DEPARTMENT OF DEFENSE
COMMANDER, NAVAL AIR FORCE, ATLANTIC
1562 MITSCHER AVENUE, SUITE 300
NORFOLK, VA 23551-2427

5830
Ser N01L/171
20 Jun 16

From: Commander, Naval Air Force Atlantic
To: File

Subj: ACTION OF THE FINAL REVIEWING AUTHORITY REGARDING THE COMMAND INVESTIGATION INTO THE FLIGHT DECK MISHAP ON USS DWIGHT D EISENHOWER (CVN 69) ON 18 MARCH 2016

Ref: (a) (b) (6) ltr 5830 of 29 Mar 16 w/encls
(b) JAG Manual, Chapter II
(c) USS DWIGHT D EISENHOWER ltr 5830 Ser CVN 69-00/154 of 2 Apr 16

1. Reference (a) has been reviewed in accordance with reference (b). Further endorsement is unnecessary; therefore, this 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. On 18 March 2016, an E-2C assigned to VAW-123 attempted an arrested landing onboard USS DWIGHT D EISENHOWER (CVN 69). The mishap aircraft successfully engaged the number four (#4) wire, but the #4 arresting gear engine (AGE) failed to effectively decelerate the mishap aircraft as it continued through the landing area. As the mishap aircraft approached the angled deck, the cross deck pendant parted, and the forward momentum of the aircraft carried it over the end of the angled deck. The mishap aircrew recovered the aircraft and safely returned to Chambers Field, Naval Station Norfolk. Eight flight deck personnel were injured and two aircraft were damaged by the recoil of the #4 arresting wire. The root cause of this mishap was determined to be a lack of procedural compliance by three EISENHOWER maintenance personnel while troubleshooting the #4 AGE following a system-reported fault code on a prior arrestment; specifically, while executing an approved Naval Air Systems Command (NAVAIRSYSCOM) procedure to clear the fault code and restore the AGE, the qualified maintenance personnel missed at least one and possibly two critical steps, resulting in the inadvertent programming of a valve that controls AGE pressure and energy absorption during an arrestment. Thus, on arrestment, the valve failed to seat rapidly enough, and the AGE exceeded its nominal stroke length, causing the engine to two-block and transfer the arrestment load to the cross deck pendant. This exceeded the cross deck pendant's breaking strength causing the pendant to part at or near the mishap aircraft's tailhook engagement point.

3. The circumstances that resulted in this mishap were unfortunate, but not the result of willful dereliction of duty or culpable negligence. Based upon their training, the Sailors reasonably believed they had properly and conscientiously completed the complicated troubleshooting procedure. Phenomenal airmanship by the E-2 mishap aircrew prevented any casualties among the aircrew and the loss of the aircraft, while the quick response by flight deck and medical personnel facilitated timely medical treatment and evacuation of the injured personnel.

4. Recommendations.

(b) (5)

(b) (5)

5. The point of contact for this matter is (b) (6), who can be reached either at his navy.mil address or at (b) (6)

(b) (6)

Copy to:
COMNAVAIRSYSCOM
COMCARSTKGRU TEN
COMCARSTRKGRU FOUR
USS DWIGHT D. EISENHOWER (CVN 69)
COMACCLOGWING
COMCARAIRWING THREE
Naval Safety Center
Investigating Officer
COMNAVAIRLANT (N433)

DEPARTMENT OF THE NAVY
COMMANDER
CARRIER STRIKE GROUP TEN
FPO AE 09506-4701

IN REPLY REFER TO
5830
Ser N00/025
9 Apr 16

SECOND ENDORSEMENT on (b) (6) , USN, ltr of 29 Mar 16

From: Commander, Carrier Strike Group TEN
To: Commander, Carrier Strike Group FOUR

Subj: COMMAND INVESTIGATION INTO THE FLIGHT DECK MISHAP ON USS DWIGHT D. EISENHOWER (CVN 69) ON 18 MARCH 2016

1. (b) (5)
(b) (5)

9 (b) (5)
(b) (5)

10. (b) (5)
(b) (5)

11. (b) (5)
(b) (5)

2. In the wake of this incident, Commanding Officer, USS DWIGHT D. EISENHOWER took immediate action to mitigate and control any and all risks to force and mission related to the AGE and ARC systems. He raised immediate awareness throughout the Fleet on the potentially severe and catastrophic results stemming from this matter.

3. (b) (5)
(b) (5)

4. My point of contact on this matter is (b) (5) . He can be reached via email at (b) (5) or via telephone at (b) (5)
(b) (5)

Copy to:
CVN 69

DEPARTMENT OF THE NAVY
USS DWIGHT D. EISENHOWER (CVN 69)
UNIT 100236 BOX 1
FPO AE 09532

5830
Ser CVN 69-00/154
2 Apr 16

FIRST ENDORSEMENT on (b) (6), USN, ltr of 29 Mar 16

From: Commanding Officer, USS DWIGHT D. EISENHOWER (CVN 69)
To: Commander, Carrier Strike Group FOUR
Via: (1) Commander, Carrier Strike Group TEN

Subj: COMMAND INVESTIGATION INTO THE FLIGHT DECK MISHAP ON USS DWIGHT D. EISENHOWER (CVN 69) ON 18 MARCH 2016

1. (b) (5)
(b) (5)

2. I took corrective action immediately following this incident in order to ensure it was briefed across the carrier fleet. An initial SITREP, enclosure (8), and pertinent updates were distributed to raise awareness of Advanced Recovery Control (ARC) System troubleshooting procedures. I have also taken the corrective actions listed below.

a. (b) (5)
(b) (5)

b. (b) (5)
(b) (5)

c. (b) (5)
(b) (5), (b) (6)
(b) (5)

d. A Local Operating Procedure implementing additional ARC-related troubleshooting is in progress and all V-2 personnel will become proficient on its contents.

3. Additional corrective actions, if necessary, will be taken upon receipt of the results from the Aviation Mishap Board (AMB) and Safety Incident Report (SIR).

4. I recognize the hard work, dedication, and training of the crew and have deep gratitude and respect for their professionalism in response to this mishap. I also appreciate the outstanding support from military and civilian experts that have aided in this investigation, the AMB, and SIR.

5. My point of contact in this matter is (b) (6) . He can be reached via email at (b) (6) or via telephone at (b) (6)

(b) (6)

5830
29 Mar 16

From: (b) (6) USN
To: Commander, Carrier Strike Group FOUR
Via: (1) Commanding Officer, USS DWIGHT D. EISENHOWER
(2) Commander, Carrier Strike Group TEN

Subj: COMMAND INVESTIGATION INTO THE FLIGHT DECK MISHAP ON USS DWIGHT D. EISENHOWER (CVN 69) ON 18 MARCH 2016

Ref: (a) JAGMAN Ch. II
(b) NAVAIR 51-5BBA-2.1
(c) NAVAIR 51-5BBA-2.2

Encl: (1) Appointing order
(2) PLAT video recording
(3) Summary of interview - Mishap Mission Commander
(4) Summary of interview - Mishap Copilot
(5) Summary of interview - Mishap Pilot
(6) Memorandum - VAW-123 supplemental information
(7) IKE Deck Log of 18 Mar 16
(8) IKE SITREPs
(9) CVW-3 Maintenance Officer email - damage totals
(10) Photos - damage to C-2A and MH-60S
(11) Green sheet of 18 Mar 16
(12) Air Plan of 18 Mar 16
(13) Summary of interview - Navigator
(14) Operations Officer email - weather data
(15) Aircraft 602 Weight Records
(16) Summary of interview - CVW-3 LSO
(17) Summary of interview - Air Boss
(18) Summary of interview - Primary Gear Operator
(19) Post- and pre-operational AGE#4 checks
(20) Summary of interview - Pre-Op Maintenance Person
(21) Summary of interview - Engine Operator
(22) Arresting Gear Recovery Logs
(23) NAVAIR Preliminary Engineering Investigation
(24) Summary of interview - Arresting Gear Officer
(25) Summary of interview - Hook Runner
(26) Summary of interview - Deck Edge Operator

(27) Senior Medical Officer memorandum
(28) Senior Medical Officer mass casualty report
(29) AGE#4 damage cost estimate
(30) Mishap aircrew qualifications
(31) LSO qualifications
(32) Air Department designations
(33) Air Department Operator qualifications
(34) VAW-123 Aircraft Data Sheet
(35) Aircraft 602 Inspection and Acceptance Record
(36) AGE#4 ARC Configuration Log
(37) Recovery Equipment Status Log
(38) MAF 7771 - CDP
(39) MAF 7696 - Purchase Cable
(40) MAF 7784 - CROV Periodic Maintenance
(41) Summary of interview - ALRE Bos'n
(42) Summary of interview - Arresting Gear LPO
(43) WP 008 01 - ARC Fault Code 2148 Corrective Action
(44) Work Package 039 01 - CROV LVDT Alignment Procedure
(45) Summary of interview - ALRE Maintenance CPO
(46) Summary of interview - ALRE QA LPO
(47) Summary of interview - Maintenance CDI
(48) Summary of interview - Maintenance Person #1
(49) Summary of interview - Maintenance Person #2
(50) Summary of interview - Catapult Electrician #1
(51) Summary of interview - AG Group Supervisor
(52) MAF 7803 - MTS Replacement
(53) V-2 maintenance qualifications
(54) WP 008 01 - ARC Fault Code 2160 Corrective Action
(55) Summary of interview - Catapult Electrician #2
(56) Summary of interview - V2 Arresting Gear ALPO
(57) Mishap CROV LVDT Alignment Worksheet
(58) Post Mishap CROV NDI Results
(59) Post Mishap Engine Cross Head Weldment NDI

Subj: COMMAND INVESTIGATION INTO THE FLIGHT DECK MISHAP ON USS DWIGHT D. EISENHOWER (CVN 69) ON 18 MARCH 2016

PRELIMINARY STATEMENT

1. As directed, I investigated the facts and circumstances surrounding the cause of the 18 March 2016 flight deck mishap on USS DWIGHT D. EISENHOWER, the resulting injuries and damages, and the fault, neglect, or responsibility related to the mishap. All reasonably available evidence was collected or its location documented in this report.

