RAS 5423 72-22-ISFSI — Applicant Exhibit 202 - Rec'd 7/1/02

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-16 ACCIDENT
19 JUNE 1998

1. **AUTHORITY:** Under the provisions of Air Force Instruction (AFI) 51-503, on 2 July 1998, the Air Force Materiel Command Commander, General George T. Babbitt, appointed Colonel Glyn D. Martin to conduct an aircraft accident investigation after an F-16D aircraft, number SN 90-0798 (Tab Y-2), crashed on take-off at Hill Air Force Base (Tab A-2, B-2). No damage was caused to private property (Tab P-2). The investigation was conducted at Hill Air Force Base, Utah, from 15 July 1998 through 24 July 1998. The technical advisors were Mr. James G. McLaren (legal), Capt Manuel Griego (maintenance) and TSgt Kevin Bay (maintenance). (Tab Y-4 thru 5)

2. **PURPOSE:** An aircraft accident investigation is convened under AFI 51-503. The investigation is intended primarily to gather and preserve evidence for claims, litigation, disciplinary and adverse administrative actions, and for all purposes other than mishap prevention. In addition to setting forth factual information concerning the cause of the accident, the board president is also required to state his opinion concerning the accident (if there is clear and convincing evidence to support that opinion), or to describe those factors, if any, that in the opinion of the board president, substantially contributed to the accident. This investigation is separate and apart from the safety investigation conducted under AFI 91-204. The report is available for public dissemination under the Freedom of Information Act (5 U.S.C. 552) and AFI 37-131. Accident board members were convened to investigate the Class A aircraft accident involving one F-16D aircraft, number SN 90-0798, from the 514th Flight Test Squadron, Hill AFB Utah, which occurred on 19 June 1998 at 1146 (Local) hours / 1746 (Zulu) hours (Tab N-4). The crash on take-off happened on runway 14 of Hill AFB resulting in the total destruction of aircraft SN 90-0798. There were no casualties (Tab A-2). Total loss was $25,040,923. (Tab M-2).

3. **SUMMARY OF FACTS:**

a. History of Flight Activity:

(1) The purpose of the mission was to conduct the initial functional check flight (FCF) on F-16D, SN 90-0798 following completion of its Falcon Up modification in the OO-ALC depot. Capt Bryan K. Nordheim (Viper 3) was the mishap pilot and sole occupant of aircraft SN 90-0798 which was totally destroyed.

(2) On takeoff at 11:46:52 MDT, F-16D, SN 90-0798 pitched down moments after lifting off, when erroneous angle of attack (AOA) signals were transmitted to the F-16's Digital Flight Control System (DFLCS) from the two radome mounted AOA probes. The DFLCS ignored the pilot's control inputs and pitched the aircraft down to recover from the incorrectly perceived high pitch attitude. As it impacted the runway, the aircraft slid for approximately 4000 feet, departed the runway, and was destroyed. Capt Nordheim performed a successful ejection as the aircraft departed the runway. The malfunctioning AOA probes had been removed during a maintenance

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NUCLEAR REGULATORY COMMISSION

Docket No _____ Official Exh. No. 202

In the matter of PFS

Staff _____ IDENTIFIED ✓

Applicant ✓ RECEIVED ✓

Intervenor _____ REJECTED _____

Chmt'g Off'r _____

Contractor _____ DATE 7/1/02

Other _____ Witness _____

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action while the aircraft was on the Air Logistic Center's production line and had not been boresighted during reinstallation.

(3) Air Force Materiel Command handled questions about the accident through the OO-ALC Public Affairs (PA) office at Hill AFB, Utah. The Public Affairs representative was Major Robert Ballew. There was significant media interest after the accident. Maj Ballew received inquiries from all local television stations and numerous local newspapers. The accident was reported in local TV news reports and several articles appeared in Utah newspapers. A list of those media sources which requested information is found in Tab BB, as is a representative sample of newspaper reports on the accident.

b. Mission: The purpose of the mission was to conduct an FCF on aircraft F-16D SN 90-0798 upon its completion of the Falcon Up modification so that it could be returned to its home unit, the 347th Fighter Wing at Moody AFB GA. The mission content and execution were based on Technical Order (T.O.) 1F-16CG-6CF-1.

c. Briefing and Preflight: The mishap pilot's crew rest was within established regulations (Tab V-1.7). The mission briefing was accomplished in a thorough and professional manner. As the sole crew member for the mission, Capt Nordheim checked the weather and Notices to Airman (NOTAMs). He then concentrated on a thorough review of the aircraft's maintenance records, the Air Force Technical Order (AFTO) 781A and reviewed the inflight procedures that he would use on the FCF. Maj Jim Esch conducted the step briefing with Capt Nordheim as a final check to ensure all preflight items were completed using the 514 FLTS Form 9 (Aircrew Step Briefing Guide). Capt Nordheim stated that the aircraft preflight followed the T.O. 1F-16CG-1CL-1 checklist, and was uneventful. (Tab V-1.2; V-2.1)

d. Flight Activity:

