRIL 2010 (L)

BOARD PRESIDENT: BRIGADIER GENERAL (Ret.) DONALD D. HARVEL

Conducted in Accordance With Air Force Instruction 51-503

ADDENDUM EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

CV-22B, T/N 06-0031

NEAR QALAT, AFGHANISTAN

9 APRIL 2010 (L)

On 9 April 2010, the mishap aircraft (MA), a CV-22B, T/N 06-0031, impacted the ground at 0039L, near Qalat, Afghanistan. The mishap pilot, mishap flight engineer, and two passengers died in the mishap. The mishap copilot, mishap tail scanner, and the remaining 14 passengers sustained various degrees of injuries.

The Board President was unable to determine, by clear and convincing evidence, the cause of this mishap. The Board President determined by a preponderance of the evidence that ten factors substantially contributed to the mishap. One of those substantially contributing factors was engine power loss.

Following submission of the Accident Investigation Board report on 25 August 2010, the Convening Authority received a structural evaluation and an independent assessment of the mishap sequence from Naval Air Systems Command. Additionally, the Convening Authority wrote a statement analyzing a video of the mishap, the data transfer module recovered from the MA, and the prop rotor blade strikes on the ground. On 4 October 2010, the Convening Authority approved the AIB report with comments. The convening authority disagreed that engine power loss was supported by the greater weight of credible evidence.

On 15 November 2010, the Air Force Chief of Staff reopened the accident investigation. From 19 to 21 November 2010, the Board President considered the information prepared after submission of the original report. The Board President also consulted with the imagery analyst who performed the initial video analysis for the Accident Investigation Board. The imagery analyst used a newly available resource to assess the video and accurately measure distance and MA's air speed. The Board President determined the MA's speed on initial impact was 80 knots ground speed instead of the approximately 75 knots ground speed in the original report.

After considering the additional information, the Board President was still unable to determine a cause by clear and convincing evidence. He considered the speed at initial impact, the aircraft's deceleration rate on the ground during the mishap sequence, and the spacing of the blade strikes on the ground, and determined that the greater weight of credible evidence supports engine power loss as a substantially contributing factor. The Board President's original conclusion that ten factors substantially contributed to the mishap remained unchanged.

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

**SUMMARY OF FACTS AND STATEMENT OF OPINION
CV-22B, T/N 06-0031 ACCIDENT
9 April 2010 (L)**

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COMMONLY USED ACRONYMS & ABBREVIATIONS

AEO	All Engines Operating	MFS	Manned Flight Simulator
AFI	Air Force Instruction	MP	Mishap Pilot
AIB	Accident Investigation Board	MXM	Maintenance Member
ALA	Assistant Legal Advisor	NAVAIR	Naval Air Systems Command
ASIST	Aeromechanics Safety Investigation Support Team	Nr	Proprotor Speed
CA	Convening Authority	NST	National Geospatial-Intelligence Agency Support Team
DTM	Data Transfer Module	NTM	National Technical Means
EPP	Engine Percent Performance	OEI	One Engine Inoperative
fpm	feet per minute	PM	Pilot Member
KGS	Knots Ground Speed	SA	Situational Awareness
KTAS	Knots True Air Speed	T/N	Tail Number
L	Local Time	USC	United States Code
LA	Legal Advisor	V0	Initial Speed at ground impact
LVA	Low Visibility Approach	Vf	Speed after nose plowing
MA	Mishap Aircraft	Z	Zulu or Greenwich Meridian Time (GMT)
MFE	Mishap Flight Engineer		

The above list was compiled from the Summary of Facts, the Statement of Opinion, and Addendum Tabs A thru D.

SUMMARY OF FACTS

1. AUTHORITY, PURPOSE, AND CIRCUMSTANCES

a. Authority.

