



DEPARTMENT OF THE NAVY
COMMANDER NAVAL AIR FORCE ATLANTIC
1279 FRANKLIN ST.
NORFOLK, VIRGINIA 23511-2494

5830
Ser N01L/ 120
2 July 2012

From: Commander, Naval Air Force Atlantic
To: File

Subj: ACTION OF THE FINAL REVIEWING AUTHORITY REGARDING THE
COMMAND INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE
CLASS A AVIATION MISHAP OCCURRING AT OR NEAR THE MAYFAIR
MEWS APARTMENT COMPLEX, VIRGINIA BEACH, VIRGINIA INVOLVING
AN F/A-18D AIRCRAFT ON 6 APRIL 2012

Ref: (a) [REDACTED] (b) (6) [REDACTED], USN ltr of 20 Jun 12 w/end and
encls
(b) JAG Manual, Chapter II

1. Reference (a) has been reviewed in accordance with reference (b). Further endorsement is considered unnecessary; therefore, the investigation is final and will be retained at this command for a period of two years from the date of this action. Any further correspondence regarding this matter should be forwarded accordingly.

2. Summary. At approximately 1204 local time on 6 April 2012, an F/A-18D aircraft from Strike Fighter Squadron ONE ZERO SIX took off from Naval Air Station Oceana, VA on a routine training flight. Within seconds of takeoff, the aircraft experienced unrelated dual engine malfunctions which resulted in substantially reduced engine thrust and the pilot's inability to control flight. As a result, the aircrew ejected from the aircraft and it subsequently crashed into the Mayfair Mews Apartment Complex in Virginia Beach, VA. Miraculously, there was no loss of life and only a few reported minor injuries. The crash resulted in a total loss of the aircraft and the impact and resultant fire destroyed 27 apartments. There were seven reported injuries as a result of the crash, including those sustained by the mishap RP and IWSO. None of the injuries were life-threatening.

3. The following additional information is provided to the investigative report:

a. Within the Acronyms and Definitions, the following is added: "KCAS" means "Knots Calibrated Air Speed" which is the aircraft's indicated airspeed corrected for instrument and installation errors at a standard air pressure and temperature. It is the airspeed displayed in the pilot's Heads Up Display.

[REDACTED]

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b. Finding of Fact (7) is corrected to reflect that the
mishap IWSO is a "USN" vice "USNR" officer.

c. Finding of Fact (24) is not supported by enclosure (19).

d. Amplification of Finding of Fact 42. Because the post-
mishap runway search did not find any items that came from the
mishap aircraft, this suggests that the fuel cap was intact when
the aircraft took off. After the aircraft went down and the
wreckage was collected for investigative purposes, the fuel cap was
not recovered at the crash site and therefore could not be examined
for structural integrity or analyzed for evidence, and as such
could not be confirmed or dismissed as a possible source of the
fuel ingestion.

e. Comment on Finding of Fact 52. I concur with the
Investigating Officer's assessment that the root cause of the
afterburner anomaly cannot be precisely determined because suspect
components were destroyed during impact and resultant ground fire.
I am hesitant to speculate, as the engineering investigation
suggests, that the most likely cause of the anomaly was a fuel
delivery failure. The information collected in the engineering
investigation was insufficient to support this statement.

f. Finding of Fact 67 is modified to reflect that there was a
total of "seven" injuries reported vice "nine."

g. Findings of Fact 72 - 75 are supported by enclosure (38)
vice (36).

h. I note that Finding of Fact (76) is not supported by
enclosure (36) or any enclosure contained in the investigation. I
have been assured, however, by my Force Judge Advocate's Office
that all residents were advised of their right to submit a claim
against the Government if they suffered any loss as a result of
this crash.

4. Based on my review of reference (a), I concur with the findings
of fact, opinions and recommendations of the Investigating Officer.
With regard to the recommendations, the following is provided:

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a. Recommendation (1). Commanding Officer, Strike Fighter Squadron ONE ZERO SIX is directed to report action taken by 15 August 2012.

b. Recommendation (2). Per the First Endorsement of this investigation, this action has been completed.

c. Recommendation (3). Concur with the Investigating Officer's original recommendation and the briefings should be conducted soonest. This report has been made public and there are valid lessons here that should be discussed. Waiting until the release of the Safety Investigation Report in order to brief the F/18 squadrons, as suggested in the First Endorsement, could result in an unnecessary delay in briefing the "lessons learned" from this mishap. Accordingly, Commander, Strike Fighter Wing Atlantic is directed to ensure compliance with Recommendation (3) and report when action has been completed.

d. Recommendation (4). Is modified to read: "The engineering analysis emphasized the effect on re-light logic due to increased bleed air demands in a single engine scenario. Naval Air Systems Command should continue to assess the failure of the left engine afterburner to relight in this mishap in order to ensure single engine afterburner reliability meets specifications."

e. Recommendation (5). Concur with the Investigating Officer and the previous endorsers that no disciplinary action is warranted in this matter.

f. I concur with the Investigating Officer and the previous endorsers that injuries sustained by (b)(6) and (b)(6) were incurred in the line of duty and not a result of any misconduct. Commanding Officer, Strike Fighter Squadron ONE ZERO SIX is directed to ensure appropriate entries are made into their medical records.

5. Finally, the following comments are provided as amplification of the Investigating Officer's "Primary Cause Analysis." I concur with the Investigating Officer's assessment that had the aircrew initially not attributed the vibration of the aircraft at nose wheel liftoff to a blown tire and recognized the insidious second engine malfunction, it would have been physically possible to keep

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the aircraft flying by raising the landing gear, jettisoning the external fuel tank, and precisely managing airspeed. That is not to axiomatically conclude that had a more experienced aircrew been flying the aircraft, the result would have been different. Given the fact that the mishap RP and IWSO scanned the engine indicators on takeoff roll in accordance with NATOPS procedure and were satisfied that the engines were operating normally, and that this noise and vibration happened just after nosewheel liftoff with the main mounts still on the runway -- the aircrew attributing this malfunction to a blown tire is understandable. The rapid onset of right engine cautions could be attributed to a blown tire flogging the engine. These conclusions could have been reached by any aircrew -- regardless of experience level.