(1) The flight plan was a local standard (stereo) flight plan, that had just been released for use by FCF crews. There were a number of NOTAMs affecting operations at Hill AFB associated with a runway repair that had the first 4000 feet of runway 14 closed. None of these were a factor in the mishap. (Tab V-1.2; V-3.2)

(2) F-16D, SN 90-0798 began its takeoff roll at 11:46:52 MDT from the displaced threshold of runway 14. Less than 2 seconds after liftoff it pitched over uncontrollably and impacted the runway. (Tab V-1.4; N-4) The impact collapsed the left main landing gear (LMLG) and the nose gear (NG). The aircraft slid down the runway for about 4000 feet and then departed to the left of the hard surface where the remaining right main landing gear (RMLG) was sheared off. The aircraft continued sliding through the grass covered runway infield until it hit the east control fixture for the BAK-12 barrier. (Tab V-3.2) It then flipped over and was subsequently destroyed by the ensuing fire. Capt Nordheim performed a successful ejection as the aircraft departed the runway. (Tab V-1.4).

e. Impact. The crash site was located entirely on the premises of Hill AFB. The aircraft slid off the left side of the runway approximately 2000 feet from the departure end. The nose gear door, portions of the nose wheel, pieces of the nose and main landing gear attaching structure,

and the left wing Leading Edge Flap mounted Threat Warning antenna were found on the runway. The largest piece of wreckage, including the aft fuselage, the empennage (with the exception of the right horizontal tail), left wing, center fuselage and portions (the aft cockpit) of the forward fuselage came to rest inverted, approximately 260 feet left of the runway centerline and 6768 feet from the arrival threshold. The rest of the forward fuselage, including front cockpit, forward avionics bays and radome, was found in two pieces approximately 50 yards down track from the main wreckage (Tab J-3)

f. Egress System: Capt Nordheim (Viper 3) accomplished a successful Mode I in-the-envelope ejection from his aircraft and everything with the seat functioned normally. He had the "solo" mode of operation selected on the ACES II seat since the rear cockpit was unoccupied. As a result, only the front seat was ejected from the aircraft (Tab J-21 thru 22). Capt Nordheim testified that the only difficulty he encountered during the ejection was having enough time to assume the proper position for a parachute landing fall prior to contact with the ground. The pilot remarked that his only injuries were small bruises and a sore back, both of which cleared up with in a few days after the accident (Tab V-1.8; X-2).

g. Personal and Survival Equipment: Maintenance and life support records show all of the survival equipment inspections were properly performed and up-to-date. Capt Nordheim testified that he had no time to use any of the signaling devices or survival equipment packed in his survival kit. (Tab V-1.6 thru 7).

h. Rescue: The time of the F-16's runway impact was 11:46:59L (Tab N-4). Local time was Mountain Standard Time. The crash response was initiated by the Hill Tower Local Control within seconds at 11:47:05L. The pilot, Capt Nordheim, completed his parachute landing fall in the grass covered runway infield, approximately 470 feet short of the main wreckage, which was engulfed in fire. Fire and rescue personnel were already in the vicinity of the accident, as they were returning to their stations following an airborne emergency that had just terminated. The Hill AFB Fire Chief first spotted Capt Nordheim and directed the medical rescue team, MED 4, to his location at 11:48:16L. Within 5 minutes after the runway impact, MED 4, had Capt Nordheim in their ambulance and enroute to the Hill AFB hospital. (Tab N-11)

i. Crash Response: Being at the runway due to a previous Inflight Emergency, noted above, the fire department (Chief 2) was on scene directing the crash response within 33 seconds after the runway impact. Three peices of crash equipment were eventually used to extinguish the fire on the mishap aircraft. Since the crash was entirely on Hill AFB property, no civilians or outside authorities were involved in the crash response. By 12:04L, per the Hill Command Post Log (not attached), the 75th Support Group Commander, Col Charles Cotter, assumed On Scene Commander duties and preserved the crash site for the accident/safety investigation teams.

j. Maintenance Documentation:

(1) Work Control Documents:

(a) The mishap aircraft's active forms, AFTO 781 series, and Work Control Documents, AFMC Forms 173, and AFLC Form 959 were reviewed. Several discrepancies were discovered

in both the 781 and 173 forms that contributed to the failure to accomplish the AOA probe boresight and to aircraft 90-0798's mishap sequence.

(b) AFMC Forms 173 and 959s are utilized within the depot maintenance complex, including flight test, to control and document depot maintenance repair actions completed on the aircraft. Both the 781A's and 173s are utilized to document over and above (O/A) maintenance discrepancies (maintenance discrepancies discovered that were not forecast in the original depot contract with using activity) depending on the time and location that the maintenance discrepancy is discovered. An O/A discrepancy discovered in the examination and inventory phase (E/I) will be documented in the AFTO 781A and on a 173 card (also referred to as a "cyber card"). The cyber card is then generated manually to: 1) obtain approval through LAO Plans and Scheduling office to repair the discrepancy 2) task the floor scheduler to schedule the maintenance for completion during the depot maintenance phase, and 3) tasks the maintenance technician to repair a maintenance discrepancy according to specific technical order guidance. According to expert witness testimonies and AFMCI, attaching an AFLC Form 959 to the cyber card instructs the technician to account for all time that each maintenance step consumes. (Tab AA-4)

