SUMMARY OF FACTS

1. AUTHORITY, PURPOSE, AND CIRCUMSTANCES

a. Authority

On 25 February 2008, General John D.W. Corley, Commander, Air Combat Command (ACC) appointed Brigadier General Floyd L. Carpenter, to conduct an aircraft accident investigation of a mishap that occurred on 23 February 2008 involving a B-2A aircraft, tail number (T/N) 89-0127 at Andersen Air Force Base (AFB), Guam (Tab Y-3). The investigation was performed in accordance with (IAW) Air Force Instruction (AFI) 51-503, *Aerospace Accident Investigations*, and was conducted at Whiteman AFB, Missouri (MO), from 26 March 2008 through 7 May 2008. The board members were: Lieutenant Colonel (Lt Col) Stephen Geringer (Legal Advisor), Lt Col Roger Forsythe (Pilot), Major (Maj) Christopher Borchardt (Flight Surgeon), Master Sergeant John Wester (Maintenance), Technical Sergeant (TSgt) Tara Stowell (Recorder), TSgt Virginia Race (Transcriptionist), and Staff Sergeant Steven Pierce (Assistant Recorder) (Tab Y-3 thru Y-5). Technical advisors were Stephanie Ellis, Robert Wilsey, Ted Schulman, Albert Myers, and John Moynes (Tabs Y-6 thru Y-10).

b. Purpose

The purpose of this investigation was to provide a publicly releasable report of the facts and circumstances surrounding the accident, including a statement of opinion on the cause or causes of the accident; to gather and preserve evidence for claims, litigation, disciplinary and administrative actions; and for other purposes.

c. Circumstances

The accident investigation board (AIB) was convened to investigate a Class A mishap involving a B-2A aircraft, T/N 89-0127, assigned to the 393d Bomb Squadron (393 BS), 509th Bomb Wing (509 BW), Whiteman AFB, MO which occurred immediately after takeoff at Andersen AFB, Guam on 23 February 2008.

2. ACCIDENT SUMMARY

The Mishap Aircraft (MA), a B-2A, T/N 89-0127, departed Andersen AFB Guam at 1030 hours local time (0030 Zulu (Z)) on 23 February 2008, to return to Whiteman AFB, MO following a four-month deployment. Approximately 17 seconds after takeoff the MA crashed, with the wreckage coming to rest on the infield between the parallel runways (Tab B-3). Mishap Pilot 1 (MP1), Maj Ryan A. Link, and Mishap Pilot 2 (MP2), Captain Justin T. Grieve, successfully ejected prior to impact (Tab B-3). MP1 was not injured; MP2 sustained a spinal compression fracture, but is expected to fully recover (Tab X-5). Local emergency personnel responded to the mishap and recovered the crew. The MA was destroyed by fire after impact with a total loss of $1,407,006,920 (Tab P-3). Andersen AFB addressed environmental remediation associated with the mishap.

3. BACKGROUND

a. 509th Bomb Wing

The 509 BW is located at Whiteman AFB in Knob Noster, MO operating and maintaining the Air Force's premier weapon system, the B-2 bomber. The B-2 brings massive firepower to bear, in a short time, anywhere on the globe through previously impenetrable defenses. Whiteman is also the home of the 442nd Fighter Wing, an Air Force Reserve Command unit that flies the A-10 Thunderbolt II, as well as the Missouri Army National Guard 1-135th Aviation Battalion, which flies the AH-64 Apache helicopter. The Navy Reserve Mobile Inshore Undersea Warfare Unit 114 also operates from Whiteman. Their mission is to provide surveillance, intelligence and force protection measures for naval assets.