Once the aircrew had started down this path of thinking and left the landing gear down, it is less likely they would re-evaluate and raise the gear. The next decision point was the failure of the left afterburner to light. Analysis shows the aircrew had about a ten-second window to raise the landing gear and jettison the external fuel tank to alter the outcome. A more experienced crew may have made that split-second decision and been able to keep the aircraft airborne for a controlled ejection, but I judge it to be unlikely. Adjusting our training and incorporating this type of scenario in FRS training and annual NATOPS checks will increase the likelihood of success.

6. Per section 0223(b) of reference (b), a complete copy of the investigation is forwarded to Commander, Naval Safety Center.

7. Subject to the foregoing, the findings of fact, opinions and recommendations of the Investigating Officer are approved.

(b) (6)

Copy to:
COMUSFLTFORCOM
COMNAVAIRSYSCOM
COMSTRKFIGHTWINGLANT
CO, VFA-106
NAVSAFECEN (complete)



DEPARTMENT OF THE NAVY
COMMANDER, STRIKE FIGHTER WING ATLANTIC
NAVAL AIR STATION OCEANA
1760 FIRST STREET
VIRGINIA BEACH, VA 23460-2276

5800
N00/069
20 Jun 12

SECOND ENDORSEMENT on [REDACTED] (b) (6), USN, ltr
of 20 Jun 12

From: Commander, Strike Fighter Wing Atlantic
To: Commander, Naval Air Force Atlantic

Subj: COMMAND INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING
THE CLASS A AVIATION MISHAP OCCURING AT OR NEAR THE
MAYFAIR MEWS APARTMENT COMPLEX, VIRGINIA BEACH, VIRGINIA
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1. Forwarded. I concur with the findings, opinions and recommendations.
2. Commander, Strike Fighter Wing Atlantic will ensure actions recommended in recommendation (2) are accomplished by all U.S. Navy F-18 Fleet Replacement Squadrons.
3. My point of contact is [REDACTED] (b) (6) at [REDACTED] (b) (6) or [REDACTED] (b) (6)

[REDACTED] (b) (6)



DEPARTMENT OF THE NAVY
 STRIKE FIGHTER SQUADRON ONE ZERO SIX
 1760 FIRST ST. SUITE 200
 VIRGINIA BEACH, VA 23460-2210

5800
 N1L/ 052
 21 Jun 12

FIRST ENDORSEMENT on (b) (6) USN, ltr of
 20 Jun 12

From: Commanding Officer, Strike Fighter Squadron ONE ZERO SIX
 To: Commander, Naval Air Force Atlantic
 Via: Commander, Strike Fighter Wing Atlantic
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1. Forwarded. I concur with the findings, opinions, and recommendations, except as specified below.
2. Recommendation (3) to be modified as follow: I recommend that the Strike-Fighter community await the release of the Safety Investigation Report (SIR), so that ready-room briefings and discussions will be protected as privileged discourse.
3. The action recommended in recommendation (1) will be accomplished by the F/A-18 A-D Model Manager (VFA-106) forwarding a revised loss of thrust on takeoff procedure to be considered at the next NATOPS conference scheduled for July 2012.
4. The action recommended in recommendation (2) has been accomplished by VFA-106 making adjustments to familiarization stage simulators and NATOPS evaluation procedures to address the loss of thrust on takeoff procedures and decision matrix.

5. My point of contact is (b) (6) COMM: (b) (6)
 (b) (6)/DSN: (b) (6) and E-mail: (b) (6)

(b) (6)

(b) (6)

20 Jun 12

From: (b) (6) USN
To: Commander, Naval Air Force Atlantic

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Ref: (a) JAG Manual
(b) OPNAVINST 3710.7U

- Encl:
- (1) Command Investigation convening ltr of 9 Apr 12
 - (2) Official PCS duty orders for (b) (6)
(b) (6) USN
 - (3) NATOPS Training Jacket excerpts of (b) (6)
(b) (6) USN
 - (4) Log Book excerpts of (b) (6)
USN
 - (5) CAT 1 RP performance summary for (b) (6)
(b) (6) USN
 - (6) 72 Hour History for (b) (6) USN
 - (7) Post-incident toxicology report for (b) (6)
(b) (6), USN
 - (8) Official PCS duty orders for (b) (6) USN
 - (9) NATOPS Training Jacket excerpts of (b) (6)
(b) (6) USN
 - (10) Log Book excerpts of (b) (6) USN
 - (11) VFA-106 Instructor Qualifications Listing for Apr 12
 - (12) 72 Hour History for (b) (6) USN
 - (13) Post-incident toxicology report for (b) (6)
(b) (6) USN
 - (14) Aircraft Monthly Flight Summary chronology for
BUNO 163436
 - (15) Analysis of BUNO 163436 maintenance data and logbooks
by (b) (6) USN, Strike Fighter Wing
Atlantic Maintenance Officer, email of 17 Apr 12
 - (16) BUNO 163436 Aircraft Discrepancy Book (ADB) excerpts
 - (17) VFA-106 flight schedule of 6 Apr 12
 - (18) VFA-106 "by direction" authority letter
 - (19) Written Statement of Mishap Flight Lead (b) (6)
(b) (6) USMC, of 9 May 12
 - (20) FFWT 102 Syllabus Guide
 - (21) Weather forecast for 6 Apr 12
 - (22) Written Statement of Mishap Plane Captain, (b) (6)
(b) (6), of 6 Apr 12