(c) Current written instructions do not mandate the 959 be used to document each maintenance step completed by the technician. From expert witnesses it was found that the utilization of the 959 to account for time used on a maintenance tasks is optional for jobs requiring less than 19.9 hours to complete. There is no written guidance mandating the form be used to document maintenance tasks completed under 19.9 hours or to document maintenance tasks that have been omitted by a technician. (Tab AA-4)

(d) Some expert witnesses stated (with others disagreeing) that the 959 should be initially started by the maintenance technician and/or supervisor to document all major maintenance tasks to be performed. Formal documentation requiring this step was not found.(Tab AA-4)

(2) Radome Removal and Reinstallation Documentation:

(a) In this mishap sequence, the poorly written instructions for documentation of O/A maintenance discrepancies contributed to the faulty documentation of discrepancies and repair actions required for the removal and installation of the mishap aircraft's nose radome. (Tab AA-4)

(b) As aircraft 90-0798 entered Falcon Up depot maintenance a discrepancy for a faulty nose radome was discovered by the E/I section and annotated in the aircraft AFTO 781, a method accepted by local procedures (Tab AA-4). At the conclusion of the acceptance and initial aircraft inspections, an acceptance maintenance review team meeting (MRT) was conducted between the plans section, production section, and dock chiefs to coordinate all maintenance actions required for the mishap aircraft. At this time, the maintenance supervisor, dock chief, became aware of the radome repair requirement and initiated an O/A work requirement (cyber card) requesting the removal of the radome for repair. A Form 959 was attached to the 173 request. Attaching the 959 to this cyber card is inconsistent with written instructions requiring a 959 for time accounting since the task was estimated for less than 19.9 hours by the dock chief. (Tab AA-5) The dock chief also indicated on the 173 that the repair was a safety of flight (SOF) repair. While describing the maintenance discrepancy in block 31 of the 173, the dock chief is required to reference all applicable technical orders required for the task. (Tab AA-5) As testified by an expert witness, the LAO planner should also ensure that technical order references are indicated

on the 173 card when it is received by planning in the coordination chain. (Tab AA-5) It was observed that technical order references are typically omitted in manually generated 173s, as was the case for all maintenance tasks associated with the removal and installation of the radome. The dock chief's responsibilities also include indicating the inspection requirement for the maintenance task. In the case of the removal, it required only the single technician to sign-off the task in block 29 of the 173, indicated by an "M". Removal of equipment generally requires an M inspection; however, a critical characteristic book (CCB) is utilized to verify the level of inspection for the maintenance task. The CCB mandates the areas of an aircraft requiring a ZC or MC inspection. ZC and MC are two levels of inspection requiring two maintenance signatures or two maintenance and two PAC stamps for job completion verification. Interpretation of these codes was variable throughout witness testimonies. A clear understanding of each code was vague. It is apparent that written instructions defining the codes in are not clear even to experts. If the task is not included in the CCB, an "M" inspection is sufficient; whereby the removal of the radome was assigned an "M" inspection. (Tab AA-5)

(c) For computer generated cyber cards, the inspection codes are pre-filled for the maintenance task. Several computer generated cyber cards were discovered to have incorrect inspection codes. For example, a card with a task listed in the CCB was missing a ZC code. (Tab AA-5)

(d) The CCB is a locally generated reference guide authorized for use by OO-ALC/LAO. This CCB is reviewed and updated by a CCB committee. After reviewing the CCB, several critical areas, typically requiring two level maintenance inspections, were found omitted. Of special note in this list of missing inspections, is that of the boresight of the AOA probes on a replaced nose radome. This omission contributed to the mishap. (Tab AA-5)

(e) After filling out the 173, the dock chief routed the request through floor scheduling to LAO Plans, who coordinated the approval of the radome removal. LAO Plans then routed the 173 back to floor scheduling for inject into the mishap aircraft maintenance flow. (Tab AA-5,6)

(f) Witness testimonies produced various opinions regarding the quality verification process for ensuring the 173 is correctly filled out. Various levels of the coordination process were assumed responsible for ensuring the quality of the form to include assignment of the inspection codes as well as instituting a 959 form in conjunction with the 173 for time accounting. Several 173 cards had missing signatures, stamps, incorrect inspection codes, and attachments of 959s when less than 19.9 hours were required for the tasks, all contrary to written guidance. (Tab AA-6).