On 15 November 2010, General Norton A. Schwartz, Chief of Staff of the United States Air Force directed Brigadier General (Retired) Donald D. Harvel¹ to reopen the investigation into the mishap of CV-22B, T/N 06-0031, which crashed near Qalat, Afghanistan on 9 April 2010, local time. (Tab A-2) Brigadier General (Ret.) Harvel conducted the follow-on investigation in Atlanta, Georgia from 19 November through 21 November 2010. He was assisted by the following original board members: Pilot Member (PM), Legal Advisor (LA), Assistant Legal Advisor (ALA), and Maintenance Member (MXM).

b. Purpose.

The follow-on investigation was convened under Air Force Instruction (AFI) 51-503. The investigation was reopened to allow the Board President to analyze additional documents that were produced following the completion of the original report on 25 August 2010. The original report was approved with comments on 4 October 2010 by the Convening Authority (CA), Major General Kurt A. Cichowski, AFSOC/CV. The CA considered two reports prepared by Naval Air Systems Command (NAVAIR) and wrote a statement summarizing his analysis of the AIB's findings. (Tab B-3 thru B-53, Tab C-3 thru C-4) This reopened investigation is separate and apart from the safety investigation, which was conducted pursuant to AFI 91-204 for the purpose of mishap prevention. This addendum is available for public dissemination under the Freedom of Information Act (5 United States Code (U.S.C.) §552) and AFI 37-131.

c. Circumstances.

The accident board was reconvened to investigate new information concerning the Class A accident involving a CV-22B aircraft, T/N 06-0031, assigned to the 8th Special Operations Squadron, 1st Special Operations Wing, Hurlburt Field, FL, which crashed on 9 April 2010, killing the Mishap Pilot (MP), Mishap Flight Engineer (MFE), and two passengers.

¹ Brig Gen Harvel was on Active Duty at the time of the original investigation. He retired in the permanent grade of Brigadier General on 15 September 2010.

2. TECHNICAL ANALYSIS

a. Structural Analysis

The board reviewed the Structural Evaluation Report prepared by NAVAIR and conducted a telephone conference with the lead structural engineer. Paragraph 5 of the report lists the reference documents used. (Tab B-11) The lead structural engineer was asked to answer the following two questions: (1) Was the post-impact breakup of the Mishap Aircraft (MA) a reasonable structural response given what little was known or estimated about the impact sequence? and (2) Was there sufficient evidence from the post-impact events that would confirm the state of the MA's engines just prior to impact? (Tab B-3)

The report confirms the impact sequence was consistent with CV-22 design characteristics in relation to energy that would need to be dissipated during this type of impact. (Tab B-3) During the structural evaluation of the mishap sequence, the lead structural engineer estimated the deceleration of the MA after touchdown and before flipping over. (Tab B-6 thru B-7) The MA decelerated as a result of the nose section plowing into the dirt and impacting a two-foot deep natural drainage ditch. (Tab B-5) This impact produced significant g-forces and provided a fulcrum for the MA to flip over. (Tab B-7) The deceleration was calculated to be between 10% and 50% of the MA speed at initial ground impact (V0). (Tab B-7) With an estimated V0 of 80 Knots True Air Speed (KTAS), the speed after deceleration (Vf) would be 40 to 72 KTAS.² Due to the initial momentum of the flipping motion, the MA would have continued to flip with or without the rotors providing thrust. (Tab B-4) The post-impact manner of breakup, tumbling, and detachment of primary structural elements for the MA was a reasonable structural response. (Tab B-4)

The lead structural engineer also concluded that the reported "broomstraw" failure³ of the blades and tearing away of both nacelles supported the assertion that the rotors were turning upon impact. (Tab B-10) If the rotors were turning, at least one of the CV-22's engines was operational at the time of impact. (Tab B-11)

b. ASIST Report

The board reviewed the NAVAIR report from the Aeromechanics Safety Investigation Support Team (ASIST) and conducted a telephone conference with the lead engineer. The team, consisting of four engineers, was provided with Tabs A-S of the original AIB report and the unclassified A-10 video of the mishap. (Tab B-24) The lead engineer stated that ASIST was given two weeks to conduct an independent assessment of the mishap. Specifically they were

² The ASIST Report provided a value of 90 Knots Ground Speed (KGS) / 80 KTAS as the estimate of MA's impact speed. (Tab B-26) The lead structural engineer used true air speed for the calculations.