000007

Subj: COMMAND INVESTIGATION INTO THE CIRCUMSTANCES SURROUNDING THE CLASS A AVIATION MISHAP OCCURRING AT OR NEAR THE MAYFAIR MEWS APARTMENT COMPLEX, VIRGINIA BEACH, VIRGINIA INVOLVING AN F/A-18D AIRCRAFT ON 6 APRIL 2012

- (23) Written Statement of Mishap Pilot, (b) (6), (b) (6), USN, of 12 Apr 12
- (24) Interview addendum of Mishap Pilot, (b) (6), (b) (6), USN, of 29 May 12
- (25) Written statement of Mishap Weapon System Operator, (b) (6), USN, of 11 Apr 12
- (26) Interview addendum of Mishap Weapon System Operator, (b) (6), USN, of 18 May 12
- (27) Written Statement of Mishap Final Checker, (b) (6), (b) (6), USN, of 6 Apr 12
- (28) Naval Air Systems Command Engineering Analysis Supporting Data Report and Visualization (CD-R)
- (29) Engineering Investigation on Right Engine
- (30) Engineering Investigation on Left Engine
- (31) Naval Air Systems Command Fuel Systems Mishap Report
- (32) NATOPS excerpt, "right engine stall" emergency procedure
- (33) NATOPS excerpt, "blown tire on take-off" emergency procedure
- (34) F/A-18A/B/C/D NATOPS Flight Manual Excerpts - Performance Charts
- (35) NATOPS excerpt, "loss of thrust on take-off" emergency procedure
- (36) Commander, Naval Air Systems Command ltr of 15 Dec 10 regarding Average Aircraft Investment Costs for 2010
- (37) Injury and medical treatment information provided by Virginia Beach Fire Department
- (38) Property damage information provided by Office of Judge Advocate General Claims Tort Division email of 18 May 12
- (39) Mishap injury summary concerning (b) (6), (b) (6), USN
- (40) Mishap injury summary concerning (b) (6), USN
- (41) NATOPS excerpt, "go around" emergency procedure
- (42) Naval Safety Center's chart, "F404 Mishap Rate"
- (43) NATOPS excerpt, "General Emergencies"
- (44) NATOPS excerpt, "Safety"
- (45) (b) (6), NAS Oceana (b) (6), email of 15 Jun 12

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Preliminary Statement

1. Pursuant to enclosure (1) and in accordance with ref (a), a Command Investigation was conducted to inquire into the facts and circumstances of a Class A Mishap involving an F/A-18D aircraft. On 6 April 2012 at 1204 local time, an F/A-18D aircraft from Strike Fighter Squadron ONE ZERO SIX (VFA-106), piloted by (b) (6) a Category 1 Replacement Pilot (CAT-1-RP), and crewed by (b) (6), an Instructor Weapons Systems Officer (IWSO), initiated takeoff from Runway 05 Left at Naval Air Station Oceana, VA. Within seventy seconds, an inability to continue controlled flight primarily due to sequential and dual engine malfunctions resulted in substantially reduced combined engine thrust and the ejection of the aircrew. The subsequent crash of the F/A-18D aircraft into the Mayfair Mews apartment complex resulted in no loss of life or major injury.
2. All available relevant evidence was collected. All records regarding the Mishap Aircraft and Mishap Aircrew are retained by the Aircraft Mishap Board convened at VFA-106, homeported at Naval Air Station Oceana, Virginia. All documentary evidence enclosed is either the original or a true representation of the original document.
3. Factual evidence collected and processed from the CSFIR combined with engineering investigations conducted on the post-mishap wreckage of the port and starboard engines have been essential elements in determining root cause of this crash. Additionally, aircrew and maintenance personnel interviews have been utilized to complement engineering data and reveal human factors, ranging from individual aircrew "acts," preconditions for those acts, and existing supervision and organizational influence.
4. I received a verbal time extension from (b) (6), USN (b) (6) to complete the investigation due to the timelines associated with necessary engineering investigations.
5. I am qualified to conduct this investigation in accordance with 10 U.S.C. § 2255 and A-2-n of reference (a). I am a Naval Aviator with twenty years of military flying experience and over 3300 hours in the F/A-18 type/model/series. I am a graduate of (b) (6)

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the Naval Aviation Safety School. I have previously served as senior member on a Class A Safety Investigation Report and as a Squadron Aviation Safety Officer.

6. (b)(6), (b)(6), USN, (b)(6), (b)(6), (b)(6), assisted the Investigating Officer with legal advice during the course of the investigation.

7. I have met each of the Convening Authority's directives. I have investigated the cause of the accident and provided opinions as to any fault, neglect or responsibility. I have also provided recommendations to mitigate the possibility of this type of mishap happening in the future. Knowing that the substance of this report will likely be made available to the general public, I have sought to provide some explanations and the following discussion of terminology to provide not only a report usable to the expert, but readily accessible to the layman.

Acronyms and Definitions

"FRS" = Fleet Replacement Squadron. The mishap squadron, VFA-106, is one of three Fleet Replacement Squadrons whose primary function is to provide training to newly-winged Naval Aviators and Naval Flight Officers ("NFOs") on employment of the F/A-18. Every 6 weeks, a class of between 8-12 newly-winged Navy and Marine Corps pilots and Naval Flight Officers begins the 9 month training course in which they learn the basics of air-to-air and air-to-ground missions, culminating in day/night carrier qualification and subsequent assignment to fleet Hornet squadrons.

"CAT 1 RP" = Category 1 Replacement Pilot. Such a pilot is the primary "customer" of an FRS. This is a winged Naval Aviator who has previously completed primary, intermediate and advanced training in high performance training aircraft to include carrier qualification. Upon successful completion of the FRS syllabus, a CAT 1 RP receives orders to one of the operational VFA squadrons located in NAS Oceana, NAS Lemoore, or NAF Atsugi, Japan. (b)(6) is a CAT 1 RP.