(g) There is the capability to generate the cyber work deck automatically for O/A discrepancies, as is done for preplanned work, if the task has a 20% frequency rate or greater. Since radome removal frequency is below this 20% standard, automatic generation of a work deck for all tasks associated with the removal and reinstallation of the radome did not occur. Approval of the removal of the radome was given and the task was completed and documented by hand on the 173 and 959 forms. The dock chief hand generated a second cyber card for the installation of the radome. (Tab AA-6)

(h) The cyber card requesting installation of the radome did not include a 959 form for time accounting. LAO planning section, scheduling, and floor scheduling, throughout their portion of the 173 coordination chain, did not include a 959 sheet for any of the additional maintenance tasks associated with installing the mishap aircraft's repaired nose radome. (Tab AA-6,7)

(i) Expert testimony stated that all installations should have at a minimum an MC inspection code which would require two maintenance personnel to sign off the work. For installation of the nose radome, an M code was assigned and ultimately signed off by one technician. Therefore, a second set of eyes was not used to verify this installation was done correctly and completely. Ultimately, the maintenance technician did not document the steps of the technical order he completed using the Form 959. This was an appropriate omission according to depot guidance and policies -- he was not required to document all maintenance tasks completed. The maintenance technician did request a pitot-static tube leak test, a task he was fully qualified to accomplish. The remaining follow-on maintenance (FOM) tasks were not requested as additional O/A work nor were they documented as incomplete by anyone. The omission of the FOM request at all levels of the maintenance task coordination contributed to the mishap sequence. Specifically, an AOA boresight was not completed after installation of the AOA probes on the mishap aircraft's new radome. (Tab AA-6)

(j) A 173 card, for the inspection and closing of the nose radome, was coordinated, approved and completed. Discrepancies noted on this card include: the lack of technical order references in block 31; the lack of a ZC inspection code in block 31 since the task is listed in the CCB; and, the lack of an additional maintenance inspector's initials and employee number in block 37. This is required by the inspection code MC in block 29. (Tab AA-7)

(3) AFTO 781 Misuse:

(a) The utilization of the 781A's within the depot maintenance system contributed significantly to the aircraft's mishap sequence. Documentation of discrepancies and corrective actions within the 781As were not completed according to Technical Order 00-20-5 (Tab AA-7)

(b) Personnel within the depot production line utilize 781As to annotate O/A discrepancies along with 173 forms, depending on the timing and location of discovery. Floor schedulers and maintenance supervisors have the discretion to utilize a 173 card versus a 781A.

(c) Documentation of AFTO 781 forms training was found in some individual training records, but shown as awaiting completion in others.

(d) Technicians and supervisors responsible for annotating aircraft discrepancies and corrective actions did not understand the proper usage of the 781As. Supervisors and mechanics within the depot production section did not use 781s to document maintenance according to applicable technical orders. Page 5, block 1 of the mishap aircraft's active forms indicated the removal of the nose radome for repair. The corrected-by and inspected-by blocks were signed off by supervisors who did not perform the removal or the installation of the nose radome. According to T.O. 00-20-5, the corrected-by block should have been signed by the person who actually accomplished the work, the inspected-by block and symbol block should have been signed and initialed by the maintenance inspector over the specific maintenance task. Per the regulation, the inspector is to ensure that all maintenance tasks have been completed for all applicable technical orders as stated in the corrective action block. In the mishaps aircraft's AFTO 781, all references to the technical order were omitted in the corrective action block contrary to 00-20-5 guidance. (Tab AA-7)

(4) AFTO 781 Open Discrepancies and Post Accident POL Samples:

(a) After reviewing the original aircraft AFTO Forms 781K, sections E and H and their duplicates, there were no Time Compliance Technical Orders (TCTOs) overdue that contributed

to this incident. The original AFTO Forms 781K, sections A and G, and their duplicates do not indicate any overdue scheduled inspections (Tab AA-7).

(b) Pre-mission oil analysis was accomplished on the aircraft and revealed no abnormalities. Post-accident samples taken from aircraft SN 90-0798, oil servicing carts and JOAP samples confirmed no contamination. In addition to the thorough review of the aircraft jacket files and engine equipment records, no open discrepancies for time change requirements or negative trends were noted. (Tab AA-7,8)

(5) The AF Form 711C, Aircraft Maintenance and Material Report (Tab D-2), indicated no components removed for inspection as a result of this accident. Lockheed Martin-Tactical Aircraft Systems, Ft Worth, TX, provided post-accident analysis of the Digital Flight Control System (DFLCS), Seat Data Recorder (SDR), left and right Angle of Attack (AOA) transmitters. (Tab AA-8)

k. Maintenance Personnel and Supervision:
There appeared to be maintenance procedures, and practices by civilian technicians and supervisors that contributed to this accident. The procedures for documenting, tracking, and performing O/A maintenance actions produced the conditions necessary for the aircraft's mishap sequence. (Tab AA-8)

(1) Inadequate and deficient utilization of cyber cards and 959 forms coupled with inadequate knowledge and utilization of AFTO Form 781As allowed the aircraft to fly with AOA probes that had not been boresighted after installation. The processes established by governing instructions, publications, manuals, process orders and training do not adequately track O/A discrepancies. (Tab AA-8)

(2) Supervisors and technicians were found to make assumptions that certain coordination, documentation, and maintenance steps were accomplished outside their scope of responsibility. Supervision and technician interpretations of the processes for an O/A discrepancy allowed the lack of documentation for installation and boresight of the AOA probes.