The bomb wing's mission is to provide full spectrum, expeditionary, B-2 global strike and combat capabilities to geographic commanders and the Commander, United States Strategic Command, while supporting Team Whiteman. The wing is assigned to ACC's 8th Air Force (Tab BB-3).

b. 393d Bomb Squadron

The 393 BS is one of two bomb squadrons assigned to the 509 BW, activated by the Army Air Forces on 28 February 1944. The squadron served continuously until its deactivation by Strategic Air Command on 30 September 1990. On 27 August 1993 the squadron was reactivated in preparation to become the first B-2 squadron in the United States Air Force. The squadron received its first airplane, the "Spirit of Missouri," on 17 December 1993 and started flying missions. On 1 April 1997, the Air Force declared the squadron and the bomb wing as initial operational capable. The squadron supports the wing's mission by providing worldwide capability with a force of B-2 aircraft, aircrews and operations personnel supporting Joint Chiefs of Staff nuclear and conventional taskings, capable of projecting B-2 global firepower at a moment's notice, anytime, anywhere.

c. 36th Operations Group (36 OG)

When deployed to Guam in support of Pacific Air Force's (PACAF) continuous bomber presence, the bomb squadron is assigned to the 36 OG and takes on the expeditionary role. The 36 OG is part of the 36th Wing based at Anderson AFB. The wing's mission is to provide a United States-based lethal warfighting platform for the employment, deployment, reception and throughput of air and space forces in the Asia-Pacific region. The 36 OG executes this mission by receiving, integrating, supporting and employing assigned flying units, ensuring they are prepared to prevail and ready to deliver sovereign options for the defense of the United States of America and its global interests. In addition, they maintain safe airfield operations to support peacetime, contingency, and wartime employment and throughput. On order, combat power is employed to support our allies, deter potential adversaries and destroy active enemies throughout the Pacific Theater.

d. B-2 Spirit

The B-2 Spirit is a multi-role bomber capable of delivering both conventional and nuclear munitions. A dramatic leap forward in technology, the bomber represents a major milestone in the United States bomber modernization program.

Along with the B-52 and B-1B, the B-2 provides the penetrating flexibility and effectiveness inherent in manned bombers. Its low-observable, or "stealth," characteristics give it the unique ability to penetrate an enemy's most sophisticated defenses and threaten its most valued and heavily defended assets. Its capability to penetrate air defenses and threaten effective retaliation provides a strong, effective deterrent and combat force well into the 21st century. The revolutionary blending of low-observable technologies with high aerodynamic efficiency and large payload gives the B-2 important advantages over existing bombers. The B-2 has a crew of two pilots, a pilot in the left seat and mission commander in the right.

The first B-2 was publicly displayed on 22 November 1988, when it was rolled out of its hangar at Air Force Plant 42, Palmdale, California. Its first flight was 17 July 1989. The combat effectiveness of the B-2 was proven in Operation Allied Force, where it was responsible for destroying 33 percent of all Serbian targets in the first eight weeks by flying nonstop to Kosovo from its home base in Missouri and back. In support of Operation Enduring Freedom, the B-2 flew one of its longest missions to date from Whiteman to Afghanistan and back. The B-2 completed its first-ever combat deployment in support of Operation Iraqi Freedom, flying 22 sorties from a forward operating location as well as 27 sorties from Whiteman AFB, releasing more than 1.5 million pounds of munitions. The B-2's proven combat performance led to declaration of full operational capability in December 2003 (Tab BB-4 thru BB-5).

4. SEQUENCE OF EVENTS

a. Mission

The Mishap Mission (MM) began with scheduled mission planning two days before the flight occurred. The mission was planned as a long-duration formation sortie with the MA scheduled as number two in the two-ship formation. The aircraft was returning to Whiteman AFB after a four-month deployment in support of PACAF's continuous bomber presence. The sortie was planned with two air refuelings and total duration of 16.2 hours (Tab K-3). The sortie was originally scheduled for 22 February 2008; however it was cancelled at crew showtime due to inclement weather at the landing base. The entire plan was slipped 24 hours (Tab V-3.5, V-9.5 thru V-9.6, V-24.7, V-25.7).