"WSO" = Weapon Systems Operator. A winged Naval Flight Officer who specializes in F/A-18 employment and occupies the aft crew

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station. A WSO does not operate flight controls but is knowledgeable in aircraft handling characteristics and emergency procedures. (b) (6) is a WSO.

"PIC" = Pilot in Command. The pilot of an individual aircraft, the PIC is responsible for the safe, orderly flight of the aircraft and well-being of the crew. The PIC may also be the mission commander or formation leader when so designated. The authority and responsibility of the PIC shall not be transferred during flight. It shall not be transferred to another individual except as required by emergency, operational necessity, or as directed by the commanding officer of the unit to which the aircraft is attached. The authority and responsibility of a PIC is independent of rank or seniority. (b) (6) was the PIC of the mishap flight.

Mission Commander. The mission commander shall be a properly qualified naval aviator or NFO designated by appropriate authority. The mission commander may exercise command over single naval aircraft or formations of naval aircraft. The mission commander shall be responsible for all phases of the assigned mission except those aspects of safety of flight that are related to the physical control of the aircraft and fall within the prerogatives of the PIC. Mission commander qualifications shall be outlined in appropriate NATOPS manuals. The mission commander shall direct a coordinated plan of action and be responsible for effectiveness of the mission. (b) (6) was the mission commander of the mishap flight.

Instructor. In those aviation commands where training is conducted, the commanding officer is authorized to designate highly qualified naval aviators and NFOs as instructors. Instructor duties shall be specifically delineated by the unit commanding officer in formal directives. The instructor will be charged with authority and responsibility to provide appropriate direction to students (naval aviation or NFO) to ensure safe and successful completion of each training mission. The exact function, authority, and responsibility of the individual flight instructor are dependent upon the training mission and the crew assigned as issued in approved training syllabuses. On those training missions where a pilot under instruction is the PIC, instructor guidance shall be advisory in nature and under no circumstance shall pilots in command be relieved of their authority and responsibility. Termination of the training or

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evaluation portions of the flight for reasons of safety, unsatisfactory performance, or material discrepancy shall be the instructor's prerogative. (b)(6) is an instructor.

"IWSO" = Instructor WSO. (b)(6) was the IWSO on the mishap flight.

"F/A-18D" = The "D" model is a two-seat version of the Hornet. Within the United States Navy, these aircraft are primarily utilized as trainers, providing advanced tactics exposure to F/A-18C pilots. The mishap aircraft was an F/A-18D crewed by a CAT 1 RP in the forward crew station and an IWSO in the aft crew station.

"CSFIR" = Crash Survivable Flight Incident Recorder (CSFIR). The mishap aircraft had a Voice and Data Recorder (VADR) installed as its CSFIR. This type of recorder has the ability to store several hours of data. The VADR was recovered from the crash site and was sent to NAVAIR at Patuxent River, MD. The data from the VADR was then successfully downloaded and provided in a RAW binary format for analysis. The VADR records aircraft dynamic data, engine and flight control data as well as caution and warning data as dictated by the Mission Computer Operational Flight Program.

"Class A Mishap" = Any accident resulting in permanent total disability or fatality, complete destruction of naval aircraft, or exceeding \$1 million in property or aircraft damages.

"NATOPS" = The Naval Air Training and Operating Procedures Standardization program prescribes general flight and operating instructions and procedures applicable to the operation of US naval aircraft. NATOPS manuals provide emergency procedures for most circumstances, to include "immediate action" emergency procedures as required.

"MIL" = Military Rated Thrust; also known as "MRT"; this power setting is the highest thrust setting without using the afterburner stage of the engine. The static military rated thrust for an F/A-18 F404-GE-400 engine is 10,200 lbs.

"MAX" = Maximum-Rated Thrust; also known interchangeably as full afterburner ("FULL AB") or maximum afterburner ("MAX AB"); this power setting is the highest thrust setting for the engine.

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The static maximum rated thrust for an F/A-18 F404-GE-400 engine is 16,000 lbs.

AOA = "Angle Of Attack." In aerodynamics, angle of attack specifies the angle between the chord line of the wing of a fixed-wing aircraft and the vector representing the relative motion between the aircraft and the atmosphere. The lift coefficient of a fixed-wing aircraft such as the F/A-18 varies uniquely with angle of attack. Increasing angle of attack is associated with increasing lift coefficient up to the maximum lift coefficient, after which lift coefficient decreases. During times of degraded flight characteristics, pilots are trained to fly at an optimum AOA for the best lift versus drag flight profile; it is displayed in the Heads Up Display (HUD) of the front cockpit and on a HUD repeater in the aft cockpit.

FINDINGS OF FACT

Background (aircrew/pilot)

1. The mishap RP was (b) (6) USN, age (b) (6) (b) (6) received a Regular Commission and was on active duty at the time of the mishap, permanently assigned to the mishap squadron, VFA-106. [Encl (2)]
2. (b) (6) was fully NATOPS qualified for front-seat/single-seat operation (Aircraft Commander) of F/A-18A/B/C/D aircraft in accordance with NATOPS, OPNAVINST 3710 and VFA-106 Standard Operating Procedures. [Encl (3)]
3. The mishap RP had 337.6 total flight hours, 83.1 hours in the F/A-18. [Encl (4)]
4. As a Category 1 RP undergoing initial training in the F/A-18, he was in the Fighter Weapons phase of a CNO approved training syllabus and had performed better than 85 of the last 100 replacement pilots to complete the syllabus. [Encl (5)]
5. The mishap RP's 72 hour history was unremarkable. During this period, he slept 23.6 hours, 10 of which occurred in the 24 hours prior to the mishap flight briefing. [Encl (6)]
6. The post-mishap toxicology report for (b) (6) showed nothing adverse in his blood or urine. [Encl (7)]

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Background (aircrew/IWSO)