2. In accordance with reference (a), I acted so as to protect the privileged nature of the Aviation Mishap Investigation that ran concurrently with the command investigation. I coordinated with (b)(6) USN, Senior Member of the Aviation Mishap Board, to ensure that my investigation did not interfere with the Aircraft Mishap Investigation.

3. The line of duty determinations for the eight Sailors injured in the mishap are being made by DWIGHT D. EISENHOWER and are not addressed in this report.

4. I was assisted by (b)(6) ALRE Boatswain, USS ABRAHAM LINCOLN (CVN 72), and (b)(6) USN, Carrier Strike Group FOUR. NAVAIR engineers also provided technical assessments vital to my opinions and recommendations.

EXECUTIVE SUMMARY

1. On 18 March 2016, DWIGHT D. EISENHOWER (CVN 69) was executing Carrier Qualifications on day two of its Composite Training Unit Exercise in the Virginia Capes operating area.

2. At 1352L an E-2C assigned to VAW-123 attempted an arrested landing on board DWIGHT D. EISENHOWER. The E-2C successfully engaged the number four wire with a clear deck and a satisfactory arresting gear and lens crosscheck, but the number

four arresting gear engine (AGE) failed to effectively decelerate the mishap aircraft as it traveled through the landing area toward the end of the angled deck. The cross deck pendant parted, and the mishap aircraft's forward motion carried it over the end of the angled deck. The mishap aircrew recovered the aircraft and landed safely at NAS Norfolk. The recoil of the parted number four arresting wire cross deck pendant injured eight active duty Navy personnel on the flight deck and damaged two CARRIER AIR WING THREE aircraft. All injured personnel are expected to recover. Prognosis for return to full duty for four of eight injured Sailors is unknown.

3. The root cause of this mishap was a lack of procedural compliance by three DWIGHT D. EISENHOWER V-2 Division personnel while troubleshooting arresting gear engine number four following a system-reported fault code on the prior arrestment. While executing an approved NAVAIR procedure to clear the fault code and restore the arresting gear engine, a procedure that contained no WARNING notations, CAUTION notations, or QA monitored procedural steps, and with adequate supervision, the properly designated and qualified maintenance personnel missed at least one and possibly two critical steps. The missed step(s) resulted in inadvertently mis-programming the Constant Runout Valve (CROV), which controls arresting gear engine pressure and energy absorption during an arrestment. As a result, the CROV stem height was set to a pre-arrestment position almost double the nominal value. On arrestment, the CROV failed to seat rapidly enough, and the arresting gear engine exceeded its nominal stroke length. The engine two blocked, and transferred the arrestment load to the cross deck pendant, exceeding its breaking strength at or near the aircraft's tailhook engagement point.

4. While a failure to comply with a technically correct written procedure is clearly the root cause of this mishap, the Sailors involved reasonably believed they had properly and conscientiously completed the complicated procedure. Their human error is understandable in view of a procedure that (1) did not explicitly state the technical basis for its steps, (2) lacked technically-directed supervisory controls, and (3) failed to warn users of the critical nature of the CROV alignment. In

evaluating the mishap chain of events, I find no evidence of willful dereliction of duty or culpable negligence on the part of any Sailors involved.

FINDINGS OF FACT

THE MISHAP EVENT

1. The mishap occurred at 1352:58L, Friday, 18 March 2016, when an E-2C, AC 602, BUNO 165293, assigned to VAW-123, attempted an arrested landing on board DWIGHT D. EISENHOWER. [Encl (2)]

2. After AC 602 successfully engaged the number four wire, the number four arresting gear engine (AGE) failed to effectively decelerate the mishap aircraft as it traveled through the landing area towards the end of the angled deck. The cross deck pendant parted, and the aircraft's forward motion carried it over the end of the angled deck. The mishap aircrew recovered the aircraft and landed safely at NAS Norfolk. [Encls (3)-(6)]

3. The recoil of the parted number four arresting wire cross deck pendant injured eight active duty Navy personnel on the flight deck and damaged two CARRIER AIR WING THREE aircraft. [Encls (2), (6)-(10)]

4. The event during which the mishap occurred was properly authorized and scheduled in accordance with the DWIGHT D. EISENHOWER Green Sheet (by (b)(6) USN, Strike Operations Officer), the DWIGHT D. EISENHOWER Air Plan (by (b)(6) USN, Commanding Officer), and the VAW-123 Flight Schedule (by (b)(6) USN, Commanding Officer). [Encls (6), (11), (12)]

5. At 1305L, the Commanding Officer, USS DWIGHT D. EISENHOWER, left the bridge. (b)(6) ship's Navigator, assumed duty as Command Duty Officer (Underway). [Encls (7), (13)]

6. DWIGHT D. EISENHOWER was located at North 36.4 degrees latitude, West 74.1 degrees longitude in the Virginia Capes operating area at the time of the mishap. [Encls (7), (8)]

7. The weather conditions at 1355L were: winds from 000 degrees at 10 knots, visibility 10 statute miles, sky condition FEW 030 / SCT 050 / SCT 220, air temperature 64 degrees Fahrenheit, sea surface temperature 53 degrees Fahrenheit, relative humidity 54 percent, altimeter setting 29.94 inches. [Encl (14)]

8. At the time of the mishap, DWIGHT D. EISENHOWER was on a north by northeasterly course at a speed of 15 knots. [Encl (7)]

9. The mishap flight crew briefed at Chambers Field, Naval Air Station Norfolk, as dash three of a three plane formation flight for transit to DWIGHT D. EISENHOWER, before briefing NATOPS and safety of flight requirements as an individual crew. [Encls (3)-(6)]

10. Walk, aircraft preflight, and aircraft start were normal. [Encls (3)-(6)]

11. The three E-2C aircraft launched at 1145L, and executed an uneventful transit to the operating area. At launch, (b)(6) (b)(6) USN, 1310, VAW-123, was in the left (pilot at the controls) seat. LT Matthew Halliwell, USN, 1310, VAW-123, was in the right (copilot) seat, and (b)(6) USN, 1320, was in back (CICO; mission commander). [Encls (3)-(6)]

12. After being directed by DWIGHT D. EISENHOWER tower to "Charlie", (b)(6) entered the day pattern and commenced carrier qualifications. Following a foul deck wave off, he flew a hook skip bolter (counted as a trap by the Landing Signal Officers), two touch and go landings, and a successful arrestment, completing his CQ requirements. [Encls (3)-(6)]

13. After (b)(6) last trap, aircraft 602 taxied to catapult number one. Following an uneventful launch, the aircraft departed the pattern to complete a pre-briefed side-by-side crew swap between (b)(6) and (b)(6) [Encls (3)-(6)]

14. The Mishap Pilot (MP), (b)(6) now in the left seat as the pilot at the controls, returned to the pattern and

completed one arrested landing. After launching from catapult number one, LT Halliwell executed two touch-and-go landings, then lowered the tailhook in preparation for completing his final trap. [Encls (3)-(6)]

15. On the mishap approach, the mishap flight crew "called the ball" with 3,300 pounds of fuel, corresponding to a landing weight of 45,200 pounds. [Encls (3)-(6), (15)]

16. The mishap aircraft rolled into the groove slightly above glideslope and on centerline. The MP flew an uneventful gear down, hook down, 20 degree flap, maximum rudder, on-speed approach. The aircraft went slightly low and slightly flat at the ramp, and the MP added power and engaged the number four arresting gear wire slightly left of centerline. [Encls (2), (3)-(6), (16)]

17. All four arresting gear engines (AGEs) were set for 47,000 pounds, and the Improved Fresnel Lens Optical Landing System (IFLOLS) was set for an E-2C. [Encls (16)-(18)]