Aside from the delay, the mission was planned as scheduled; the flight was authorized IAW instructional guidance by the 393 BS Director of Operations (DO) (Tabs K-3, K-7).

b. Planning

The instructor pilot from the lead aircraft directed the mission planning which was accomplished IAW Air Force and local instructional guidance. Due to the 24-hour delay, the Deputy Operations Group Commander, the squadron DO, the operations supervisor and the flight leader met before the crew showtime to check landing weather and make a final go/no-go decision for the mission (Tab V-2.6, V-3.6, V-9.6, V-24.8, V-25.7). The two flight crews then assembled at the operations building and the flight lead re-briefed the highlights of the sortie. The operations supervisor briefed all crews prior to their departure for the aircraft. The briefing covered administrative flight information, weather, notices to airmen (NOTAMS), jet status and all items necessary to safely execute the planned redeployment sorties. All crewmembers understood the briefing and had no questions as they departed for their aircraft (TAB V-2.6, V-3.6, V-8.4, V-9.6). MP1 was the designated Aircraft Commander for the MA (Tab K-7).

c. Preflight

The Mishap Crew (MC) departed the squadron operations area, picked up their life support equipment and applicable classified material, then continued to the aircraft (Tab V-2.6, V-3.6). The MC arrived at the MA, reviewed the aircraft forms and finished loading the aircraft. Since it was a redeployment sortie, maintenance loaded spare equipment in the aft equipment bay. The MC loaded their personal equipment, the classified material and the long duration crew comfort equipment in the cockpit (Tab V-2.7, V-3.7). The MC conducted a pre-flight walk-around inspection of the MA after all equipment was loaded (Tab V-2.7). At 2315Z, on 22 February 2008 the engines were started and avionics power was applied; nothing remarkable was noted (Tab V-2.9, V-3.9).

d. Summary of Accident

After engine start the MC continued with aircraft checklists. The crew chief updated the aircraft operating weight and center-of-gravity on the data entry panel to account for the extra equipment (Tab V-2.8, V-3.9, V-21.11). At 2329Z the MC selected flight control systems (FCS) maintenance mode IAW instructional guidance. This step checks for any FCS status messages prior to the flight control abbreviated built-in-test (ABIT) (Tabs V-2.10, V-3.11, DD-3). The MC noticed an "AIRDATA CAL" required message on the FCS status display and called for a flight controls specialist (Tab V-2.10, V-3.11). The specialist reported to the MA and performed the air data calibration procedure at 2334Z (Tabs J-60, V-5.11, DD-3).

The air data calibration procedure was designed to allow maintenance crew to correct accumulated instrument error in the port transducer units (PTUs) when required. This function is enabled when the operator enters FCS maintenance mode. By specification tolerance, PTU pressure measurement can accumulate an instrument error at a rate of 0.006 inches of mercury (in-Hg) annually. During an air data calibration, the PTU pressure reading for each PTU is compared to the average of all 24 PTUs. If any PTU reports a pressure reading that differs from the average by more than +/- 0.0 5 in-Hg, the FCS computes and sends a bias value to that PTU. The PTU stores that bias value in its non-volatile memory and sends this value along with all sensed pressure readings back to the flight control computers (FCC). The FCS uses sensed air pressure from PTUs at various locations on the wing to calculate aircraft airspeed, angle of attack (AOA), angle of sideslip (AOS) and altitude (Tab J-59 thru J-60).

When the air data calibration was accomplished on the MA, three of the four upper gust load alleviation port transducer units (GLA PTUs) required and accepted the calibration offset (bias), rescinding the AIRDATA CAL required message (Tab DD-3 thru DD-4).