7. The mishap IWSO was (b)(6), USNR, age (b)(6) (b)(6) received a Regular Commission and was on active duty at the time of the mishap, permanently assigned to the mishap squadron, VFA-106. [Encl (8)]

8. (b)(6) was fully NATOPS qualified to man the aft crew station as Mission Commander in two-seat Hornet variants (F/A-18B and F/A-18D) and the two-seat Super Hornet variant (F/A-18F) in accordance with NATOPS, OPNAVINST 3710 and VFA-106 Standard Operating Procedures. [Encl (9)]

9. The mishap IWSO had 1127.2 total flight hours, 947.2 hours in the F/A-18B/D/F, and 21.9 hours specific to the F/A-18D. [Encl (10)]

10. The mishap IWSO is qualified to instruct in both the F/A-18F and F/A-18D models in Transition, Basic Fighter Maneuvers, Strike, 2v1, Fighter Weapons and Strike Fighter Tactics Phases of the FRS Category 1 Replacement Pilot and Replacement WSO syllabi. [Encl (11)]

11. The mishap IWSO 72 hour history was unremarkable. During this period, he slept approximately 33 hours, 9 of which occurred in the 24 hours prior to the mishap flight briefing. [Encl (12)]

12. The post-mishap toxicology report for (b)(6) showed nothing adverse in his blood or urine. [Encl (13)]

Background (Maintenance)

13. The mishap F/A-18 (Bureau Number (BUNO) 163436, side number 411) was a "D" variant and for the purposes of this report will be referred to by its aircraft BUNO, 163436. [Encl (14)]

14. 163436 was factory delivered in 1987 and had flown 6512.8 total flight hours as of 31 March 2012. The service life for 163436 as configured was 8000 flight hours. [Encl (14)]

15. 163436 was in compliance with all required technical directives, including flight hours since last overhaul and flight hours since last intermediate check. [Encl (15)]

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16. 163436 was in compliance with all required special inspections. The last "28 day" inspection was completed on 2 APR 2012. [Encl (16)]

17. 163436 flew 4 times in the three days previous to the mishap flight without any maintenance action required other than daily/turnaround inspections. [Encl (16)]

18. 163436 was deemed "safe for flight" on the mishap flight by (b)(6) USN, assigned to VFA-106 F/A-18 A-D Maintenance Control. [Encl (16)]

Flight Briefing

19. The mishap flight was authorized by the VFA-106 Commanding Officer and was published on the 6 April 2012 flight schedule as Event 8. [Encl (17)]

20. The schedule was signed by (b)(6), USN for the Commanding Officer, (b)(6) USN in accordance with local "by direction" authority. [Encl (18)]

21. The mishap flight brief was conducted by (b)(6) (b)(6), USMC, in accordance with NATOPS and the Fighter Weapons Syllabus standardization guide. [Encl (19)]

22. The mishap flight was briefed to be a two-ship element as part of the Fighter Weapons 102 sortie and would be executing air to air intercepts against another two-ship in the W-72 offshore training range/warning area. [Encl (19)]

23. This sortie is designed to help prepare replacement aircrew to employ the F/A-18 radar and radar missiles in the "beyond visual range" arena and is typically flown in one of the last phases of the Category 1 syllabus. [Encl (20)]

24. Weather during the flight was forecast to be BKN020 OVC 070. At the 12:11 local time, 6 minutes after the crash, the weather conditions reported at Oceana NAS (KNTU) via recorded METAR were as follows:

Air Temp: 51.8-deg F Sky Cond: SCT 029 BKN 150
Rel Humd: 58% Visibility: 10 miles
Dew Point: 37.4-deg F Altimeter: 29.96 in-Hg

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Wind Dir: 030 (True) Precip: None

Wind Vel: 15 gusts 18 kts RWY Cond: Dry [Encls (19), (21), (28)]

25. The mishap RP was briefed to utilize an afterburner takeoff 10 seconds after his flight lead in accordance with squadron and VFA community standardization. [Encl (19)]

26. Nose wheel liftoff speed was calculated to be 155 knots, takeoff speed was calculated to be 167 knots, and takeoff distance was calculated to be 2200 ft. [Encl (19)]

Aircraft Pre-Flight

27. The contracted mishap maintenance Plane Captain (b)(6) had conducted all required pre-flight checks and greeted the mishap RP upon arrival at 163436. [Encl (22)]

28. The mishap RP conducted a pre-flight/walk-around in accordance with NATOPS prior to aircraft start. [Encl (23)]

29. The mishap IWSO arrived at the aircraft subsequent to the mishap RP and conducted an abbreviated walk-around noting panel security and general aircraft integrity. He asked the mishap RP if he was satisfied with the walk-around. The mishap RP, as the aircraft commander, verbally confirmed the pre-flight was complete in accordance with NATOPS. [Encl (25)]

Line Procedures

30. Aircraft engine starts and aircrew system checks were conducted in accordance with NATOPS and were unremarkable. [Encls (23), (25)]

31. The aircraft was "final checked" in accordance with instruction by (b)(6), USN, prior to taxi. [Encl (27)]

Aircraft Taxi

32. During aircraft taxi, all systems onboard 163436 continued to indicate "normal" with the exception of low cockpit environmental control system (ECS) airflow. This was mitigated when the mishap IWSO directed the mishap RP to place the control

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system from automatic to manual to improve temperature management. [Encl (25)]

Takeoff

33. The mishap flight was cleared for takeoff at approximately 1203L as a flight of two. The mishap flight lead executed a normal afterburner (AB) takeoff. After waiting 10 seconds, the mishap RP selected MAX to start the takeoff sequence as dash 2. [Encl (23)]

34. Both the mishap RP and mishap IWSO scanned engine indications in accordance with NATOPS and VFA-106 Standard Operating Procedure and were satisfied that the engines were operating normally. Normal engine status was verbalized by the mishap RP in accordance with VFA-106 Standard Operating Procedures. [Encls (23), (25)]