18. The arresting gear cross check system, which allows arresting gear engine weight settings to be inputted in primary flight control and provides verification that all engines are in battery and IFLOLS is set, indicated that the arresting gear engines and IFLOLS were properly set for AC 602. [Encls (17)-(18)]

19. The required post-operational and pre-operational checks on arresting gear engine number four were completed and properly documented at 0200 and 0800, 18 March 2016, respectively. (b)(6) (b)(6) who completed the pre-operational check, reported no noted discrepancies or anomalies. [Encls (19)-(20)]

20. The arresting gear engine number four Engine Operator, (b)(6) confirmed that the arresting gear engine was set correctly at 47,000 pounds and in battery. [Encls (21)-(22)]

21. Arresting gear engine number four has the Advanced Recovery Control (ARC) system installed. [Encl (23)]

22. The mishap arrestment was the second arrestment of the CQ period on the number four arresting wire (four wire). [Encl (22)]

23. During the mishap aircraft's final approach, the flight deck was in a "Clear Deck" status. [Encls (2), (17), (24)]

24. On landing, the MP maintained power and initially sensed normal deceleration. Subsequently, all three mishap aircrew heard a loud bang, heard the tailhook re-contact the flight deck, and felt a shudder. Both pilots realized that "something" had happened and observed that they were continuing to roll towards the end of the landing area. [Encls (3)-(5)]

25. As the mishap aircraft engaged the four wire, the arresting gear engine failed to build sufficient pressure to effectively stop the mishap aircraft prior to the nominal service stroke of the arresting gear engine (183.9 inches). This failure resulted in a transfer of load to the number four wire, exceeding the breaking strength of the number four cross deck pendant (CDP). [Encl (23)]

26. The number four CDP parted at, or slightly to starboard, of the tailhook engagement point. [Encls (25)-(26)]

27. On the flight deck, the two sections of the parted number four CDP and purchase cable recoiled sharply and backlashed, injuring eight Sailors and damaging a C-2A and MH-60S. [Encls (2), (9), (27)-(28)]

28. Simultaneously, as the mishap aircraft rolled off the end of the flight deck, the mishap aircrew raised the landing gear, selected full (30 degree) flaps, opened and locked the copilot ditching hatch, and recovered the aircraft at an estimated 10-20 feet AGL. The aircrew noted no degradation in flying qualities and executed an uneventful straight-in recovery at Chambers Field, Naval Air Station Norfolk. [Encls (2)-(6)]

29. At 1354L, the Assistant Air Officer, (b)(6) USN, called away Mass Casualty on the flight deck via 5MC. This

was followed with a Medical Emergency call via 1MC, and immediately corrected to Mass Casualty on the same circuit. [Encls (7), (17), (27)]

30. At 1355L, the CO returned to the bridge, and DWIGHT D. EISENHOWER slowed to five knots. [Encl (7)]

31. Immediately following the mishap, the Air Officer directed all overhead aircraft to "max conserve." Following a roll call and fuel check, he directed all aircraft to divert to shore bases. [Encl (17)]

32. Mass Casualty procedures were fully activated by 1400L. Hangar Bay 2 was established as the initial collection and triage point. Non-ambulatory patients were transported by litter from the flight deck to Hangar Bay 2 by Weapons and Medical Department personnel via Upper Stage 4 weapons elevator. [Encls (7), (27)]

33. All eight injured Sailors were evaluated, treated, and stabilized by DWIGHT D. EISENHOWER Medical Department personnel. [Encl (27)]

34. Six Sailors were prepared for MEDEVAC flights coordinated by Combat Direction Center personnel. [Encl (27)]

35. At 1552L, aircraft 615 (HSC-7 MH-60S) launched to MEDEVAC two injured Sailors to Sentara Norfolk General Hospital, Norfolk, Virginia. [Encl (7)]

36. At 1553L, aircraft 621 (HSC-7 MH-60S) launched to MEDEVAC two injured Sailors to Sentara Norfolk General Hospital, Norfolk, Virginia. [Encl (7)]

37. At 1607L, Mass Casualty was secured on board by DC Central. [Encl (7)]

38. At 1608L, aircraft 616 (HSC-7 MH-60S) launched to MEDEVAC two injured Sailors to Naval Medical Center Portsmouth, Portsmouth, Virginia. [Encl (7)]

39. All six transported Sailors arrived at definitive medical care sites in less than three hours from the time of the mishap. [Encl (27)]

40. The two remaining injured Sailors were evaluated and admitted to the DWIGHT D. EISENHOWER inpatient ward for observation and treatment. [Encl (28)]

41. At 1632L, a man overboard for mustering purposes was executed on board. [Encl (7)]

42. At 1644L, DWIGHT D. EISENHOWER secured from man overboard after all personnel were accounted for. [Encl (7)]

PERSONNEL INJURIES AND EQUIPMENT DAMAGE

The following is a description of the injuries sustained by embarked active duty U.S. Navy personnel in the mishap, updated as of 27 March 2016:

43. (b)(6) USN, VAW-123 (SVM1): suffered a right wrist distal radius fracture; minor head laceration; possible Traumatic Brain Injury leading to event amnesia. SVM1 was treated initially on board DWIGHT D. EISENHOWER, and transported to Naval Medical Center Portsmouth via routine medical evacuation on 20 March 2016. SVM1 was treated and released. [Encl (28)]

44. (b)(6) USN, VAW-123 (SVM2): suffered a sprained right ankle. SVM2 was treated on board DWIGHT D. EISENHOWER. SVM2 was discharged from ship's medical to light duty 19 March 2016. [Encl (28)]

45. (b)(6) VAW-123 (SVM3): suffered a right bimalleolar ankle fracture. SVM3 was medically evacuated on 18 March 2016 to Naval Medical Center Portsmouth. SVM3 was discharged from NMCP 19 March 2016 to Wounded Warrior Wing, NMCP, for 30 days convalescent leave. [Encl (28)]

46. (b) (6) VAW-123 (SVM4): suffered a basilar skull fracture; multiple non-operable facial fractures; pulmonary contusion; pelvic fracture; bilateral ACL tear; left fibia fracture; left MCL tear; right iliotibial band tear; perineal puncture; scrotal hematoma. SVM4 was medically evacuated to Naval Medical Center Portsmouth 18 March 2016 and admitted. [Encl (28)]

47. (b) (6) VAW-123 (SVM5): suffered bilateral tibia/fibia fracture; pulmonary contusion. SVM5 was medically evacuated to Sentara Norfolk General Hospital 18 March 2016. SVM5 was discharged from Sentara Norfolk General Hospital 21 March 2016. [Encl (28)]

48. (b) (6) VAW-123 (SVM6): suffered left tibia / fibia dislocation; proximal fibia fracture; left popliteal artery occlusion. SVM6 was medically evacuated to Sentara Norfolk General Hospital on 18 March 2016 and admitted. [Encl (28)]

49. (b) (6) DWIGHT D. EISENHOWER (SVM7): suffered nasal fracture; soft tissue injuries to lower left leg. SVM7 was medically evacuated to Sentara Norfolk General Hospital 18 March 2016. SVM7 was discharged from Sentara Norfolk General Hospital on 19 March 2016. [Encl (28)]

50. (b) (6) DWIGHT D. EISENHOWER (SVM8): suffered right humerus fracture; left tibia/fibia fracture. SVM8 was medically evacuated to Sentara Norfolk General Hospital 18 March 2016. SVM8 was discharged from Sentara Norfolk General Hospital on 21 March 2016. [Encl (28)]

51. The line of duty determinations for the aforementioned eight Sailors are being conducted by DWIGHT D. EISENHOWER. [Encl (28)]

52. The following is a summary of equipment damage resulting from the mishap, by command.

53. VRC-40: one C-2A, BUNO 162125: damage to aircraft structure at multiple locations; damage to LF ADF antenna. Repair / replacement cost estimated at $71,465.19. [Encls (9)-(10)]

54. HSC-7: one MH-60S, BUNO 167886; damage to tail strut; damage to electro-mechanical actuator; damage to actuator harness cable assembly. Repair / replacement cost estimated at $11,494.46. [Encls (9)-(10)]

55. DWIGHT D. EISENHOWER: Damage to arresting gear engine number four components, including CROV actuator assembly; CROV air piping assembly; purchase cable wire rope and cable and wheel assembly; engine anchor packing assembly, o-ring and piston rod spacer; RAM block assembly, packing assembly, follower, piston ring, spacer ring; retract hydraulic actuator. Repair / replacement cost estimated at $127,135.33. [Encl (29)]

56. Total damage repair / replacement cost: $210,094.98. [Encls (9), (29)]

MISHAP AIRCREW QUALIFICATIONS AND EXPERIENCE

57. The MP, (b)(6) USN, was permanently assigned to VAW-123 for duty in a flying status involving flying at the time of the mishap. He reported to VAW-123 on 29 May 2013. [Encl (30)]

58. The MP was physically qualified and aeronautically adapted for flight duty at the time of the mishap. [Encl (30)]

59. The MP had 1,008 total flight hours, of which 780 were in the E-2C, at the time of the mishap. [Encl (6)]

60. The MP was currently qualified in aviation physiology, water survival, emergency egress training and aircrew coordination training at the time of the mishap. [Encl (30)]