(3). The incorrect installation of the AOA probes was proven by technical analysis of the radome, AOA probes and mounting hardware. (Tab AA-8)

(4) Supervisors and technicians involved in the aircraft's transfer MRT did not correctly utilize guidance established within Air Force Technical Orders 00-20-1, 00-20-5 to identify the incorrect documentation of the removed and repaired nose radome, including the identification of missing FOM steps required for the installation of a nose radome. (Tab AA-8)

(5) A review of aircraft preflight servicing and supervision of those tasks revealed no discrepancies. (Tab AA-8)

l. Engine, Fuel, Hydraulic, and Oil Inspection Analysis:
Upon review of AF Form 711C (Tab D-2, D-3) and the engine equipment records, no abnormalities or open discrepancies were discovered. Engine inspection documentation was

appropriately maintained. Although not a contributing factor, FOM after installation of the engine was not documented in the aircraft's 781As. The base fuels laboratory noted no deficiencies in fuel delivery vehicle or aircraft fuel samples (Tab H-3, H-6). In any event, Capt Nordheim testified that there were no aircraft hydraulic or engine problems prior to the mishap. (Tab AA-8,9; V-1.3)

m. Airframe and Aircraft, Missile, or Space Vehicle Systems:
The AF Form 711C (Tab D-2) indicated no components or accessories were sent for testing or tear down due to potential deficiencies. According to Lockheed-Martin Tactical Aircraft Systems Report (J-2) the following components were evaluated for flight data pertinent to the flight profile of the mishap sequence: Digital Flight Control System (DFLCS), Seat Data Recorder (SDR), left and right Angle of Attack (AOA) transmitters. Capt Nordheim's testimony verified the flight characteristics reported by the flight data recorder. Both corresponded exactly to the technical evaluation's prediction of flight characteristics with improperly installed AOA probes as found on the mishap aircraft. (Tab AA-9; V-1.4)

n. Operations Personnel and Supervision: The mission was authorized by Maj Jim Esch (Tab K-3), the squadron's Operations Officer. Capt Nordheim, as the sole crew member, conducted his own preflight briefing which concentrated on a review of the FCF profile he would fly per T.O. 1F-16CG-6CF-1 and a review of the aircraft's AFTO 781A maintenance records. Maj Esch, who was also acting as the squadron's Supervisor of Flying that day, conducted a "step briefing" with Capt Nordheim to ensure all preflight items were complied with. Overall the preflight preparation and supervisory oversight were thorough. (Tab V-2.1).

o. Pilot Qualifications: A review of Capt Nordheim's training and Flight Evaluation records show that he was an accomplished pilot fully qualified to perform the functional check flight (FCF) on 19 Jun 98. Recent flight time is as follows (Tab T-3):

	Hours	Sorties
30 days	10.4	9
60 days	24.2	20
90 days	39.6	34

Capt Nordheim arrived at Hill AFB, UT from Shaw AFB, SC qualified as an FCF pilot. All specialized flight and ground training at Hill AFB was accomplished with no discrepancies. He completed upgrade to instructor pilot (IP) locally with laudable comments. (Tab T- 3)

p. Medical: Medical and dental records were reviewed. The mishap pilot was qualified for flight duty at the time of the accident. Toxicological examination was negative for ethanol, drugs, or carbon monoxide. The mishap pilot complained of mild back pain following the mishap. X-ray and MRI showed a 10% compression fracture of the sixth thoracic vertebral body. This type of injury could result from poor body position on ejection or as a result of parachute landing fall. However, it is the opinion of the treating orthopedic surgeon that this finding represents an old injury or congenital anomaly, and is not related to the ejection. The mishap pilot has been cleared for flying duties (Tab X; V-10.2)

q. Navaids and Facilities: Navaids, facilities and NOTAMs were reviewed. Nothing was noted that could have contributed to the mishap (Tab CC).

r. Weather: At the time frame of this mishap the weather at Hill AFB was better than 8000 scattered with unrestricted visibility. Winds were 160 degrees at 12 knots and the altimeter setting was 29.94 inches of mercury. This actual weather corresponded to the forecast and did not contribute to the mishap. (Tab W-2)

s. Governing Directives and Publications: Primary directives and publications relevant to this mishap:

(1) Pilot related Instructions (did not contribute, therefore, not attached)

T.O. 1F-16CG-1: Flight Manual F-16 C/D Block 40 and 42

T.O. 1F-16CG-6CF-1: Acceptance and Functional Check Flight Procedures Manual

AFMC 11-202: Fighter/Attack and Trainer Aircrew Procedures

OO-ALC HAFB Instruction 13-201: Air Traffic Control and Flight Operations

514 FLTS Form 9: Aircrew Step Briefing Guide

(2) Maintenance related Instructions

Technical Order 00-20-1: Preventive Maintenance Program General Policy Requirements And Policies (U17-U19)

Technical order 00-20-5: Aircraft, Drone, Aircrew Training Devices, Engines, And Air-Launched Missile Inspections, Flight Reports, And Supporting Maintenance Documents (U20-U27)

Technical Order 1F-16CG-2-53JG-00-1: Fuselage Access Panels And Structures (U28)

AFLCR 66-55: Mission Design And Series (MDS)/Project Workload Planning (U31-U32)