³ The proprotors are designed to disintegrate or broomstraw upon contact with the ground which prevents them from causing other damage.

asked to look at: (1) dual and single engine go-around⁴ capability and (2) assess available performance at the mishap flight conditions. (Tab B-25)

They performed simulation analysis at Patuxent River using the Manned Flight Simulator (MFS) models, which uses a computer to fly given profiles. (Tab B-29 thru B-31) The simulation parameters used the environmental conditions at the MA's landing zone, the last recorded Data Transfer Module (DTM) point, 100% engine percent performance (EPP), and a 504 feet per minute (fpm) rate-of-descent. (Tab B-29) This allowed for a validation of propulsion, as well as aerodynamic contributions to climb performance with all engines operating (AEO) and one engine inoperative (OEI). (Tab B-29) The report concluded that the simulations demonstrated that adequate go-around performance existed for both AEO and OEI until just seconds prior to impact. (Tab B-35) The report also states that during all OEI simulator runs, insufficient power was available to attain a positive rate of climb at stated conditions. (Tab B-32)

The report concluded that this mishap was related to loss of situational awareness (SA) and not a failure of one of the engines. (Tab B-25) It also states that loss of visual SA along with the coning of attention on airspeed at the expense of other key parameters like altitude, flight path, and rate of descent were considered the most likely causal factors in this mishap. (Tab B-35)

c. Convening Authority Statement

The CA prepared a statement during the approval process of the AIB Report. (Tab C-3 thru C-4) He disputed the final ground speed derived from video analysis⁵ and the resultant determination of low prop rotor revolutions per minute (Nr). The CA determined that an error was made in calculating distance, or time elapsed, or both. He noted any conclusions drawn from this analysis should be treated as suspect, if not completely discarded. He also concluded that any aircraft issue would have had to occur within the period of 22 seconds prior to impact. He stated there was no testimony indicating any issues either before or during the final 22 seconds of flight. The CA concluded that human factors and a poorly executed low visibility approach (LVA) rather than mechanical failure led to the MA unintentionally impacting the ground.

d. Additional Imagery Analysis

The reopened AIB provided the Imagery Analyst from the National Geospatial-Intelligence Agency Support Team (NST) with the Structural Evaluation Report, ASIST Report, and the CA's statement. On 19 November 2010, the Imagery Analyst produced a memorandum clarifying his initial video analysis and calculations of MA's speed and Nr. (Tab D-9 thru D-10) His new analysis provided a more precise measurement due to the use of National Technical Means (NTM) resources that were unavailable when he conducted his initial analysis. He concluded that the MA had an average speed of 104 KGS during the last eight seconds of flight. Using this average and the last DTM recorded speed of 128 KGS (112 KTAS), he estimated the MA's speed at touchdown was 80 KGS. Based on the 7.5 foot spacing between the first two

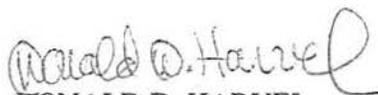
⁴ The ASIST Report used the Navy term "waveoff" as opposed to the Air Force term "go-around."

⁵ This analysis is located at Tab HH-27 in the original AIB report.

proprotor blade ground strikes and the 80 KGS touchdown speed, he calculated a maximum Nr of 360 RPM (91% of normal Nr).⁶ He also calculated Nr for 75 KGS, 70 KGS, and 65 KGS to account for further deceleration of the MA before the first blade strike. These Nr values were, respectively, 336 RPM (85%), 314 RPM (79%), and 293 RPM (74%). The NST Imagery Analyst stated that he is highly confident in his calculations due to the clarity provided by the NTM resources.

After consideration of this new information, the only fact in the original AIB report that should be modified is the ground speed at impact. A more accurate speed of 80 KGS should be substituted for the approximate speed of 75 KGS contained on the original report on page 12.