35. The takeoff sequence occurred as planned and expected. The mishap RP initiated nose wheel lift off at approximate time 12:04:24. [Encls (23), (25), (28)]

36. Within two seconds of rotation, the mishap RP experienced what he called a "serious vibration" and the WSO experienced a "series of thumps and bumps on the right side of the airplane". [Encls (23), (25), (28)]

37. At time 12:04:29, five seconds after the takeoff rotation, the mishap aircraft mission computer reported an "engine right, engine right" aural caution to the aircrew and displayed a R STALL caution and master caution, indicating that the right engine had experienced an engine compressor stall. [Encl (28)]

38. Post flight analysis shows the right engine suffered a catastrophic stall at approximate time 12:04:25 as evidenced by dramatic reduction in Compressor Discharge Pressure. [Encl (28)]

39. Post flight engineering investigation of the right engine shows that the high pressure compressor section blades failed due to ingestion of a flammable fluid. The fracture surface of the mishap blades was consistent with the fracture surface of failed blades documented in previous mishap events where fuel ingestion was proven as cause or suspected. [Encl (29)]

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40. The ingestion of a flammable fluid into the right engine in turn caused combustion of the fluid and catastrophic failure of some of the compressor. [Encl (28, 29)]

41. Neither the Engineering Investigation for the right engine nor the NAVAIR Fuel Systems Mishap Report teams were able to determine the most likely source of the ingested flammable fluid. [Encls (28), (29)]

42. The post-mishap runway search did not find any items that came from the mishap aircraft. [Encl (45)]

43. The right engine produced negligible thrust for the remainder of the flight. [Encl (28)]

First Reactions

44. The mishap RP initially pulled back the throttles to MIL, then pulled the right throttle back to idle by which point the airspeed had dropped to 164 KCAS with AOA at 5.6 deg. The aircraft climbed at 7.0 deg AOA and 10 deg pitch. [Encl (28)]

45. The mishap RP stated that his initial reaction after nose-wheel liftoff was to adjust the throttles from MAX to MIL. [Encl (23)]

46. Shortly thereafter, in response to the "engine right, engine right" aural caution, the mishap RP retarded the right throttle to "idle", in accordance with NATOPS emergency procedure "Right Engine Stall" immediate action requirements. [Encls (23), (28)]

47. The mishap IWSO, after feeling a series of jolts and vibrations, stated that he believed the aircraft had blown a tire on takeoff. He directed the mishap pilot to "take the aircraft flying, stay below 250, and leave the gear down". [Encl (26)]

48. After becoming airborne, the mishap IWSO observed the "engine right, engine right" aural caution and noted that the mishap pilot retarded the right throttle to idle. [Encl (25)]

49. Not cycling the landing gear with a suspected blown tire is in accordance with NATOPS procedure. [Encl (33)]

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The Next Sixty Seconds

50. As the mishap RP held 10 deg of pitch, airspeed bled and AOA increased. 25 seconds after liftoff with airspeed below 150 KCAS and AOA above 8 deg, the aircraft reached a peak altitude of 452 ft. As the flight path went negative, the aircrew increased the left throttle to MAX. Pitch attitude was still maintained near 10 deg or slightly below. [Encl (28)]

51. After the left engine throttle is advanced to MAX, the nozzle responds by properly by preopening and then releasing to open the nozzle, indicating a successful AB light off. However, prior to reaching a similar MAX AB nozzle position consistent with that demonstrated on take-off, the nozzle closes to 50%, which is the minimum allowable with AB operation selected. Final nozzle position combined with the reduction of turbine temperature and pressure and the resulting fan rotor up speed indicate that afterburner combustion was not typical. The data further suggests that the left AB experienced a blowout which was undetected by the engine control system. An extensive root cause analysis was completed including all engine or aircraft potential causes for this AB anomaly. [Encl (28), (30)]

52. The root cause of the AB anomaly could not be precisely determined because suspect components were destroyed during impact and ground fire. Based on the engine sequence of events the most likely initial cause of the anomaly was a fuel delivery failure. An electrical failure of the electrical control assembly (ECA), afterburner fuel control (ABFC) and electrical "green" harness were also remote possibilities. Of note, CSFIR data indicated that automatic afterburner relight logic requirements were not satisfied due to an insufficient T5 temperature drop most likely due to a combination of increased compressor bleed air extraction from a single properly operating engine and inefficient clearances due to increased throttle transients. This caused the engine to operate at a higher than expected turbine temperature preventing T5 to drop by at least 150 degrees F. It is unknown whether AB relight would have occurred even if these conditions had been met. [Encl (30)]

53. Based on the modeling efforts, the left engine was producing less than MIL power thrust while operating in this

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condition. Post flight analysis shows resultant thrust output for the left engine was reduced by approximately 700 lbs to a final thrust of 7630 lbs. Following the reduction in thrust after selection of FULL AB, the negative rate of descent increased and mishap RP AOA control was degraded. [Encl (28)]

54. As a reference, the resultant thrust on the left engine was approximately half of what a properly functioning F/A-18D engine (F404-GE-400) should produce in full AB and only 83.8% of what a properly functioning F/A-18D engine (F404-FE-400) should produce at MIL. [Encl (28)]

55. Single engine rate of climb for the F/A-18D is a function of thrust, weight, configuration, angle-of-attack (AOA) and ambient conditions. [Encl (28)]

56. Single engine rate of climb for a 38000 lb aircraft, inoperative engine windmilling, maximum thrust, half flaps, gear down is between 1500 and 2000 feet per minute. [Encl (34)]

57. The mishap RP was aware that the left afterburner had not engaged properly. [Encl (24)]

58. Resultant thrust available was insufficient to maintain flight without timely aircrew action, to include both raising the landing gear and jettisoning the external centerline fuel tank. [Encl (28)]

59. NATOPS does not recommend any specific immediate action for loss of thrust on take-off. The mishap RP action was in compliance with NATOPS emergency "go around" procedures. [Encls (35), (41)]

60. Aircrew are required to carry the NATOPS Pocket Checklist on all flights. [Encl (44)]

61. Neither the mishap RP nor the mishap IWSO considered jettison of the centerline tank. [Encls (24), (26)]

62. Approaching 300 ft altitude, the mishap RP increased aft stick. This increased AOA to 14-15 degrees and momentarily arrested the descent 40-45 seconds after liftoff. A favorable gust may have also contributed to the lowering of descent rate.

