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From: LCDR (b) (3) (A), (b) (6)
To: Commander, Naval Air Forces Pacific

Subj: SUPPLEMENTAL COMMAND INVESTIGATION OF THE AVIATION MISHAP INVOLVING THE INBOUND FLIGHT OF A C-2 TO USS RONALD REAGAN (CVN 76) ON 22 NOVEMBER 2017

Ref: (a) JAGINST 5800.7F, JAGMAN
(b) CAPT (b) (3) (A), (b) (6) ltr of 16 Apr 17
(c) CCSG-5 ltr 5830 Ser N00/127 of 26 Apr 18
(d) NA 03-20NP2K-1/01AUG2018

Encl: (1) CNAP ltr 5340 Ser N01 of 20 Dec 19
(2) PROP Aircraft Propellers CAT I EI Final Report (Port)
(3) PROP Aircraft Propellers CAT I EI Final Report (BUNO 162147)
(4) T56-A-425 CAT I EI Final Report (Port)
(5) T56-A-425 CAT I EI Final Report (Starboard)
(6) PROP Aircraft Propellers CAT I EI Final Report (Starboard)

## Preliminary Statement

1. Purpose and Scope. In accordance with Reference (a), this report contains the results of the supplemental command investigation convened pursuant to Enclosure (1) to inquire into the facts and evidence derived from the salvage of the C-2A aircraft (BUNO 162175), call sign PASSWORD 33 (PW33), and ascertain whether any of the new information now available should change any of the conclusions or recommendations of Reference (b) or (c).

2. Executive Summary.

a. On 22 November 2017, PW 33 was flying from Kadena Air Force Base (AFB) to USS RONALD REAGAN (CVN76) with four crew, seven U.S. military passengers and approximately 2,200 pounds of cargo.

b. Approximately 15nm from RONALD REAGAN, the crew and passengers of PW 33 heard a sudden loud bang. The aircraft immediately began to shake violently and a "foggy", acrid smelling smoke entered the cockpit and cabin. 23 seconds later PW 33 declared an emergency, citing dual engine failure. One minute after declaring an emergency (less than 90 seconds after the initial emergency indications), PW 33 stated that they were going into the water.

c. A second C-2A, Password 30 (PW 30), was also inbound to RONALD REAGAN from Kadena AFB and visual confirmed PW 33 had ditched in the water. Less than four minutes after the initial emergency indications, PW 30 stated to Tower, "the whole plane has sunk."

d. Search and Rescue (SAR) efforts recovered eight survivors (three crew and five passengers). After 43 hours and a search of almost 900 square nautical miles, SAR operations were ceased. On 25 November 2017, the Navy publically identified LT Steven Combs, ABEAN Matthew Chialastri and AOAA Bryan Grosso as the Sailors lost aboard PW 33.

e. On 29 December 2017, PW 33 was located on the floor of the Philippine Sea at a depth of 18,600 feet. While images of PW 33 on the sea floor were captured from a submersible remotely operated vehicle (ROV), the aircraft had not been recovered at the time Reference (b), CCSG-5's Command Investigation, was completed.

f. Reference (b) concluded that there were "no known maintenance, cargo, fuel, or environmental factors, nor any aircrew action that caused the initial emergency aboard PW 33…there were 101 seconds between initial indications of an emergency and when PW 33 was observed in the water. During this time, the pilots took steps to identify the cause of the emergency, attempted to regain thrust from at least one engine, and crewmen prepared the passengers and aircraft for a successful ditch at sea…Despite the tragedy and loss of three Sailors, the crew of PW 33 should be commended for their efforts that enabled eight Sailors to survive this mishap."

g. In May of 2019, PW 33 was recovered and the propellers and engines were submitted for CAT I Engineering Investigations (EIs). While Enclosures (2)-(6) provide facts and insight into the rapid sequence of events that resulted in this mishap, there is no additional information that would alter the conclusions of References (b) and (c).