OO-ALCR 66-23: Aircraft Over And Above Work Processing (U29-U30)

OO-ALC/*LAOOI 21-3: Processing Work Control Documents (WCDs)* (U33-U34)

OO-ALC/*LAOOI 21-4: Aircraft Examination And Inventory Process And Control Of Unpredictable Write-Ups* (U35-U36)

OO-ALC/*LAOOI 21-18: Assigning Production Acceptance Certification (PAC) Codes To Work Control Documents (WCD)* (U37-U40)

OO-ALC/*LAOOI 21-56: Aircraft Maintenance Review Team (MRT), And Job Order Numbers (JON) Closeout Procedures* (U41-U43)

Critical Characteristics Checklist (U44-U48)

Process Order B825901: Processing AFMC Form 173/959 Work Control Documents (U49-U50)

(3) Maintenance: known or suspected deviations.

(a) Maintenance: known or suspected deviations. There were several discrepancies in both aircraft active AFTO 781 forms and depot maintenance workload control documents, AFMC Form 173, and AFLC Form 959 which contributed to the mishap sequence.

i. Technical Order 00-20-1(Tab U17-U19), Technical Order 00-20-5(Tab U20-U27): A maintenance discrepancy requiring the removal and repair of a nose radome was made on page 5, block 1 of the mishap aircraft AFTO 781 forms (Tab U-9). The discrepancy was cleared by the wrong individuals after the depot maintenance production line replaced the radome while on the production line. According to both reference T.Os, the discrepancy should be cleared by having the individual who performed the work sign the corrected-by block, and the individual who inspected the work sign the inspected-by and initial the symbol block. The discrepancy was cleared by the section's supervisor and assistant supervisor, neither of whom were the individuals who accomplished or inspected the work. Both the supervisor and assistant supervisor were awaiting training on use of the AFTO 781.

ii. *Technical Order 00-20-1(Tab U17-U19), (Tab U20-U27), Technical Order 1F-16CG-2-53JG-00-1 (Tab U-28), OO-ALC/LAOOI 21-3 (TAB U-33-U-34), OO-ALC/LAOOI 21-4 (TAB U-35-U-36):* Follow-on-Maintenance (FOM), and operational check-out requirements for the maintenance discrepancy on page 5, block 1 (Tab U-9) were not documented in the AFTO 781As per *Technical Order 00-20-5, page 3-11, para. 3-12.1.1.* Technical Order 1F-16CG-2-53JG-00-1 (Tab U-28) lists numerous FOM actions required for the installation of the nose radome that should have been listed here. On the production line the AFMC Form 173 (Tab U-60), cyber card, and AFLC Form 959 replace the AFTO 781 process. The still to be accomplished FOM actions were not documented on the cyber cards and Form 959s either (Tab U-60). However, no written requirement was found requiring documentation of still to be accomplished FOM on these work control documents.

iii. OO-ALC/LAOOI 21-3 (TAB U-33-U-34), OO-ALC/LAOOI 21-18 (TAB U-37-U-40), OO-ALCR 66-23 (TAB U-29-U-30), Process Order B825901(Tab U-49-U-50), Critical Characteristics Checklist(Tab U-44-U-48): Utilizing AFMC Form 173, an over and above (O/A) maintenance discrepancy was initiated for the removal, repair(Tab U-58,U-59), and installation (Tab U-60) of a nose radome on the mishap aircraft. The following documentation errors were recorded on the 173 cards for the referenced maintenance discrepancy: (1) Technical Order references were missing from all 173 forms which tasked the maintenance technicians to perform the jobs (Tab U-58-U-62); (2) Incorrect inspection codes in blocks 29 and 31 of the 173 form were noted on the installation and closing work control documents, respectively; and (3) A signature verifying an inspection of the installation and closing of the nose radome was omitted.

(b) The following discrepancies were not a factor in the aircraft mishap sequence; however, they were deviations from written directives.

i. Technical Order 00-20-1(Tab U17-U19), Technical Order 00-20-5(Tab U20-U27): Operational check-out write-ups were not documented in the AFTO 781A's for the installation of the mishap aircraft's engine (Tab U-8). Technical Order references were not made on operational check-outs within the aircraft AFTO 781As. Page 1, block 1 (Tab U-8), page 21, block 1 (Tab U-15), and page 10, block 1 (Tab U-12) did not have references. These errors did not contribute to the mishap sequence.

ii. Technical Order 00-20-1(Tab U17-U19): Several overdue inspections (Tab U-16) were not carried-forward to the AFTO Form 781As prior to obtaining an exceptional release for the aircraft's first flight after depot maintenance. The overdue inspections were not related to the mishap sequence.

(c) The documentation errors impacted the mishap aircraft's final sortie mishap sequence. Without the documentation mandating FOM requirements, the boresight for the Angle of Attack mounts was omitted. Requests for additional over and above maintenance actions within the depot production line and flight test section did not produce the requirements for the boresight maintenance task.