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Descent rate picked up again after aft stick was slightly relaxed. At 50 seconds after liftoff, AOA was maintaining 14-15 deg, altitude was dropping through 270 ft, and airspeed was 136 KCAS. At this point the mishap RP pushed the right throttle to MIL and then MAX A/B. 60 seconds after liftoff, as the aircraft continued lower, aft stick increased and raised the AOA to 19 deg. [Encl (28)]

63. The Class A mishap rate associated with F404-GE-400 engine failures is 0.16 per 100,000 hours. [Encl (42)]

Ejection

64. Approaching 100 feet above ground level and just prior to ejection, the aircraft departed controlled flight characterized by rolling and yawing to the right due to a combination of asymmetric thrust, high angle of attack, and low airspeed. [Encl (28)]

65. At approximately 50 feet above ground level with the aircraft beginning to roll right, the mishap IWSO initiated command ejection, successfully ejecting both the mishap RP and mishap IWSO. [Encl (28)]

Rescue

66. The first response effort was a combined and coordinated response led by the Virginia Beach Fire Department and assisted by NAS Oceana Fire Department and Security. At the time of this report, the VBFD post-accident report was not yet available. [Encl (37)]

Injuries

67. There were nine total injuries reported due to the aircraft mishap, two of which were the mishap RP and mishap IWSO. No life threatening injuries were sustained. [Encls (37), (39), (40)]

68. A cursory summary of civilian injuries was provided by Virginia Beach EMS to the Virginia Beach Fire Department. [Encl (37)]

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69. As a result of the ejection and/or landing, (b) (6) suffered relatively minor injuries requiring physical rehabilitation and a period of light duty. (b) (6)

(b) (6)

(b) (6) His return to flight status is pending. [Encl (39)]

70. As a result of the ejection and/or landing, (b) (6) suffered injuries requiring physical rehabilitation and a period of light duty. (b) (6)

(b) (6)

and his return to flight status is anticipated. [Encl (40)]

Property Damage

71. Government property damage was entirely associated with complete loss of BUNO 163436 and its ancillary equipment. Mishap costing data provided by the Naval Safety Center was \$64.1M. [Encl (36)]

72. Non-government property damage was primarily restricted to the Mayfair Mews Apartment complex structure where the aircraft impact and resultant fire destroyed 27 apartments. The remaining 37 units of the Mayfair Mews Apartment complex were evacuated but undamaged. All residents were offered emergency compensation for temporary food and lodging. [Encl (36)]

73. There was some minor property damage to residences adjacent to Mayfair Mews housing units, as well as some minor damage to vehicles parked at or near the complex. [Encl (36)]

74. Remediation efforts were completed on 9 May 2012 and the State of Virginia Department of Environmental Quality determined no further action was required. [Encl (36)]

75. The City of Virginia Beach also cleared the site as safe on 9 May 2012. [Encl (36)]

76. All residents were advised that if they suffered any loss as a result of the crash they could file a claim against the U.S. Government. The claims process is ongoing. The point of

(b) (6)

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contact for further inquiry regarding the claims process or property damage is the Office of the Judge Advocate General's Tort Claims Unit, 9620 Maryland Avenue Suite 295, Norfolk, Virginia, 23511-2949. [Encl (36)]

Opinions

1. The mishap RP was not derelict in his duties. [FF (1), (4), (5), (6)]
2. The mishap IWSO was not derelict in his duties. [FF (7), (8), (10), (11), (12)]
3. (b)(6) was not under any undue fatigue, use of medication, intoxication or anguish the night prior or day of the mishap. [FF (5)]
4. (b)(6) was not under any undue fatigue, use of medication, intoxication or anguish the night prior or day of the mishap. [FF (11)]
5. (b)(6) was in the line of duty at the time of the mishap. The mishap was not due to misconduct. [FF (1), (4), (5), (6)]
6. (b)(6) was in the line of duty at the time of the mishap. The mishap was not due to misconduct. [FF (7), (8), (10), (11), (12)]
7. The mishap aircraft maintained visual meteorological conditions throughout the flight. Weather was not a significant factor to the crash. [FF (24)]

Primary Cause Analysis

This mishap was a function of inadequate thrust to maintain controlled flight. The combination of a catastrophic right engine compressor stall shortly after nose-wheel liftoff followed by a left engine afterburner failure resulted in a thrust profile insufficient for continued controlled flight utilizing existing NATOPS immediate action procedures.

Even though fuel ingestion into the engine compressor was determined to be the likely cause of the right engine compressor

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stall, neither the engineering investigation on the right engine nor the NAVAIR Fuel Systems Mishap Report was able to determine the most likely source of the ingested fluid. Of note, one of the possibilities assessed by the Fuel Systems report was loss of the external fuel tank cap. Within the aforementioned report, this possibility was deemed unlikely due to the CSFIR data showing a normal centerline quantity for the duration of the event. Additionally, the runway environment was investigated by a team of VFA-106 personnel multiple times in search of the fuel cap, with negative results.

The engineering investigation (EI) of the left engine focused on the afterburner malfunction. Based on the engine sequence of events, the most likely cause of the AB blowout was a fuel delivery failure. An electrical failure of the ECA, ABFC or green harness was also a remote possibility. The root component cause of the AB anomaly cannot be definitively determined because suspect components were destroyed during impact and ground fire.