61. The MP was fully NATOPS and Instrument qualified as an E-2C pilot at the time of the mishap. [Encl (30)]

62. The MP was ACTC Level 3 qualified at the time of the mishap. [Encls (6), (30)]

63. The MP flew 21.7 hours in the thirty days prior to the mishap flight. [Encl (6)]

64. The Mishap Co-pilot (MCP), (b)(6) USN, was permanently assigned to VAW-123 for duty in a flying status involving flying at the time of the mishap. He reported to VAW-123 on 30 July 2015. [Encl (30)]

65. The MCP was physically qualified and aeronautically adapted for flight duty at the time of the mishap. [Encl (30)]

66. The MCP had 2,035 total flight hours, of which 1,442 were in the E-2C, at the time of the mishap. [Encl (6)]

67. The MCP was currently qualified in aviation physiology, water survival, emergency egress training and aircrew coordination training at the time of the mishap. [Encl (30)]

68. The MCP was fully NATOPS and Instrument qualified as an E-2C pilot at the time of the mishap. [Encl (30)]

69. The MCP was ACTC Level 4 qualified at the time of the mishap. [Encls (6), (30)]

70. The MCP flew 26.1 hours in the thirty days prior to the mishap flight. [Encl (6)]

71. The Mishap Mission Commander (MMC), (b)(6) USN, was permanently assigned to VAW-123 for duty in a flying status involving flying at the time of the mishap. He reported to VAW-123 on 01 August 2015. [Encl (30)]

72. The MMC was physically qualified and aeronautically adapted for flight duty at the time of the mishap. [Encl (30)]

73. The MMC had 1,547 total flight hours, of which 1,462 were in the E-2C, at the time of the mishap. [Encl (6)]

74. The MMC was currently qualified in aviation physiology, water survival, emergency egress training and aircrew coordination training at the time of the mishap. [Encl (30)]

75. The MMC was fully NATOPS and Instrument qualified as an E-2C Naval Flight Officer at the time of the mishap. [Encl (30)]

76. The MMC was ACTC Level 4 qualified at the time of the mishap. [Encls (6), (30)]

77. The MMC flew 12.4 hours in the thirty days prior to the mishap flight. [Encl (6)]

LANDING SIGNAL OFFICER (LSO) QUALIFICATIONS

78. The CARRIER AIR WING THREE Landing Signal Officer, (b)(6) was on the LSO platform at the time of the mishap. He was properly qualified and designated as a staff LSO. [Encl (31)]

79. The controlling LSO at the time of the mishap, (b)(6) USN, VAW-123, was properly qualified and designated to act as the controlling LSO. [Encls (16), (31)]

80. The backup LSO at the time of the mishap, (b)(6) USN, VFA-131, was properly qualified and designated to act as the backup LSO. [Encls (16), (31)]

81. There were additional personnel on the LSO platform at the time of the mishap, but these personnel were not involved in the recovery of the mishap aircraft. [Encls (16), (31)]

DWIGHT D. EISENHOWER PERSONNEL QUALIFICATIONS

82. The Air Officer (Air Boss) at the time of the mishap was (b)(6) USN. He was qualified and designated in writing by Commanding Officer, DWIGHT D. EISENHOWER to serve in this position. [Encl (32)]

83. The Assistant Air Officer (Mini-Boss) at the time of the mishap was (b)(6) USN. He was qualified and

designated in writing by Commanding Officer, USS DWIGHT D. EISENHOWER to serve in this position. [Encl (32)]

84. The V-2 Division Officer at the time of the mishap was (b) (6) (b) (6) He was qualified CVN Assistant Air Officer and fully capable of performing division officer duties. [Encl (32)]

85. The V-2 Aircraft Launch and Recovery Equipment Maintenance Officer was (b) (6) USN. He was qualified and designated in writing by Commanding Officer, USS DWIGHT D. EISENHOWER to serve in this position. [Encl (32)]

86. The V-2 Leading Chief Petty Officer at the time of the mishap was (b) (6) USN. He was qualified and designated in writing to serve in this position. [Encl (32)]

87. The V-2 Aircraft Launch and Recovery Equipment Maintenance Control Supervisor was (b) (6) USN. He was qualified and designated in writing by Commanding Officer, USS DWIGHT D. EISENHOWER to serve in this position. [Encl (32)]

88. The V-2 Arresting Gear Leading Chief Petty Officer at the time of the mishap was (b) (6) USN. He was designated in writing to serve in this position. [Encl (32)]

89. The V-2 Arresting Gear Leading Petty Officer at the time of the mishap was (b) (6) USN. He was qualified and designated in writing to serve in this position. [Encl (32)]

90. The Arresting Gear Engine Number Four (VB08) Work Center Supervisor at the time of the mishap was ABE2 Steven Martin. He was qualified and designated in writing to serve in this position. [Encl (32)]

91. The Arresting Gear Officer at the time of the mishap was (b) (6) (b) (6) USN. He was PQS qualified for this position. [Encl (33)]

92. The Engine Operator for arresting gear engine number four was (b)(6) USN. He was PQS qualified for this position. [Encl (33)]

93. The Primary Flight Controller at the time of the mishap was (b)(6) USN. He was also assigned as the VB08 Work Center Supervisor. He was PQS qualified for this position. [Encl (33)]

94. The Deck Edge Operator at the time of the mishap was (b)(6) (b)(6) USN. He was PQS qualified for this position. [Encl (33)]

95. The Topside Petty Officer at the time of the mishap was (b)(6) USN. He was PQS qualified for this position. [Encl (33)]

96. The Hook Runner at the time of the mishap was (b)(6) (b)(6) USN. He was PQS qualified for this position. [Encl (33)]

MISHAP AIRCRAFT

97. VAW-123 accepted aircraft AC 602, Bureau Number 165293, an E-2C, on 03 August 2015. Prior to the mishap, the aircraft had flown 8,786.1 flight hours. The mishap flight was 3.0 hours in duration. [Encl (34)]

98. The last phase inspection completed was a 400-hour phase inspection, completed on 17 September 2015. [Encl (34)]

99. The mishap aircraft had logged a total of 2,115 catapult launches and 2,119 arrested landings at the time of the mishap. [Encl (34)]

100. Both Chart C and Form F - Tactical sheets confirmed aircraft basic weight as 41,312.2 pounds. Form F - Tactical sheet confirmed operating weight with three aircrew on board at 41,912.2 pounds. [Encl (15)]

101. The mishap aircraft had a total of sixteen "up" discrepancies. None were related to flight control or tailhook systems. [Encl (6)]

102. (b)(6) signed the Aircraft Inspection and Acceptance record as the Plane Captain. (b)(6) signed the record releasing the aircraft safe for flight, and (b)(6) accepted the aircraft for flight. Fuel quantity was annotated as "11.9", indicating 11,900 pounds of JP-5, and oxygen quantity is listed as "10", indicating a sufficient quantity of oxygen on board. [Encl (35)]

ARRESTING GEAR OPERATION

103. The Mark 7-MOD 3 arresting gear system installed on DWIGHT D. EISENHOWER consists of four arresting gear engines configured with a cross deck pendant (CDP) for conventional fixed wing shipboard recovery, and one barricade engine for emergency landings. [Ref (b)]

104. DWIGHT D. EISENHOWER operates with the Advanced Recovery Control System (ARC). ARC was installed on board in 2011. [Encl (23)]

105. The ARC system is a software-driven hydraulic control system for the arresting gear engine. It incorporates both a Primary mode and a back-up Fail-Safe mode of operation. [Ref (b)]

106. Prior to a normal arrestment, the Air Officer in Primary Flight Control (Pri-Fly) will determine the aircraft type and landing weight on approach and confirm proper settings for that aircraft with the Arresting Gear Primary Operator. [Ref (b)]

107. The Primary Operator will then enter the data in the Arresting Gear Cross Check System (AGCCS) Pri-Fly panel. This weight setting is transmitted through the ARC Distribution Hub to each Arresting Gear engine controller, and the Constant Runout Valve (CROV) stem height is set in each engine in preparation for arrestment. An acknowledgement signal is sent back to the AGCCS when each engine is set, and the Arrestment

Ready Status Window "READY" light illuminates. With all on line engines properly set and checked, "BATTERY" is declared. [Ref (b)]

108. CROV initial setting, provides, and equates to, the amount of energy absorption required and available to slow and stop an arresting aircraft. Low weight settings equate to a relatively large CROV initial valve opening, and the initial valve opening becomes smaller as landing weight settings for heavier aircraft increase. [Ref (b)]

109. During a normal arrestment sequence, the tailhook of an incoming aircraft engages a CDP that is held slightly off the flight deck by wire rope supports. The force generated by the aircraft's forward motion is transferred from the aircraft to the purchase cable system installed in the arresting gear engine. [Ref (b)]