24 Jul 98

GLYN D. MARTIN, Col, USAF
Accident Investigation Board President

STATEMENT OF OPINION

F-16 ACCIDENT
19 JUNE 98

1. UNDER 10 U.S.C. 2254(d) ANY OPINION OF THE ACCIDENT INVESTIGATORS AS TO THE CAUSE OR CAUSES OF, OR THE FACTORS CONTRIBUTING TO, THE ACCIDENT SET FORTH IN THE ACCIDENT INVESTIGATION REPORT MAY NOT BE CONSIDERED AS EVIDENCE IN ANY CIVIL OR CRIMINAL PROCEEDING ARISING FROM AN AIRCRAFT ACCIDENT, NOR MAY SUCH INFORMATION BE CONSIDERED AN ADMISSION OF LIABILITY OF THE UNITED STATES OR BY ANY PERSON REFERRED TO IN THOSE CONCLUSIONS OR STATEMENTS.

2. OPINION SUMMARY (See Discussion of Opinion section after the Opinion Summary section for detailed explanation):

a. The primary cause of this mishap, supported by clear and convincing evidence, was the failure of maintenance personnel to accomplish a boresight of the radome mounted angle of attack (AOA) probes during installation of a repaired radome. The radome was removed as an Over and Above (O/A) task; but, the boresight required by T.O. 1F-16CG-2-53JG-00-1, as a sub task in the installation of a radome was not accomplished. (Tab AA-3)

b. An additional primary cause of this mishap, supported by clear and convincing evidence, was the absence of procedural guidance for maintenance personnel on how to document and perform maintenance actions for approved O/A work. In the absence of clear procedural guidance, no one was responsible and accountable for the sub-maintenance tasks required in O/A work. (Tab AA-8)

c. A contributing factor to this mishap, supported by clear and convincing evidence, was the lack of understanding on the proper use of the AFTO 781 by personnel in the depot (OO-ALC/LAO). (Tab AA-7)

d. A contributing factor to this mishap, supported by clear and convincing evidence, was the use, on the production line, of a locally generated and incomplete Critical Characteristics Book to verify the level of inspections required for maintenance tasks. (Tab AA-5)

e. A contributing factor to this mishap, supported by clear and convincing evidence, was the inability of the Digital Flight Control System's (DFLCS's) logic to handle a near simultaneous dual AOA failure while in the takeoff and landing gains mode of operation (gear handle down). (Tab J-9 thru 10)

f. See last page of this report for Conclusions.

3. **DISCUSSION OF OPINION:** I derived my opinion as to the cause of this mishap primarily through information found in Part 1 of the Safety Report (Tab A thru S) and testimony from numerous sources. The Lockheed analysis and testimony of OO-ALC mechanics and maintenance supervisors was especially valuable. (Tabs J and V).

a. **AOA PROBE ALIGNMENT (BORESIGHT) NOT ACCOMPLISHED:**

(1) The primary cause of this mishap, supported by clear and convincing evidence, was the failure of maintenance personnel to accomplish a boresight of the AOA probes when reinstalling the radome following its repair. At the initial inspection of SN 90-0798 when entering the depot, the radome was identified for repair. It was subsequently removed, repaired and reinstalled. Post accident investigation found the right AOA probe to be 45 degrees higher than the required mid-range value of 20 degrees nose down and the left AOA probe to be 35 degrees above this mid-range value. The summation of these sensors would result in an erroneous and very large AOA signal to the Digital Flight Control System (DFLCS) at weight off wheels. (Tab J-11)

(2) The DFLCS logic uses the middle value of three available sources of AOA -- that is from the above left and right mounted probes and a side mounted probe. A failure of an AOA source is declared by the DFLCS if it exceeds 6 degrees difference from the selected AOA. With a single failure of one of these sources the DFLCS introduces a fixed 11 degree signal and continues to calculate a mid value between the remaining two signals and the fixed 11 degrees. With a second failure, the DFLCS continues to calculate a mid AOA value based on the fixed 11 degrees and the same two remaining signals following the first failure. This logic can not handle two simultaneous failures of AOA sources. In this case, it voted out the accurate AOA source and calculated the mid value of the erroneously high signals and the 11 degree fixed value. The resulting AOA value used in the DFLCS commands to the flight control surfaces was extremely high. (Tab J-9 thru 10)

(3) The DFLCS provides a warning tone when the AOA exceeds 15 degrees in takeoff and landing gains (gear handle down). Capt Nordheim reported that he heard this horn as soon as the aircraft lifted off the runway (weight off wheels). Additionally, the DFLCS ignores all aft stick inputs if it senses an AOA greater than 21 degrees and further commands the horizontal tails to full trailing edge down if the AOA exceeds 35 degrees. This would result in an uncontrolled negative pitch-rate, as was experienced by Capt Nordheim on the mishap sortie.