Of note, the EI indicated that automatic afterburner relight logic requirements were not satisfied due to an insufficient T5 temperature drop most likely due to a combination of increased compressor bleed air extraction from a single properly operating engine and inefficient clearances due to increased throttle transients. This caused the engine to operate at higher than expected turbine temperature preventing the requisite T5 temperature drop by at least 150 degrees F. In layman's terms, the increased bleed air demands on the left engine, due to the catastrophic failure of the right engine compressor, exacerbated the fulfillment of fuel control logic requirements necessary for the left engine afterburner to automatically relight. However, it is unknown whether AB relight would have occurred even if these conditions had been met due to uncertainties regarding the cause of the initial AB blow out. This is further visited in the recommendations portion of this report.

The likelihood of catastrophic engine malfunctions is statistically very low. As a function of the dual-engine concept, engine design reliability specifications and conservative maintenance inspection cycles, the reliability of the F404-GE-400 engine has been exceptionally good over the life of the F/A-18 program. In fact, according to the Naval Safety Center, the Class A mishap rate associated with F404-GE-400

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engine failures is 0.16 per 100,000 hours. Prior to this mishap, no F/A-18s had ever crashed in the vicinity of NAS Oceana due to an engine malfunction.

Despite the fact that the root causes of the distinct and separate right and left engine malfunctions were most likely materiel related, significant analysis has been prepared on whether or not an optimum pilot technique with the mishap thrust profile could have averted this crash. Optimum technique involves maximizing thrust and lift while simultaneously minimizing weight and drag. The mishap RP's initial action to maintain proper "on-speed" or faster AOA and select MAX AB on the remaining good engine were correct and reflective of proper training. With a complete loss of thrust on the right engine, had the left engine afterburner functioned properly, the commanded resultant thrust would have provided a rate of climb in excess of 1500 feet per minute and quickly ended the extremis portion of the aircraft emergency.

Unfortunately, in the case of this mishap, a much more "varsity" problem was posed to this aircrew. While the malfunction associated with the right engine compressor stall was obvious and clearly presented, the malfunction of the left engine was not. The mishap RP was aware that the left afterburner had not engaged properly upon throttle advancement to MAX due to absence of "seat of the pants" cueing but was not aware that his movement of the throttle had actually decreased thrust by approximately 700 lbs. The resultant reduced thrust accelerated the need for timely action and exacerbated the negative rate of descent and proper AOA management. Resultant thrust was not adequate to remain airborne without a timely decision to both raise the landing gear to reduce drag and jettison the 2500 lb. centerline fuel tank over the city of Virginia Beach to reduce weight. NATOPS does not specifically address "loss of thrust on takeoff" situations with immediate action procedures.

The following is a direct excerpt from NATOPS, on the first page of Chapter 12, "General Emergencies", and helps the reader understand the methodical mindset necessary in the resolution of most aircraft malfunctions.

Apply the following rules to all emergencies:

a. Aviate: first and foremost, maintain aircraft control.

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b. Analyze the situation and take proper action. Perform immediate action procedures without delay; however, initially do only those steps required to manage the problem. When operating a control, be prepared to immediately return the control to its former setting if an undesirable response occurs.

c. Navigate: land as soon as practical, unless the situation dictates otherwise.

d. Communicate: As soon as possible, notify the flight lead, ship, ATC (air traffic control), or tower of the emergency, aircraft position, and intended course of action. Relay emergency indications, actions taken, flight conditions, power setting, etc., as time permits.

All aircrew are required to carry a fully updated and current version of the F/A-18 NATOPS Pocket Checklist for every flight. For general aircraft emergencies, aircrew are trained to first reference this checklist before attempting to resolve the malfunction. The only exception to this is when immediate action is required. Immediate action procedures are memorized by all aircrew and tested monthly via written closed-book tests and annually via a NATOPS "check" simulator. Most immediate action procedures have been "written in blood" because a failure to execute expeditiously will likely result in the loss of aircraft or aircrew.

With the entire flight lasting seventy seconds, it is the opinion of the investigating officer that there was not adequate time to reference the NATOPS airborne. While there are plausible justifications for not applying the necessary corrective action, the bottom line of the aerodynamic review is that had the aircrew reacted quickly to the loss of thrust condition by retracting the landing gear, jettisoning the centerline fuel tank, and precisely managing airspeed, the aircraft could have flown away safely, even with the greatly reduced resultant thrust.

According to post-flight interviews, both the mishap RP and mishap IWSO did not consider jettison of the centerline tank over a populated area. Additionally, the mishap RP bypassed the opportunity to raise the gear when it mattered most primarily due to a mistaken assumption that the aircraft had blown a tire on the right side. To reiterate, timely execution of both of these steps were required to avert a crash. It is the opinion

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of the investigating officer that without an immediate action procedure in place, the successful employment of the necessary and time-critical combination of pilot actions would not be assured for the mishap RP, unless he had unique familiarity with "loss of thrust" scenarios through personal experience. Absent immediate action procedure, the mishap RP and the mishap IWSO did not have the necessary experience to draw upon in resolving this emergency.

Recommendations

1. Develop numerated and immediate action NATOPS emergency procedures associated with loss of thrust on field takeoff, similar in function to "emergency catapult flyaway" for carrier-based takeoffs.

2. The F/A-18 community, specifically the FRS commands, should consider enhanced training, both in the simulator and classroom that emphasizes the immediate value of raising the landing gear when confronted with a loss of thrust condition and discusses the decision matrix for jettisoning stores over a populated area.

3. All F/A-18 squadrons should brief this Command Investigation to all aircrew.

4. Naval Air Systems Command should further investigate the current automatic afterburner re-light logic and capability within the full range of degraded engine scenarios given the requirement for this system to work properly during single-engine emergencies.

5. No punitive action should be taken with regards to (b) (6), (b) (6), or (b) (6).

(b) (6)

(b) (6)