Based on post-mishap testing (Tab J-31 thru J-36), the presence of moisture in the PTUs can result in an air data calibration applying a bias that exceeds a negative 0.40 inches of Mercury (Hg). Analysis indicated that when the calibration was accomplished on the MA, three PTUs contained moisture and required a bias correction that was larger than would otherwise be necessary (Tab DD-3, DD-4). The applied bias values differed from the average readings of the remaining 21 PTUs by as much as a negative 0.262 Hg. In effect, inappropriate bias values were given to the PTUs during the air data calibration. Following the air data calibration, analysis indicates the barometric altimeter measurement on the MA had increased by 31 feet from 576 to 607 feet. The MA altimeters checked within +/-75 feet of field elevation as required by the last step in the air data calibration checklist (Tab J-55, J-60, J-63). The remaining ground operations were unremarkable and the MA taxied at 0019Z (Tabs V-2.11, V-3.12, DD-4).

Pre-takeoff visual ("last chance") inspections were accomplished by the maintenance Production Supervisor on the MA at 0021:45Z and the MA taxied to the hold line for runway 06R (Tab V-2.11 thru V-2.12, V-3. 12 thru V-3.13, DD-4 thru DD-5). At 0029:32Z the MC turned on the pitot-static heater switch in preparation for takeoff. The MC verified the "PS HTR OFF" advisory rescinded from the status page, confirming the pitot heat was on (Tabs V-2.12, V-3.13, DD-5). Data shows the surveyed field elevation at the hold line was 546 feet and the MA altimeter indicated 682 feet, an instrument error of 136 feet. However, there was no placard indicating field elevation at the hold line so the error went unnoticed (Tab J-44 thru J-45). At 0030Z MP1 advanced the throttles to maximum continuous thrust (MCT) for takeoff; at 0030:01Z flight control channels 2, 3 and 4 PTU heaters reported normal heating; at 0030:10Z, channel 1 port transducer unit heater also reported normal heating (Tab DD-5). MP1 released brakes starting the takeoff roll at 0030:12 (Tab V-2.12 thru V-2.13, V-3.13 thru V-3.15, DD-5).

At 0030:31Z, approximately 19 seconds after brake release, the master caution light illuminated along with a FCS caution on the status display. Seconds later, the MC observed associated air data faults on the FCS status page (Tabs V-2.14 thru V-2.15, V-3.18 thru V-3.21, DD-6). MP2 acknowledged the caution and analyzed the indications (Tab V-3.18 thru V-3.21). Almost immediately, the flight control fault indications went away indicating to MP2 that the discrepancy had cleared (Tab DD-6). Six seconds after initial indications (0030:37Z), the FCS caution rescinded suggesting to the MC that the MA was capable of normal flight (Tab DD-6).

Analysis indicates the FCS status page displayed two yellow "X's" and two white "X's" in the AOA row of the air data matrix (Tabs V-3.19 thru V-3.20, DD-6). The two yellow X's and two white X's in the matrix is known as a "2-on-2" condition. The 2-on-2 is an effort by the FCS to reconcile data differences from two channels against two other channels and both pairs to a previously acceptable value. In this case, the FCS was trying to reconcile data differences introduced as a bias to three of the four GLA PTUs during the moisture contaminated air data calibration. When two channels resolved to within established parameters, the FCS logic exited the 2-on-2 condition and the FCS caution was rescinded (Tab DD-34 thru DD-37).

As the MA proceeded through takeoff , the air data system became fully operational as a function of an airspeed threshold and aircraft state logic. Therefore the full impact of the air data biases and subsequent complete air data system failure were not detected until the aircraft was weight off wheels (WOW). As the aircraft went WOW, the MA calculated an excessive negative AOA value that pitched the aircraft up in a manner the crew was unable to override. It was not possible for the crew to be aware of the AOA error prior to the pitch up (Tabs DD-24, DD-35).

The lead and MA both accelerated on a similar groundspeed profile until each achieved WOW. The lead aircraft's takeoff roll distance was approximately 5,825 feet with a calibrated airspeed between 145 and 147 knots at liftoff. The MA takeoff roll distance was estimated at 4,375 feet and calibrated airspeed at liftoff of approximately 132–134 knots. Due to the errors in the FCS, the indicated airspeed displayed to the MC was an estimated 144-146 knots indicated airspeed (KIAS), approximately 12 knots higher than actual speed. Based on these values, takeoff roll for the MA was 1,450 feet shorter and liftoff occurred 13 knots slower than the lead aircraft (Tabs J-45 thru J-46, DD-25).