22 November 2010



DONALD D. HARVEL
Brigadier General (Ret.), USAF
President, Accident Investigation Board

⁶ Proprotor RPM is a constant 397 RPM (100% Nr) during normal operation in conversion and helicopter mode. Aircraft thrust (speed and lift) is controlled by the pitch of the blades. If the pilot has armed interim power, when the aircraft speed decreases below 60 KCAS and the nacelles are greater than 70 degrees, Nr then increases to 413 RPM (104% Nr).

STATEMENT OF OPINION
ADDENDUM
CV-22B, T/N 06-0031 ACCIDENT
9 APRIL 2010 (L)

1. Under 10 U.S.C. 2254(d) any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report may not be considered as evidence in any civil or criminal proceeding arising from an aircraft accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

2. OPINION SUMMARY:

The ASIST engineers did not have all of the evidence or resources that were utilized by the AIB to evaluate this mishap. (Tab B-21 thru B-53) Specifically, they had no pilot, maintenance, medical or human factors expertise. (Tab B-24) They also used an automated computer model that assumed 100% engine health (EPP) in their simulations. They did not have the benefit of the imagery analysis or AIB witness interviews. Additionally, ASIST used an erroneous weather source which listed an 11 knot quartering tailwind. (Tab B-26) Actual wind speed from witness testimony and correct weather sources verified it was a 17 knot tailwind near the landing zone. Finally, they used a constant 504 feet per minute (fpm) rate of descent instead of the more accurate maximum estimated value of 1,800 fpm. (Tab B-29, Original Report Tab JJ-4) The ASIST simulations confirmed that the MA did not have a single engine capability at the constant 504 fpm rate of descent. At the higher descent rate the single engine capability was even less. I also weighed the ASIST report's assertion that the probability of a single engine failure within the last two to three seconds was highly remote. (Tab B-35) While engine failures are rare, they are more likely to occur during a high power demand situation such as a landing with a limited power margin.

Situation awareness (SA) played an important role in the sequence of events. However, I disagree with the ASIST report's assertion that the pitch-up attitude of the MA during the final phase of the approach limited the MP's SA. (Tab B-33) CV-22 procedures for a low visibility approach (LVA) are largely dependent on the pilot looking at the cockpit instrumentation and heads-up display; seeing outside is not required to land the CV-22. The ASIST report also concluded that since there was no evidence of a change in the flight path prior to terrain impact, loss of SA caused the mishap. (Tab B-35) To the contrary, I believe the MA's flight path did change. The MP did have sufficient time to arrest the descent rate in order to land just past three deep wadis, executing a near-perfect roll-on landing. In summary, nothing in the ASIST report caused me to believe that loss of SA was the cause of the mishap by clear and convincing evidence.

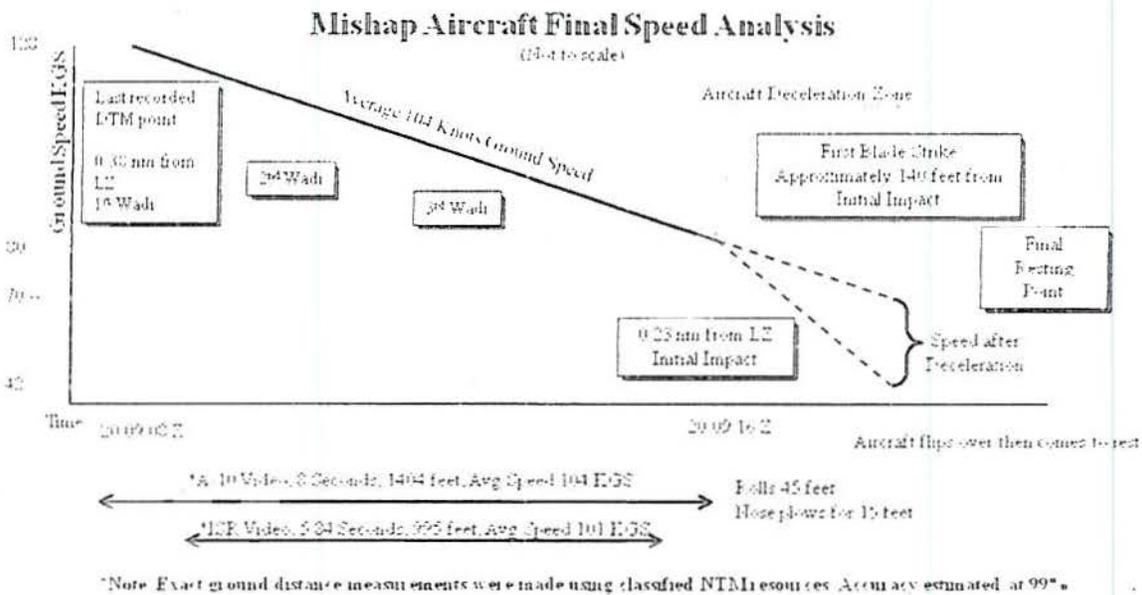
I found the NAVAIR structural engineer's analysis to be consistent with my finding that at least one engine was driving the rotors on impact and that the MA broke apart as expected. (Tab