(4) A thorough review of maintenance documentation for F-16D SN 90-0798 could find no record of an AOA alignment or boresight being accomplished in conjunction with the removal and replacement of the radome during or after the Falcon Up modification. (Tab AA-7)

b. **DEPOT GUIDANCE ON HOW TO DOCUMENT AND TRACK REQUIRED MAINTENANCE OF "OVER AND ABOVE" TASKS NOT PROVIDED:**

(1) An additional primary cause of this mishap, supported by clear and convincing evidence was the absence of procedural guidance for maintenance personnel on how to document and perform maintenance actions for approved O/A work. The AFTO 781A is not used in the OO-ALC/LAO process to document maintenance tasks on the depot's production line. The replacement process, using the Work Control Documents, AFMC Form 173 and AFLC Form 959, is complete for preplanned work where these tracking documents are computer generated

for all maintenance tasks required. This process falls seriously short for O/A work. The Work Control Documents are hand generated with no requirement to document all maintenance actions that will be needed. Additionally, no individual in the process is held accountable to ensure all sub-tasks found in the Job Guide are documented and tracked to completion.

(2) Upon entry into the depot, SN90-0798 was targeted for radome removal, repair and reinstallation. The primary Job Order task, being O/A, was documented by hand on an AFMC Form 173. The sub tasks, which, during the reinstallation, included an AOA boresight, were not documented on an AFLC Form 959. Since all the sub-tasks for the reinstallation required less than 20 hours, this was an acceptable set of Work Control Documents per OO-ALC/LAO policies (Tab AA-4). As a result, F-16D SN 90-0798 progressed through the extensive Falcon Up modification on the depot's production line with NO documentation showing a requirement for an AOA boresight prior to flight. Furthermore, an extensive review of maintenance records for SN 90-0798 found no documentation of an AOA boresight being performed. (Tab AA-7)

c. **THE PROPER USE OF THE AFTO 781 NOT UNDERSTOOD:**

(1) A contributing factor to this mishap, supported by clear and convincing evidence, was a serious lack of understanding in the use of the AFTO 781. (Tab AA-7)

(2) The last opportunity to recover from the missed AOA probe boresight was at the Aircraft Maintenance Review Team (MRT) meeting #2 where the mishap aircraft was transferred from the depot's production line to flight test. This team found no open tasks relating to the AOA probes because none had been generated. (Tab AA-2)

(3) One task relating to the removal and reinstallation of the radome was entered in the AFTO 781; but, was cleared (signed off) by the production line when the radome was reinstalled. Since the AFTO 781 was not the tracking system used on the production line, the production line maintenance personnel mistakenly cleared the "radome removed" write-up with a "radome reinstalled" comment without consideration for the sub-tasks required in this operation. T.O. 00-20-1 requires maintenance supervision to ensure sub-tasks are completed before an AFTO 781 wite-up is cleared. Production line personnel considered that the Work Control Documents were the tracking system for these sub-tasks, per their OO-ALC/LAO policies, and made no attempt to carry over the sub-tasks to the AFTO 781 system. (Tab AA-7)

(4) Flight test personnel at the MRT, who were accustomed to the use of AFTO 781s to document all maintenance requirements, assumed the sign off of the radome reinstallation was the production line's assurance that all sub-tasks were complete. (Tab V-8.3)

(5) It is my opinion that this confusion over the proper use of the AFTO 781 contributed to this mishap.

d. **THE CRITICAL CHARACTERISTICS BOOK (CCB) NOT COMPLETE:**

(1) A contributing factor to this mishap supported by clear and convincing evidence was an incomplete, locally generated, CCB.

(2) Production line maintenance personnel rely on the OO-ALC/LAO written and maintained CCB to verify the level of inspection required for maintenance tasks. An examination of the CCB found several areas, normally requiring two level maintenance inspections, NOT covered. One of these omitted dual inspections was of the alignment/boresight of AOA probes on a replaced nose radome. This oversight in the CCB was one more example of depot guidance that could have prevented this mishap. (Tab AA-5)

(3) When the dock chief referred to the CCB to set up the Work Control Documents for the radome repair, it gave him no warning that one of the sub-tasks, the AOA alignment/boresight, was a "critical" task. (Tab AA-5)

e. **THE DFLCS NOT DESIGNED TO HANDLE NEAR SIMULTANEOUS DUAL AOA FAILURES IN THE TAKEOFF AND LANDING MODE:**

(1) A contributing factor to this mishap, supported by clear and convincing evidence, was the inability of the Digital Flight Control System's (DFLCS's) logic to handle a near simultaneous dual AOA failure while in the takeoff and landing gains mode of operation (gear handle down). (Tab J-9 thru 10)

(2) It is my opinion that in this critical phase in flight, which is typically near the ground, the DFLCS's logic, described in 3a(2) and 3a(3) above for departure protection, should not be activated. By having this logic incorporated, the DFLCS took the pilot out of the loop at the most critical phase of his flight. (J-9 thru 10; V-1.4)

4. CONCLUSION:

a. It is my opinion, which is supported by clear and convincing evidence, that the failure to accomplish an AOA alignment or boresight on the left and right radome mounted AOA probes, which was allowed by incomplete procedural depot guidance on Over and Above work, caused this mishap.

b. **The primary cause of this mishap,** supported by clear and convincing evidence, was (OO-ALC/LAO depot policies and procedures that did not clearly assign the responsibility to fully document and accomplish all Over and Above tasks to ANYONE.

24 Jul 98

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Accident Investigation Board President