At 0030:49Z the MA nose-wheel gear lifted off the runway (Tab DD-6). MP1 initiated the takeoff with a normal stick force, attempting to establish a standard pitch attitude and climb-rate (Tabs V-2.16, DD-22). As the MA main gear lifted off the runway, the miscalculated negative AOA was interpreted as a dangerously nose-low attitude by the FCS which therefore commanded "full nose-up" to the flight controls. The result was an abrupt 1.6 times the force of gravity (G) pitch-up (0030:50Z) and a 30 degree nose-high pitch angle (Tabs J-57, DD-6 thru DD-7, DD-22, DD-24). As the MA lifted off at 0030:15Z, all air data was lost, causing the FCS to substitute inertially derived values for air data computations and the MA to revert to default flight control gain settings (Tabs J-57 thru J-58, DD-7). With loss of air data, AOA, AOS, airspeed and altitude indications, flight control response, as well as longitudinal and directional stability of the aircraft, were degraded. MP1 attempted to recover from the low altitude, low airspeed condition, but was not successful (Tab V-2.16 thru V-2.21, DD-7 thru DD-9, DD 22 thru DD-23). MP2 initiated the ejection sequence at 0031:06Z just after the left wingtip made contact with the ground, successfully ejecting MP2 first, followed by MP1 (Tabs V-3.26 thru V-3.28, DD-7 thru DD-9).

e. Impact

Ground impact started with the left wingtip dragging the ground approximately 7,500 feet from the beginning of the takeoff roll (Tab H-91, J-8). After the pilots ejected, the MA pitched over striking the ground with a 6 G impact on the nose gear (NG) and the left main landing gear (LMG) at 0031:08Z (Tab H-91, J-6 thru J-8). Upon impact, the NG and the LMG collapsed, the NG door separated from the MA ending up 400 meters (m) from the MA wreckage. The LMG was located 475m from the MA wreckage (Tab H-91). After initial impact, the MA rolled right striking the ground with the right main landing gear with a 2.44 G impact (Tab H-91, J-6 thru J-8). The MA continued to skip along the ground for another six seconds before coming to stop 717m from the initial impact (H-91, J-8). The initial ground impact caused fuel to begin spilling from the LMG wheel well, as the MA came to stop the fuel burst into flames burning for approximately six hours (H-91). The scorched area covered an area of approximately 29,517 square meters (H-91). The debris field was 18,964 square meters. The debris field consisted of composite material fragments and metal pieces of various sizes and shapes (H-91).

f. Life Support Equipment, Egress and Survival

Analysis of the recovered ejection seats and assorted aircraft equipment demonstrated that all critical components required to execute a survivable escape from an endangered aircraft worked appropriately (Tab H-5 thru H-6). The ejection seat system was set in AUTO mode which ensures both aircrew are ejected when either pulls their seat actuation handles (Tab H-3). Both seats had their ejection actuation handles pulled in the up and locked position indicating that either pilot could have initiated the ejection (Tab H-5).

Testimony indicates that MP2 verbalized that an ejection may be necessary following the aggressive, uncommanded pitch-up (Tab V-3.25). The entire airborne event lasted mere seconds, so when MP2 determined that an ejection was required, he did not recall verbalizing his intention to MP1 (Tab V-3.26 thru V-3.27). MP1 did not recall actuating his ejection handles following his struggle to maintain control of the aircraft although he did testify to feeling his right hand 'hitting' the top of the handle and hearing a voice or thought saying "get out" (Tab V-2.20 thru V-2.21). Since both seats had their ejection handles up and locked it is possible that the pilots' ejections were initiated simultaneously.

Both MP1 and MP2 were evaluated at the base clinic. MP1 was released without serious injury. However, MP2 was further evaluated for back pain (Tab X-5).

g. Recovery of Remains

Not applicable.