## Findings of Fact

1. Prior to lifting the aircraft from the ocean floor, a ROV was used to survey the aircraft. The portside spinner was missing, the spinner bracket stud that retains the spinner was sheared off at the base of the bracket, and the propeller appeared feathered. [Enclosure 2]

2. The portside propeller was delivered to Marine Corps Air Station (MCAS) Iwakuni for continued investigation. Five of the eight blades were sheared off and the remaining blades were also damaged. [Enclosure 2]

3. The Cherry Point Materials Lab performed material analysis on the portside spinner bracket and found it to be fractured in the transition radius from stud to base. Two equal and diametrically opposite fatigue cracks propagated inwards for approximately 0.3 inches until overload occurred. [Enclosure 2]

4. Measurements of the portside Variable Pitch Actuator (VPA) confirmed that the propeller was feathered. [Enclosure 2]

5. On 08 October 2017, the portside propeller was rebalanced due to significant vibration, more significant on the pilot side, in the instrument panel, yoke, seat, and pedestal. Part of the rebalancing process is to remove the spinner and reinstall once the balance run is complete. The aircraft flew approximately 75 hours following this maintenance evolution. [Enclosure 2]

6. In May 2018, a different C-2A aircraft (BUNO 162147) experienced spinner departure in flight as the result of the failure of the spinner bracket mounting stud. Though it could not be proven through material analysis, the EI Final Report stated that the most likely cause of the spinner bracket mounting stud failure was due to the front spinner being installed with an elongated mounting hole. [Enclosure 3]

7. Reference (d) is the maintenance publication governing the procedures for removing and reinstalling the propeller spinner assembly. At the time of the PW 33 and the May 2018 mishaps, there was nothing in this publication that directed squadron maintenance to inspect the spinner prior to installation. This publication now directs the maintainer(s) to inspect the spinner and spinner bracket, including inspecting for an elongated spinner mounting hole. [Enclosure 3]

8. The EI Final Report pertaining to the May 2018 spinner departure incident was released prior to the EI Final Report pertaining to PW 33's port propeller. The later report stated that it is impossible to determine how many flight hours led to the stud damage where the cracks in PW 33's mounting bracket eventually propagate from. It concluded, "If the spinner was installed with an elongated hole, as was the case of [BUNO 162147], it would have resulted in quicker loss of preload following the installation of the spinner" following the removal and reinstallation of the spinner on 08 October 2017. [Enclosures 2-3]

9. "[V]ibration resultant from propeller imbalance allowed for excessive loading at TM to AIH studs and eventual overload failure for the studs allowing the TM to disengage from the power section (PS). The splines on the TM shaft and compressor extension shaft were subsequently destroyed". [Enclosure 4]

10. The torquemeter (TM) assembly on the port engine had separated from the compressor air inlet housing (AIH), which would allow oil from the TM to enter the gas path and can result in smoke and fumes in the cockpit. [Enclosure 4]

11. The engine side mount of the starboard engine was found unattached to the engine nacelle. The bolt was found in the nacelle, but the nut was not recovered. [Enclosure 5]

12. There was evidence of fire in the forward outboard side of the starboard nacelle. The source of the fire was not found in the engine components. Several Quick Engine Change (QEC) items were found suspect and may have provided the initiation and fuel sources to sustain fire. [Enclosure 5]

13. The TM to AIH self-locking nuts in the starboard engine exhibited significant ovalization and heavily worn threads that were smeared aft from the top to the base of the nuts. The nuts were determined to have an approximate hardness of 14 to 22 Rockwell C Hardness (HRC). Original design specifications specified a minimum hardness requirement of 26 HRC, but a subsequent revision in June 2002, only specified a maximum hardness requirement of 34 HRC, and minimal properties controlled by axial tensile strength requirements. [Enclosure 5]