110. There are two purchase cables installed. One purchase cable attaches to one end of the CDP and reaves around a retractable sheave and three additional sheaves to the arresting gear engine room. It is then reaved around the 28-inch fixed and crosshead sheaves. The purchase cable then leads off the inner fixed sheave and attaches to the anchor damper. [Ref (b)]

111. The second length of purchase cable attaches to the other end of the CDP, and reaves in a similar manner to the opposite end of the arresting gear engine room, where it is reaved around the 33-inch fixed and crosshead sheaves and attached to its own anchor damper. [Ref (b)]

112. As the aircraft tailhook engages, both attached purchase cables are pulled out from the arresting gear engine. The initial stress on the purchase cables is sudden and violent. [Ref (b)]

113. The use of two purchase cables allows unequal cable payout during an off-center CDP engagement, if the aircraft does not engage on centerline. [Ref (b)]

114. As the purchase cables are pulled out through the sheaves on the flight deck, the arresting gear engine crosshead and RAM are pulled towards the Main Engine Cylinder (MEC). RAM penetration into the engine cylinder forces engine fluid out through the CROV and into the accumulator. Fluid pressure in the MEC increases rapidly to the pressure required to absorb the energy of the arrestment. [Ref (b)]

115. The ARC system detects that an arrestment has occurred when the MEC RAM Displacement Encoder indicates a change in position and a rate of change of the RAM, when the MEC RAM sensors indicate motion has occurred and when engine pressure increases above 400 psi. As the crosshead and RAM move toward the MEC, primary actuators close the CROV via a programmed arrestment control algorithm, or profile, allowing the CROV stem to seat, controlling fluid flow and thus the run-out of the purchase cables. [Ref (b)]

116. When the arrestment is complete, the CDP is retracted via the Deck Edge operator retract valve, arrestment data is logged, and the system is readied for the next arrestment. [Ref (b)]

117. The ARC system logs and records the date and time of each arrestment, changes to configuration parameters (CROV Aligned Zero Position and CROV Align Factor), and registered fault codes. [Ref (b); Encl (36)]

ARRESTING GEAR MAINTENANCE AND MATERIAL CONDITION

118. Prior to commencement of flight operations at 1254L on 18 March 2016, there had been 67,470 arrested landings on arresting gear engine number four. [Encl (19)]

119. The mishap occurred on the second arrestment on the four wire of the Carrier Qualification (CQ) period. The first arrestment was executed by an E-2C. MEC travel (runout) was logged at 183 inches. [Encl (22)]

120. During the previous fly day, extending from 17 March into the early morning hours of 18 March, there were 16 arrestments

on the four wire. All had logged runouts of either 182 inches or 183 inches. [Encl (22)]

121. A CDP is limited to 125 arrestments, or "hits". At the beginning of flight operations on the afternoon of 18 March 2016, the CDP had 16 hits, with 109 hits remaining. At the time of the mishap, 108 hits remained. [Encls (22), (37)]

122. The CDP had been replaced 16 March 2016 per MRC R-15 (MIP 5861/022) and properly documented and signed off by departmental maintenance personnel. [Encl (38)]

123. A purchase cable is limited to 2,000 hits. Prior to the start of flight operations on 18 March 2016, the purchase cable had received 890 hits. [Encl (37)]

124. The purchase cable was installed (re-reaved) on 19 November 2015. This maintenance action was properly documented and signed off by departmental maintenance personnel. [Encl (39)]

125. CROV periodic maintenance was completed per MRC 18M-1R on 07 March 2016. This check included a nondestructive inspection (NDI) of the valve seat. No discrepancies were noted, and the maintenance action was properly documented and signed off by departmental maintenance personnel. [Encl (40)]

126. VB08 Recovery status boards for 17 March 2016 and 18 March 2016 indicate all required maintenance complete and all components within required periodicity. Each is signed by required personnel. [Encl (37)]

ARRESTING GEAR FAULT DETECTION AND TROUBLESHOOTING

127. NAVAIR Technical Manual 51-5BBA-2.1 "provides operating procedures along with Organizational and Intermediate (O&I) maintenance instructions for aircraft recovery equipment", and serves as the technical reference for arresting gear corrective maintenance, fault detection and troubleshooting. [Ref (b)]

128. The manual is divided into Work Packages (WPs), which are self-contained procedures that support specific tasks. The WPs describe equipment, operating procedures, malfunctions, post-maintenance test procedures, and specific maintenance work tasks. [Refs (b)-(c)]

129. WPs are identified by five digit numbers in the upper right hand corner of each page of the respective WP. [Refs (b)-(c)]

130. At the time of the mishap, NAVAIR 51-5BBA-2.1 / 2.2 contained 41 WPs. [Refs (b)-(c)]

131. WP 002 00 (Organizational and Intermediate Maintenance Introduction for Operation and Maintenance Instructions for Shipboard Aircraft Recovery Systems) provides an overview of the WP system. [Ref (b)]

132. WP 002 00 states that, "All procedures that pose a danger to personnel are preceded by a WARNING which provides specific guidance to ensure personnel safety." [Ref (b)]

133. WP 002 00 states that, "All procedures that cause equipment damage if improperly performed are preceded by a CAUTION which provides pertinent data concerning particular procedures or items that require special attention." [Ref (b)]

134. WP 002 00 states that, "A NOTE is used to highlight procedural steps to promote efficiency, prevent difficulty in performing the step or to provide specific guidance concerning clearances, torque requirements, etc." [Ref (b)]

135. WP 002 00 states that, "Key steps in maintenance and inspection procedures are listed with a "(QA)" immediately preceding the step. The "(QA)" notation indicates that the step describes a procedure that requires a QA inspection". [Ref (b)]

136. WP 005 00 (General Maintenance Instructions and Procedures for Aircraft Recovery Equipment) provides instructions and procedures governing general maintenance requirements that are

applicable to maintenance actions required for recovery equipment at the O&I level. [Ref (b)]

137. WP 005 00 states that, "Throughout this manual, important maintenance steps are preceded with a (QA) notation. This notation is a signal to repair personnel that the step about to be undertaken is critical to the repair action and that observation or concurrence from quality assurance personnel is required before the next maintenance step is performed." [Ref (b)]

138. WP 005 00 defines the use of WARNING notation as follows; "This notation heads an inset paragraph alerting all personnel that the next procedural step involves a maintenance action that, if not properly accomplished, could result in injury, death or a long term health hazard." [Ref (b)]

139. WP 005 00 defines the use of CAUTION notation as follows; "This notation alerts all personnel that the next procedural step could result in damage or destruction of equipment if not properly performed." [Ref (b)]

140. WP 005 00 defines the use of NOTE notation as follows; "This notation alerts all personnel that the next procedural step requires special emphasis and care should be taken during accomplishment." [Ref (b)]

141. WP 008 01 (Organizational and Intermediate Maintenance Troubleshooting and Fault Detection (ARC)) states that "Troubleshooting is performed to discover and eliminate the cause of a mechanical, hydraulic or electrical malfunction. Most malfunctions, if and when they occur, will be readily apparent and easily resolved by the use of equipment familiarity and pure logic. The troubleshooting in this Work Package (WP) are a means of applying troubleshooting procedures for malfunctions that may not be easily resolved." [Ref (b)]

142. The ARC system provides continuous interface checking and component fault location. [Ref (b)]

143. Fault information is displayed on the System Operating Graphical User Interface (GUI) and the Engine Operation GUI. [Ref (b)]

144. The GUI is the primary ARC user interface for V-2 personnel. [Ref (b)]

145. Faults are displayed by ERROR [unique numeric code], SOURCE [provides source identification of the error], SEVERITY [critical or serious], STATUS [new or previously acknowledged], TIME [time the fault was reported], and a description of the fault. [Ref (b)]

146. Critical faults are defined as "**Taking an arrestment may cause death or major equipment damage.**" (bold in original) [Ref (b)]

147. Serious faults are defined as "**Taking an arrestment may cause equipment damage.**" (bold in original) [Ref (b)]

148. Following the conclusion of WP 008 00 step 7.f.(3), describing fault code components, is the following NOTE, "After receipt of **any** fault code, perform a CLEAR, RESET, and select aircraft to be recovered. If fault does not return, continue normal operations. If fault returns, troubleshoot per the table below." (emphasis added) [Ref (b)]

149. The next step, WP 008 00 step 7.g. states that "The following seven critical faults require removal of the engine from service for troubleshooting and are not authorized to be cleared without isolating and reporting the fault source":

Fault Code	Description
2127	CROV maximum stem error exceeded
2139	MEC Ram encoder belt failure
2148	CROV zero alignment error - Rezero CROV
2155	No MEC ram started
2157	Missing configuration parameters
2158	Maximum MEC pressure exceeded
2159	Maximum CROV delta exceeded (WP8)

150. These seven faults are commonly known as "strippable" faults, requiring the CDP to be removed and the arresting gear engine to be taken off line to troubleshoot. [Ref (b); Encls (41)-(42)]