5. MAINTENANCE

a. Forms Documentation

The maintenance history of every Air Force aircraft is recorded on paper forms called Air Force Technical Order (AFTO) Form 781's as well as a computerized database called Integrated Maintenance Data System (IMDS). These two methods combine to track every maintenance action taken on the aircraft to include routine inspections and any overdue items. When AFTO 781 Forms are removed from the aircraft's active forms binder, they are kept in a jacket file along with all other aircraft historical data.

A thorough review of the AFTO 781 Forms and jacket file for the MA from 90 days preceding the mishap revealed no evidence of mechanical, structural, electrical or avionics failures that contributed to the mishap (Tab D-3, D-7 thru D-33).

IMDS data for the MA from 90 days preceding the 23 February 2008 mishap was reviewed. No overdue inspections, time-change items or Time Compliance Technical Orders (TCTO) were found (Tab D-21). IMDS data verified that no negative maintenance trends existed. There were no "could not duplicate" items listed in the forms, meaning there were no discrepancies annotated by pilots inflight that could not be found or duplicated and repaired by maintenance.

b. Inspections

Maintenance documentation confirmed that all inspections were satisfactorily accomplished in accordance with applicable maintenance directives AFI 21-101 and 1B-2A-6. All scheduled aircraft inspections found on the AFTO Form 781K were current and up-to-date (Tab D-19). All recurring hourly scheduled inspections, to include Hourly Post Flight (HPO) and Phase inspections, were current (Tab D-19).

The MA had a current pre-flight inspection signed off in the AFTO 781H (Tab D-5). There were two pre-flight inspections documented two days apart prior to the mishap due to the 24-hour delay of the scheduled flight. Both pre-flights were complete and did not highlight any outstanding issues with the MA.

The MA was equipped with four General Electric F118-GE-100 engines that are paired in engine bays located to the left and right of the main fuselage center. The engines are numbered 1 - 4 going from left to right, as you sit in the aircraft facing forward. All four engines' scheduled inspections were aligned so they would come due at the same time and be accomplished with the HPO inspection which occurs every 200 hours of flight time.

The MA's number 1 engine, with 4,398.2 operating hours (Tab D-17), was installed on 26 February 2007. This engine was last overhauled on 2 August 2006 (Tab D-3). The engine had no overdue inspections or TCTOs. The engine had 111.5 hours of operation time remaining before its next scheduled inspection was due. No significant engine maintenance, scheduled or unscheduled, relevant to the mishap was performed on engine number 1.

The MA's number 2 engine, with 2,270.5 operating hours (Tab D-17), was installed on 22 February 2007. This engine was last overhauled on 24 June 1997 (Tab D-3). The engine had no overdue inspections or TCTOs. The engine had 111.5 hours of operation time remaining before its next scheduled inspection was due. No significant engine maintenance, scheduled or unscheduled, relevant to the mishap was performed on engine number 2.

The MA's number 3 engine, with 2,625.9 operating hours (Tab D-18), was installed on 8 September 2007. This engine was last overhauled on 16 January 2007 (Tab D-3). The engine had no overdue inspections or TCTOs. The engine had 111.5 hours of operation time remaining before its next scheduled inspection was due. No significant engine maintenance, scheduled or unscheduled, relevant to the mishap was performed on engine number 3.

The MA's number 4 engine, with 4,021.2 operating hours (Tab D-18), was installed on 14 September 2007. This engine was last overhauled on 28 February 2006 (Tab D-3). The engine had no overdue inspections or TCTOs. The engine had 111.5 hours of operation time remaining before its next scheduled inspection was due. No significant engine maintenance, scheduled or unscheduled, relevant to the mishap was performed on engine number 4.

c. Maintenance Procedures

All maintenance procedures, practices, and policies were in compliance with Air Force guidance. Maintenance tasks were documented with proper reference to applicable technical orders. "Red ball" maintenance, or those items that maintenance was called out to fix after the crew's arrival at the aircraft and often after engine start, were not always documented in the forms. Air data calibrations are an example of red ball maintenance that was not documented in the AFTO 781A. Air data calibrations were sometimes documented in a shop log book, but not always.