14. The EI on the starboard engine concluded, "The root cause of engine failure can most likely be attributed to a combination of overload and loss of torque on the TM to AIH self-locking nuts which allowed the TM housing to strip the nuts away from the AIH studs. The splines on the TM shaft and compressor extension shaft were subsequently destroyed and the PS was no longer able to transmit torque to the propeller. The overload on the nuts was most likely a result of excess vibration. Exact source of the excess vibration could not be confirmed…it is possible the port propeller imbalance combined with a loose side mount on STBD engine contributed to the failure. The nut material being softer than original design intent most likely lead to insufficient inbuilt nut torque and loss of applied torque on the TM to AIH self-locking nuts." [Enclosure 5]

15. The EI on the starboard propeller concluded that the propeller responded as it should have given the events that were going on with the engine. [Enclosure 6]

16. The damage sustained to all the starboard propeller blades led the EI to conclude that the propeller was rotating at the time impact. A relay lockout system prevents both propellers from being feathered in flight so that in the case of a dual engine failure one propeller will continue to windmill (rotate with engine shutdown), in order to maintain adequate hydraulic pressure for aircraft controllability. [Enclosure 6]

## Opinions

1. The portside propeller spinner departed in flight. Damage to the blades and extreme vibration resulted in the aircrew feathering the propeller and shutting down the engine in flight. [FF 1-4]

2. The violent vibration caused by the portside spinner departure caused the TM to separate from the PS, resulting in no way for the engine to provide torque to the propeller or thrust from the portside engine. [FF 9]

3. The extreme vibration caused by the portside spinner separation and resulting propeller imbalance accelerated the failure of the TM to AIH self-locking nuts and AIH studs and the subsequent destruction of the TM and compressor extension shafts in the starboard engine. At this point, the PS has no means of delivering torque to the propeller or providing thrust to the aircraft. [FF 11-14]

4. The EI on the port propeller was unable to determine how many flight hours led to the stud damage, ultimate failure, and eventual separation of the spinner. However, if the port spinner mounting bracket on PW 33 had an elongated mounting hole at the time it was reinstalled on the aircraft, it would have accelerated the damage to the stud and the catastrophic failure would have occurred quicker. [FF 5-8].

5. It is unknown whether or not a loose engine side mount in the starboard engine was a causal factor or a contributing factor in this mishap. The engine side mount on the port engine was not discovered to be loose and that engine experienced a similar failure in the TM to AIH self-locking nuts and AIH studs. [FF 10, 14]

6. With the power section of the port engine no longer able to transmit torque to the propeller, an airstart of the engine is not possible. [FF 10]

## Recommendations

1. The salvage of PW 33 and the EIs on critical components painted a grim narrative of the severity of the compound emergencies that downed the aircraft in less than 90 seconds. These compound emergencies ultimately resulted in the physical break between the power sections and the propellers. There was no action that that the aircrew could have taken to prevent this end result or recover from its zero thrust situation. These new facts strongly support concurrence of the original recommendations that the actions of the crew "are a testament to their training and courage, and are worthy of recognition."

2. These EIs also allowed investigators to determine the material failures that caused the failure of both engines, but the root cause (material, human, or other) of the portside spinner bracket failure and the loose starboard engine side mount could not be determined through the post salvage EIs. With only possible root causes offered, there are no grounds for non-concurrence on the original recommendation of "no punitive or administrative action" against VRC 30 DET 5 maintenance personnel.

3. The findings of these EIs have no bearing on the other recommendations provided in References (b) and (c).

4. This Supplemental Command Investigation concurs with the original recommendations of References (b) and (c), including "recommend[ing] no punitive or administrate action be taken against the aircrew of PW 33 or VRC 30 DET 5 maintenance personnel."

5. In addition to the recommendations made by the original Command Investigation and CCSG-5, it is also recommended that the NAVAIR analysis of C-2 flooding rates should be briefed to all C-2A aircrew and included in the Ditching Considerations section of the Ditching Emergency Procedure chapter of the C-2A NATOPS Flight Manual (NAVAIR A1-C2AHB-

NFM-000). The Ditching Checklist, general procedures, and characteristics should also be assessed given the new information, and changed as required.

(b) (3) (A), (b) (6)

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