151. WP 008 00 step 7.h. requires removal of the engine from service for an "unexplainable" fault. [Ref (b)]

152. WP 008 00 steps 7.j. and 7.k. direct the operator to evaluate a fault, and determine if it is one of ***eight*** strippable faults or an unexplainable fault. If not, the operator is directed to clear the fault. If the fault clears, no further action is required. (emphasis added) [Ref (b)]

153. WP 008 00 directs that if the fault does not clear after a clearance attempt, further troubleshooting action is required. [Ref (b)]

154. Troubleshooting steps for each fault code are provided in WP 008 00 tables. [Ref (b)]

155. Step three of WP 008 00 troubleshooting for fault code 2148 directs execution of WP 039 01, Align LVDT. [Ref (b); Encl (43)]

WP 039 01

156. WP 039 01 (Advanced Recovery Control (ARC) System Electrical Components) provides removal, disassembly, inspection, repair, replacement and adjustment procedures for the electrical components of the Aircraft Recovery Control (ARC) system. [Ref (c)]

157. The CROV LVDT Alignment Procedure begins at step 75 of WP 039 01. [Ref (c); Encl (44)]

158. The CROV LVDT Alignment Procedure requires at least 125 discrete operator inputs during execution, the recording of 25 individual data points, and the performance of 22 individual mathematical calculations. [Ref (c); Encl (44)]

159. V-2 Division has an Excel spreadsheet loaded on divisional computers which will perform procedural calculations. Operators can perform calculations either manually or by using the spreadsheet. [Ref (c); Encl (41), (42)]

160. WP 039 01 requires subtraction and division of derived values to four decimal places. [Ref (c); Encl (44)]

161. The CROV LVDT Alignment Procedure contains seven NOTES governing procedure execution. [Ref (c); Encl (44)]

162. The CROV LVDT Alignment Procedure contains zero CAUTION or WARNING notations. [Ref (c); Encl (44)]

163. The CROV LVDT Alignment Procedure directs zero steps to be executed with Quality Assurance inspection. [Ref (c); Encl (44)]

164. The CROV LVDT Alignment Procedure sets parameters for CROV operation during an arrestment. [Ref (c); Encl (44)]

165. The first parameter is CROV ALIGNED ZERO position. This portion of the procedure fully closes the CROV via the LVDT, and generates the equivalent MTS sensor position equating to full closure. The operator enters this parameter via the GUI. [Ref (c); Encl (44)]

166. MTS is a trade name designation for a magnetostrictive linear sensor. The MTS sensor provides a data reference for CROV stem height, and provides system input to record stem height, but is not used in arrestment control. [Encl (23)]

167. LVDT is an abbreviation for Linear Variable Differential Transformer. The LVDT is used in the primary closed loop arrestment control algorithm, and controls CROV operation by applying a voltage that controls CROV stem height. [Encl (23)]

168. The second parameter is the CROV ALIGN FACTOR, which defines the profile at which the CROV stem will close during an arrestment. The procedure requires the operator to measure and adjust voltages at full open and full closed CROV positions (1.8

inches and 0.0 inches respectively), then iteratively solve for the correct rate of closure by recording and calculating MTS-derived stem height at intermediate positions. [Ref (c); Encl (44)]

169. During this portion of the procedure, three different rates are entered via the GUI. The first is a CROV Align Factor of 0.500, which is required to force full CROV opening. The second is 0.900, to facilitate measurements and calculation of the third rate, the final programmed CROV Align Factor used in arrestment control. [Ref (c); Encl (44)]

170. Each time the CROV Align Factor is changed, the LVDT voltages which equate to actual CROV stem position are changed internal to ARC. There is no operator indication of these specific values. [Ref (c); Encl (44)]

171. To alleviate the potential errors induced from voltage changes, the procedure directs maintenance personnel to re-zero the CROV following each CROV Align Factor adjustment. This resets the CROV to the correct voltage, equating to an accurate stem height. [Ref (c); Encl (44)]

172. The CROV is required to be zeroed five times in the procedure. Explicit procedural steps are provided in three cases. In the final two, after the second and third CROV Align Factor adjustments (step 75.f.(6) and step 75.g.(4).(f)), WP 039 01 references maintenance personnel back to a previous portion of the procedure (step 75.d.(1) through d.(3)). [Ref (c); Encl (44)]

173. The third parameter, LVDT voltage with CROV at zero, is not derived or entered by the operator. It is derived and set each time the CROV is reset to the zero position. This voltage is the basis for CROV position as the arresting gear is set prior to an arrested landing. [Ref (c); Encl (44)]

174. The ARC system has no automated software check to determine if the CROV has been zeroed, and thus no faults are generated from this condition. [Ref (c); Encl (44)]

ARRESTING GEAR ENGINE NUMBER FOUR FAULT ISOLATION AND TROUBLESHOOTING

The following chronology is derived in part from ARC logs provided and interpreted by on site NAVAIR Lakehurst representatives. These results are preliminary pending final Engineering Analysis results.

175. On 18 March at 0037L, AC 302 successfully arrested via the four wire. This event is logged as Recovery Number 287471 on DWIGHT D. EISENHOWER recovery logs, and as Hit 67469 on ARC logs. CROV Aligned Zero Position is -0.207, and CROV Align Factor is 0.954. This is the last anomaly-free arrestment prior to the mishap event. [Encls (22), (36)]

176. On 18 March at 0045L, AC 504 successfully arrested via the four wire. This event is logged as Recovery Number 287472 on DWIGHT D. EISENHOWER recovery logs, and as Hit 67470 on ARC logs. CROV Aligned Zero Position is -0.207, and CROV Align Factor is 0.954. At 0045:08, fault code 2148 (CROV Zero Alignment Error) registered. [Encls (22), (36)]

177. Fault code 2148 is a critical, strippable fault. [Ref (b); Encl (43)]

178. Flight deck personnel stripped the four wire, took number four arresting gear engine off line, and commenced troubleshooting. [Encls (17), (18), (41), (45)]

179. WP 008 01 provides four troubleshooting steps, to be performed in order, to clear the fault and restore the arresting gear engine:

1) Check MTS connectors
2) Rezero CROV
3) Align LVDT (WP 039 01)
4) Replace MTS sensor

Troubleshooting by departmental personal indicated that a failed MTS sensor generated the fault code. [Encls (41), (45)]

180. Five personnel conducted troubleshooting and corrective maintenance on the arresting gear engine; (b) (6) USN, Maintenance Person; (b) (6) USN, Engine Operator; (b) (6) USN, Collateral Duty Inspector (CDI); (b) (6) USN, Quality Assurance Inspector; and (b) (6) USN, Steam Catapult and Arresting Gear Electrician. [Encls (46)-(52)]

181. All personnel were fully qualified to conduct this maintenance. [Encl (53)]

182. All maintenance was completed, including completion of an LVDT alignment, documented, and signed off via Maintenance Action Form (MAF). [Encl (52)]

183. The ALRE Arresting Gear Group Supervisor, (b) (6) witnessed the maintenance personnel completing the LVDT alignment with the procedure out and in hand. [Encl (51)]

184. At 0456L, (b) (6) commenced an additional LVDT alignment. The alignment was unsuccessful. (b) (6) then conducted another LVDT alignment (the third of the night) at 0518. [Encls (36), (47)]

185. The final value for CROV Aligned Zero Position was -0.064. [Encl (36)]

186. The final value for CROV Align Factor was 0.952. [Encl (36)]

187. (b) (6) did not retain copies of his data collection or calculation sheets, as they were developed in support of troubleshooting and not part of a formal maintenance action. [Encl (47)]

188. (b) (6) stated that his understanding of the WP was that if he were to miss a step in the LVDT alignment, it would be red, meaning it was unsuccessful. [Encl (47)]

189. ALREMO did not require retention of troubleshooting worksheets, and required MAFs run for ARC-related maintenance only if a component was required to be replaced. [Encls (41), (45)]

190. Between 0707L and 0708L 18 March 2016, ARC logs indicate normal fault codes expected in the course of conducting arresting gear engine number four pre-operational checks. [Encl (36)]

191. Fixed wing flight operations recommenced on DWIGHT D. EISENHOWER at 1254L, 18 March 2016. [Encl (7)]

192. On 18 March at 1303L, AC 603, an E-2C, successfully arrested via the four wire. This event is logged as Recovery Number 287480 on DWIGHT D. EISENHOWER recovery logs, and as Hit 67471 on ARC logs. CROV Aligned Zero Position is -0.064, and CROV Align Factor is 0.952. At 1302:43, fault code 2160 (MEC Tailhook Error) registered. At 1303:04, fault code 2148 (CROV Zero Alignment Error) registered. The disparity in timing is not significant, as watch standers record timing only to the minute. [Encls (22), (36)]

193. Fault code 2160 is listed as a Serious fault. [Ref (b)]

194. Corrective action for fault code 2160 is to report to PRI-Fly that aircraft may have exceeded tailhook load, and clear the fault. [Encl (54)]