Air data calibrations are a procedure to ensure all PTUs are sensing relatively the same pressure prior to takeoff. The air data calibration procedure that flight controls technicians used to calibrate the air data system was accomplished correctly with no deviations. Each step was executed in accordance with B-2 technical data.

During previous deployments to Guam, maintenance personnel noted an increased requirement to perform air data calibrations on aircraft that were deployed versus those at home station. Air data calibrations were seldom required at Whiteman AFB (Tab V-14.4, V-15.4 thru V-15.5, V-17.9). During a 2006 Guam deployment, maintenance technicians contacted support engineers via Whiteman AFB Engineering Technical Services personnel to assess the possible causes and request help to mitigate the increased calibration requirement (Tab V-14.5). A suggestion was made by system engineers at

Tinker AFB to turn on pitot heat prior to the air data calibration in order to evaporate any moisture from the system (Tab V-12.7). Testimony from maintenance technicians indicates that turning on pitot heat alleviated the requirement for an air data calibration in the majority of cases (Tab V-13.9). This technique was used in 2006 but was not documented in the after action report and there was no documented attempt to make a change to technical order guidance following the deployment (Tab V-15.18).

The increased requirement for air data calibrations surfaced again during the 2007/2008 deployment, becoming more prevalent during the fourth month. Eight instances of air data calibrations being performed during the deployment were documented in a log book; no documentation was found in aircraft forms or IDMS. While most deployed flight controls technicians had heard about the technique of using pitot heat prior to an air data calibration, at least one technician had no knowledge of the technique (Tab V-13.20 thru V-13.21).

Prior to this mishap there was no technical order guidance to use pitot heat before accomplishing an air data calibration procedure. This technique was not used on the MA the day of the mishap (Tab V-5.11 thru V-5.15).

d. Maintenance Personnel and Supervision

The 36th Expeditionary Aircraft Maintenance Squadron (36 EAMXS) Commander, First Sergeant, Maintenance Operations Officer, and Maintenance Superintendent provided adequate leadership and supervision at the deployed location. In addition, each section had a designated Section Chief. The Production Lead directed all flightline operations and determined status of the aircraft. This is the same basic supervision structure employed at Whiteman AFB.

Dedicated crew chiefs performed the preflight inspections and servicing on the MA on 22 February 2008 and the Production Superintendent released the aircraft for flight by signing the exceptional release block on the AFTO Form 781H (Tab D-5).

A thorough review of the AF Form 623, individual training record, AF Forms 797, Job Qualification Standard Continuation/Command, IMDS Special Certification Roster, and all associated maintenance forms was accomplished. Records indicate maintenance personnel assigned to maintain the MA were properly trained and had the necessary skill level and qualifications to perform their assigned duties (Tab G-53 thru G-106). Data retrieved from IMDS revealed unit ancillary training was effectively utilized and no overdue training tasks were identified.

Most maintenance supervisors were unaware of the increased number of air data calibrations being performed in Guam as compared to Whiteman AFB and only one of those interviewed was aware of the technique suggested by engineers to alleviate the requirement (Tab V-17.12 thru V-17.14, V-18.7 thru V-18.8).

e. Fuel, Hydraulic and Oil Inspection Analysis

Maintenance guidance, B-2A-6, requires engine oil samples be taken every 25 hours of accumulated flight time. Engine oil samples were taken from the MA on 21 February 2008 after flight. After the analysis, the samples were found to be code "A" flyable and all four engines were good for another 25 flight hours (Tab U-17 thru U-20). Oil analysis records from 6 October 2007 thru 21 February 2008 indicated no trends or indications of excessive engine component wear on any of the four engines (Tab U-13 thru U-16).