B-11) The structural analysis could not determine engine operational speed or condition. This analysis also provided a quantitative range of the MA's deceleration during the crash sequence. (Tab B-7)

Both the ASIST and the structural engineers from NAVAIR prepared extraordinary reports considering the short time frame allowed. Both lead engineers expressed their willingness to work with AIB investigators in the future on aircraft that the services jointly use. The AIB had previously requested formal engineering and animation support from the Air Force Safety Center and NAVAIR representatives, as their expertise would have been invaluable. These resources were unfortunately unavailable or reported to be non-existent at that time; instead, the AIB only had informal telephone conferences with a limited number of engineering subject matter experts. Future AIBs would benefit greatly from access to all Department of Defense resources that did not support the Safety Investigation Board.

The Convening Authority stated that he was unaware of any testimony that indicated an aircraft issue during or prior to the last 22 seconds of flight. (Tab C-4) I respectfully disagree. The MTS described to the MCP in the hospital that he heard an excited cockpit conversation of "something catastrophically going wrong with the airplane . . . between the 1-minute call and the impact." (Original Report, Tab V-67.32) MCP explained that this conversation could have been triggered by the MP realizing that something was "wrong with the airplane" or a "high sink rate" close to the ground that was "going to end badly." Additional evidence of this cockpit conversation came from the testimony of CHK10W, who said that the MCP told CHK10 that the "he knew something was wrong" during the final portion of the flight. (Original Report, Tab V-72.1) CHK10 also recalled MCP's explanation that the "pilots were trying to say that something happened between one minute and us hitting the ground and they were trying to help us out. They were doing everything that they could" and "trying to belly land it and save the aircraft." (Original Report, Tab V-64.16) While MCP did not recall the conversation with CHK10 and CHK10W, I believe the conversation occurred. MCP had a loss of memory for many key events that are undisputed. MTS also described the excited cockpit conversation and the warning tones he heard near the initial touchdown point to the AIB. (Original Report, Tab V-60.22, V-60.28 thru V-60.29) All of this testimony is evidence of an aircraft issue during the final seconds of flight.

Finally, I analyzed the MA's speed in order to validate the proprotor RPM (Nr). (Tab D-9 thru D-10) The greater weight of credible evidence shows that the MA's speed was approximately 80 KGS on initial impact. (Tab B-7) The MA further decelerated to between 70 and 42 KGS by the time the blades struck the ground. (See Diagram below) This speed, when used with the distance between the initial blade strike marks to calculate Nr, indicates that the Nr was lower than normal. A speed of at least 90 KGS when the blades contacted the ground is necessary to support a theory that the Nr was normal. (Original Report, Tab HH-30) Therefore I conclude that engine power loss was a substantially contributing factor in the mishap.



After considering all the information above, there is no reason to change the substantially contributing factors in my original Statement of Opinion.

22 November 2010

DONALD D. HARVEL
 Brigadier General (Ret.), USAF
 President, Accident Investigation Board