195. Engine Operator contacted tower and reported 2160 fault code. [Encls (18), (45)]

196. Fault code 2148 is a critical, strippable fault. [Ref (b); Encl (43)]

197. ALREMO visually checked arresting gear engine number four CROV and determined there was no evidence of material failure. [Encl (41)]

198. ALREMO contacted Air Officer to inform him that maintenance personnel had recorded a critical fault and were commencing troubleshooting. [Encls (17), (41)]

199. Flight deck personnel stripped the four wire, took number four arresting gear engine off line, and maintenance personnel commenced troubleshooting. [Encls (17), (41)]

200. Five personnel conducted troubleshooting and corrective maintenance on the arresting gear engine; (b)(6) USN, Engine Operator; (b)(6) USN, Collateral Duty Inspector; (b)(6) USN, Quality Assurance Inspector; (b)(6) USN, Steam Catapult and Arresting Gear Electrician; and (b)(6) USN, Steam Catapult and Arresting Gear Engine Electrician. [Encls (42), (46), (48), (50), (55)]

201. All personnel were fully qualified to conduct this maintenance. [Encl (53)]

202. The Engine Operator on duty, (b)(6) USN, stepped aside as more experienced personnel conducted the LVDT alignment. [Encl (21)]

203. The Arresting Gear Assistant Leading Petty Officer, (b)(6) (b)(6) was also present as an observer. [Encl (56)]

204. No MAF was developed in support of troubleshooting. [Encls (41), (45)]

205. ALREMO stated that MAFs are generated to complete corrective maintenance if components are replaced, but not for troubleshooting. [Encl (41)]

206. ALRE Maintenance Chief stated that MAFs are not required for troubleshooting, but only for component replacement. [Encl (45)]

207. Maintenance personnel conducted initial troubleshooting per WP 08 and determined that an LVDT alignment was required. [Encls (42), (46), (48)]

208. LVDT alignment commenced at 1314L. [Encl (36)]

209. (b)(6) stated that the alignment procedure was completed twice. The first attempt "went red" meaning a failed alignment. The second attempt was "green". [Encl (21)]

210. (b)(6) was stationed at the GUI. She stated that the alignment failed once, then was successful on the second attempt after the Catapult Electricians adjusted voltages per procedure. [Encl (48)]

211. (b)(6) stated he had the WP in hand and recorded at least some of the data on the WP procedure worksheets. He was unable to recall exactly what he wrote or correlate all of the handwritten data on the worksheet. [Encls (42), (57)]

212. (b)(6) stated he used an excel spreadsheet in the Arresting Gear office to perform required calculations. He believed that the spreadsheet would perform calculations and prevent errors. [Encls (42), (57)]

213. (b)(6) recalled that they were troubleshooting the same problem as the evening before. He observed the ABE personnel leave and return after ostensibly performing calculations on the computer. [Encl (50)]

214. (b)(6) stated that the ABE's always have a written WP (procedure) open while conducting troubleshooting. She recalls executing the entire procedure twice, after the first failed to generate a valid result. [Encl (55)]

215. (b)(6) stated that both he and ABE1 Franks entered data on the worksheets. He also stated that you have to perform every step in the procedure, or you cannot get a green (valid) result. [Encl (46)]

216. (b)(6) stated that the procedure was performed properly, with no indication of any mistakes or problems. [Encl (56)]

217. ALREMO observed the maintenance personnel entering WP-derived data into the computer in the Arresting Gear office. [Encl (41)]

218. ALREMO stated that, "If you make a mistake with a number, it will not give you a green". [Encl (41)]

219. ALREMO stated that it was his understanding that if it's green, it's good. [Encl (41)]

220. ALREMO stated that it was his understanding that no matter what you did, even if you entered the wrong weight setting, that no matter what happens, the fail-safe would kick in. [Encl (41)]

221. ALRE Maintenance Chief observed maintenance personnel conducting troubleshooting with the WP procedure in hand. [Encl (45)]

222. ALRE Maintenance Chief observed the maintenance personnel enter data into the computer in the Arresting Gear office, leave the Arresting Gear office, return, and re-enter additional data. [Encl (45)]

223. ALRE Maintenance Chief stated that his understanding, imparted from his predecessor at turnover, was, "if you're green, you're good." [Encl (45)]

224. Following the mishap, ALRE personnel produced a handwritten WP 039 01 data collection sheet. Some of the raw data on the sheet was positively identified by ABE1 Franks as his handwritten WP numbers. [Encls (42), (57)]

225. ALRE personnel also produced a copy of the excel spreadsheet that calculated system parameters from entered data that correlated generally to the handwritten data. [Encl (57)]

226. The values on the spreadsheet were entered via GUI during LVDT alignment. [Encls (36), (57)]

227. Between 1314L and 1339L, the LVDT alignment procedure was attempted twice. [Encls (36), (42), (46), (48)]

228. At 1339L, the final pre-mishap LVDT alignment was completed. [Encl (36)]

229. The final value for CROV Aligned Zero Position was -0.136. [Encl (36)]

230. The final value for CROV Align Factor was 0.962. [Encl (36)]

231. Between 1340 and 1345L, ALREMO informed tower that troubleshooting was complete, system was up, and recommended restringing the four wire. [Encls (17), (18), (41)]

232. The Air Officer concurred with the recommendation to restring the four wire and bring number four arresting gear engine back on line. [Encl (17)]

233. At 1349:30, ARC registered fault code 2122 (CROV Control Loop Error) while still in maintenance mode. [Encl (36)]

234. Fault code 2122 is a critical, but not strippable, fault. [Ref (b); Encl (54)]

235. Data does not indicate if the fault was cleared. [Encl (36)]

236. At 1352:54L, ARC registered fault code 2158 (Maximum MEC Pressure Exceeded) following the mishap arrestment. [Encl (36)]

ENGINEERING ANALYSIS

The following is based on preliminary engineering data analysis developed by on site NAVAIR Lakehurst representatives. It was reviewed by the NAVAIR ALRE Engineering Division and Northrop Grumman.

237. Mishap arrestment data analysis of arrestment 67472 determined that the CROV was initially set at the start of the

arrestment to 1.104 inches. Nominal set point for an E-2C arrestment is 0.554 inches. Thus, the CROV exceeded the correct open position by 0.460 inches. [Encl (23)]

238. The CROV, in Primary Mode, followed a programmed closing profile offset by almost 0.500 inches in the open direction. [Encl (23)]

239. Due to this offset, the arresting gear engine failed to build sufficient pressure prior to reaching the nominal service stroke of the MEC RAM (183.9 inches). [Encl (23)]

240. When reaching the 183.9 inch service stroke limit, the ARC system is programmed to fully close the CROV. [Encl (23)]

241. At CROV closing at 183.9 inches, MEC pressure spiked to 13,240 pounds per square inch. [Encl (23)]

242. Maximum operating pressure for the MEC is 11,000 pounds per square inch. [Encl (23)]

243. The nominal MEC pressure for an E-2C arrestment is 6,300 pounds per square inch. [Encl (23)]

244. The MEC RAM over-travelled to 189.4 inches before rebounding to a final reading of 187.9 inches. [Encl (23)]

245. The crosshead compressed the wooden two-block preventer approximately 0.500 inches. [Encl (23)]

246. The CDP parted as loads on the pendant exceeded CDP breaking strength. [Encl (23)]

247. Review of data from arrestment number 67471, the arrestment prior to the mishap, indicates the CROV was set 0.062 inches too high. [Encl (23)]

248. Review of data from arrestment number 67471 indicated MEC pressure reached 8,529 pounds per square inch. [Encl (23)]

249. Review of data from arrestment number 67471 indicated a RAM stroke of 184.4 inches. [Encl (23)]

250. Review of data from arrestment number 67470, two arrestments prior to the mishap, showed multiple MTS sensor system drop outs. [Encl (23)]

251. The ARC system has no automated software check to determine if the CROV was zeroed during alignment, and no faults are generated for this condition. [Encl (23)]

252. Review of configuration and fault logs from after the 67470 arrestment concluded that there was no indication that the CROV was zeroed during LVDT alignment. [Encl (23)]

253. Review of configuration and fault logs from after the 67470 arrestment concluded that the CROV Zero Aligned Position was incorrectly set at -0.064 inches. [Encls (23), (36)]

254. An alignment error from this condition would have generated a 2148 fault code if CROV zeroing had been performed. [Encl (23)]

255. Review of configuration and fault logs from after the 67471 arrestment, prior to the mishap, concluded that there was no indication that the CROV was zeroed during LVDT alignment. [Encl (23)]

256. Post mishap penetrant test on CROV revealed no mechanical defects in the valve. [Encl (58)]

257. Post mishap non-destructive inspection on the arresting gear engine number four crosshead weldments identified no cracks or defects. [Encl (59)]

OPINIONS

1. The root cause of this mishap was a lack of procedural compliance by three V-2 Division personnel, (b)(6) USN, (b)(6) USN, and (b)(6) USN, while troubleshooting arresting gear engine number four in accordance with Work Package 039 01 (CROV LVDT Alignment Procedure).

a. The mishap occurred when the number four arresting gear engine cross deck pendant parted following an attempted arrested landing by an E-2C. The recoil of the separated CDP and purchase cable injured eight Sailors and damaged two CVW-3 aircraft on the DWIGHT D. EISENHOWER flight deck. [FF 2, 3, 25-27, 33, 43-50, 53-56]

b. The CDP parted due load transfer at or near the tailhook engagement point that exceeded the design breaking strength of the CDP. [FF 2, 246]

c. Excessive loads were transferred to the CDP due to a failure of the number four arresting gear engine to build sufficient pressure to slow the aircraft prior to reaching the nominal 183.9 inch service stroke of the engine and adequately absorb arrestment energy, resulting in an approximately one half inch engine two block. [FF 236, 239-245]

d. Number four arresting gear engine exceeded the nominal engine service stroke and two-blocked due to the CROV failing to shut in time to maintain arresting gear pressure within nominal E-2C arrestment limits. [FF 238, 240]

e. The CROV failed to close in time because it was mis-programmed to a pre-arrestment position of 1.014 inches instead of a nominal 0.554 inch position (0.46 inches in the open direction) at the start of the arrestment. [FF 227-230, 234, 237-238]

f. The CROV was mis-programmed inadvertently by the above listed V-2 personnel when they failed to properly complete the LVDT alignment procedure by missing at least one and possibly two critical steps in the procedure, thus incorrectly setting

ARC voltages and mis-programming the CROV. [FF 200, 207, 208, 211-212, 215, 224-230, 234]

2. Two additional factors contributed to causality in this mishap:

a. V-2 personnel did not possess a detailed level of knowledge or technical understanding of the CROV LVDT Alignment Procedure.

(1) Personnel did not fully comprehend that execution of all procedural steps, in order, was required to ensure proper alignment, programming, and operation of the CROV on the correct closing profile. [FF 180, 184, 188, 200, 210, 215, 220, 227]

(2) Personnel believed that the critical steps in the procedure were those involving calculations and data input and that the ARC system would indicate if errors were present and prevent the input of improper settings. [FF 188, 205, 209, 212, 214, 215, 224, 225]

(3) Personnel believed that if calculations and GUI indications were green, the system was programmed and set properly. The mantra, "Green is good", succinctly summarizes the perception of the involved ALRE maintainers. [FF 188, 189, 209, 215, 218-220, 223]

(4) Personnel had minimal sensitivity to the critical nature of the procedure and were convinced that ARC was a "fail-safe" system. [FF 220, 223]

b. The WP 039 01 procedure is overly complicated, difficult to execute and does not provide requisite technical explication or any indication of the high consequence nature of its output. While, if executed verbatim, it is technically correct, it is not remotely user friendly or easily executable in the operational environment.

(1) Procedure completion is directed as a step in troubleshooting ARC-generated fault codes. NAVAIR

technical publications provide contradictory guidance for the conduct of troubleshooting and corrective maintenance of ARC fault codes. [FF 145-153]

(2) The procedure does not contain either a CAUTION or a WARNING for any listed step, failing to highlight the criticality of the step and failing to increase operator sensitivity to that step. [FF 132-134, 138-140, 161-162]

(3) The procedure does not require Quality Assurance verification for any listed step, failing to adequately ensure necessary oversight or backup during procedure execution. [FF 135, 137, 163]

(4) The procedure requires maintenance personnel to complete complicated mathematical calculations by hand or via an unregulated computer program, potentially during flight operations. [FF 157-160]

3. While V-2 personnel objectively failed to properly perform WP 039 01 correctly, there is no evidence that (b)(6) (b)(6) (b)(6) (b)(6) or any Air Department maintainers, operators or leaders performed their duties in a willfully derelict or culpably negligent manner.

a. All V-2 personnel involved in this mishap were qualified and properly designated to perform their duties. [FF 82-96, 180-181, 200-201]

b. All prerequisite requirements to operate arresting gear engine number four were met prior to commencing flight operations on the afternoon of 18 March 2016. [FF 17-20, 23, 119-126]

c. From the start of the mishap chain of events, V-2 personnel attempted to comprehensively execute all necessary troubleshooting and corrective maintenance procedures, including fault reporting, removal of the arresting gear engine from service, corrective action, and system restoration. [FF 176-179, 182-184, 190, 192-196, 199, 205, 207-208, 227-228, 231-232]

d. Communication from the Engine Operator through the ALRE chain of command to the Air Officer regarding equipment status was appropriate. [FF 178, 195, 197-198, 231-232]

e. There is no evidence that perceived pressure to rapidly repair the system, leading to personnel cutting corners through the restoration process, occurred. [FF 182, 184, 198, 208, 226-228]

f. WP 039 01 was executed not once, but twice, prior to the mishap arrestment, with the procedure out and referenced by maintenance personnel. [FF 211-217, 221, 225]

g. Experienced personnel attempted to complete WP 039 01, replacing a less experienced operator after the fault occurred. [FF 200, 202]

h. Adequate supervision was present on the deckplates during troubleshooting. A qualified QAI was present, though not required, while executing the WP. [FF 200, 215-216]

i. Per current directives, a MAF is not required to document the completion of this procedure, nor would the generation of a MAF alone have materially altered the outcome in this specific instance. [FF 196, 204-205, 207-208, 227-228]

j. Divisional leadership was fully engaged in monitoring corrective action. The ALREMO personally inspected arresting gear engine number four following recurrent faults, visually verified the material condition of the engine, and positively acknowledged and communicated its status to Pri-Fly. Leadership acted responsibly and exercised reasonable diligence during the mishap timeline. [FF 121-126, 197-199, 222, 231]

k. The Air Officer executed his responsibilities properly based on the information he was provided. [FF 17-20, 23, 198, 232]

4. No aspect of the configuration of the mishap aircraft or the performance of the Mishap Pilot during the attempted arrestment contributed to the mishap. [FF 15-16, 24, 58, 61]

5. The LSOs controlling the mishap aircraft properly performed their duties and did not contribute to the mishap. [FF 16-18, 78-80]

6. The attempted arrestment of the mishap aircraft in all aspects was normal up until the moment that the CROV begin its programmed closing profile. [FF 15-20, 23-24]

7. Immediate and correct application of recovery controls and aircraft configuration changes by the mishap flight crew, buttressed by a thorough preflight brief, training, and outstanding basic airmanship and aircrew coordination, resulted in the aircraft flying away and averted greater damage and injury. [FF 28]

8. Rapid casualty response, effective application of first aid and immediate medical care, and seamless MEDEVAC execution by coordinated ship's force and carrier air wing personnel evidenced a high level of training and integration and likely mitigated the long term impact to at least some of the injured Sailors. [FF 29, 32-40]

RECOMMENDATIONS

1. Commanding Officer, USS DWIGHT D. EISENHOWER direct training for all V-2 personnel on ARC system, components, operation, maintenance and troubleshooting.

2. Commanding Officer, USS DWIGHT D. EISENHOWER direct training for all Air Department personnel on adherence to ALREMP procedures.

3. Commanding Officer, USS DWIGHT D. EISENHOWER consider formal counseling, letter of instruction, special fitness evaluation, removal of qualification, requalification, and other lesser administrative measures for (b)(6)

4. Commanding Officer, USS DWIGHT D. EISENHOWER consider formal counseling, letter of instruction, special fitness evaluation,

removal of qualification, requalification, and other lesser administrative measures for (b) (6)

5. Commanding Officer, USS DWIGHT D. EISENHOWER consider formal counseling, letter of instruction, special fitness evaluation, removal of qualification, requalification, and other lesser administrative measures for (b) (6)

6. Commanding Officer, USS DWIGHT D. EISENHOWER direct the development and promulgation of a Local Operating Procedure to add additional controls to ARC-related troubleshooting and maintenance containing the following guidance at a minimum:

a. Notify the Commanding Officer upon indication of an ARC-generated critical, strippable fault, or a critical fault which will not clear.

b. For any ARC-related fault requiring removing an engine from service, initiate all normal corrective maintenance actions, including MAF generation, prior to commencing troubleshooting.

c. If an LVDT alignment is required, assign two qualified Engine Operators to complete the procedure, in addition to a qualified CDI and Catapult Electrician. Direct one Operator to act as reader, while the other Operator executes the procedure, performs calculations and records step completion and results.

d. Assign a qualified QAI to monitor proper completion of each step of the procedure, and verify each CROV ZERO step is accomplished properly.

e. Direct ALREMO to personally verify alignment results prior to each data input via the GUI, and prior to recommending arresting gear engine restoration.

7. Commander, Naval Air Systems Command, direct a review of WP 039 01 and add required WARNINGS, CAUTIONS, and QA oversight to procedural steps where technically appropriate.

8. Commander, Naval Air Systems Command, expedite development of an Engineering Change Proposal that will automate alignment procedures where feasible and streamline required operator input in the LVDT alignment process.

(b) (6)