After the mishap, the Aerospace Ground Equipment, fuel and oil carts were impounded and then returned to the 36 EAMXS by the Safety Investigation Board. Post-mishap fluid samples were taken from hydraulic test stand carts (Tab U-8). Fuel samples were taken from the fuel trucks (Tab U-3). These samples were analyzed at Tinker AFB, Oklahoma and met specification requirements.

f. Unscheduled Maintenance

The MA had flown six sorties within the month of February prior to the mishap, with none of these sorties requiring an air data calibration before takeoff. The last such calibration on the MA was accomplished on 8 January 2008. As discussed in Section 4, the MA required an air data calibration during ground operations prior to the mishap sortie. Once this procedure was accomplished, the message cleared (see section 6d for more details). No other unscheduled maintenance was done to the MA on the day of the mishap. The only other unscheduled maintenance performed since the last flight was changing the #4 Aircraft Mounted Accessory Drive; this maintenance was properly documented and had no impact on the mishap.

6. AIRCRAFT AND AIRFRAME, MISSLE, OR SPACE VEHICLE SYSTEMS

a. Condition of Systems

Although the aircraft was a total loss on impact, the debris area was small due to the aircraft staying mostly intact all the way to its resting point. The wings remained intact and attached to the aircraft despite structural failure to the main spars and ruptured fuel tanks. There were no structural failures prior to ground impact (Tab J-6).

The systems analysis described below was primarily accomplished using data from the Maintenance Write Cartridge (MWC), Disk Drive Unit (DDU) buffer and the Crash Survivable Memory Unit (CSMU) recovered from the MA. More information is included on the data recovery systems at the end of this section.

b. Analysis of Engines

Engine status parameters indicate no engine faults or failures until engine failures and engine stall indications were recorded a few seconds before main airframe impact with the ground. Video and data analysis indicates ingested debris from the ejection sequence caused a compressor stall on engines 1 and 2 (Tab S-15). After impact, the Onboard Test System (OBTS) and OBTS Ground Processor (OGP) showed all four engines were still operating at a high rate of thrust for approximately six seconds after impact.

c. Landing Gear System

The landing gear systems which include brakes and proximity switches, as well as hydraulic and structural components indicated no component problems or issues until the landing gear and associated structure failed at ground impact (Tab J-39).

d. Analysis of Hydraulics and Flight Controls

Although the system 1 pump sensor 1B, the system 3 temperature sensor, the system 1 pump 4B sensor, and the system 1 return filter element registered failures, these minor sensor discrepancies had no bearing on the mishap. All critical components of the hydraulics system are quad-redundant. The hydraulic system health data recorded did not indicate any significant failures (Tab J-39).

The surface commands and movements recorded on the CSMU show appropriate response of the actuators and flight controls (Tab J-39).

The Auto Flight system which includes all auto-pilot functions had normal system start up fault indications and all components of the system reported good health shortly after power up and system integration (Tab J-38).

e. Fuel System

The fuel system had intermittent right hand aft tank fuel level sensor inputs. All critical components of the fuel system are dual redundant and a single sensor failure will not affect system operation or performance. The Manual Fuel Control Panel was found intact, and the command select switch was found in the "auto" position. There was no indication of fuel system failure and there was no indication that fuel had been transferred to the surge tanks. A complete review of individual fuel tank quantities was completed and verified with no discrepancies noted. Center of gravity (CG) management was operating correctly and maintaining CG within design limits (Tab J-40).

f. Analysis of Air Data System

The aircraft's air data system uses PTUs to provide information critical to flight. Heaters attached to each PTU are controlled by one switch and are used to keep the PTU clear of ice and moisture on the ground prior to take-off and inflight. Using the heat while the aircraft is on the ground is kept to a minimum due to insufficient ambient cooling of the PTUs and concern over damaging the surface of the aircraft. A complete analysis of the power path to each PTU heater was accomplished with no discrepancies noted (Tab J-41 thru J-42).

Twenty-three of the twenty four PTU's were recovered and the components for each PTU assembly were sent in separate boxes to Goodrich Corporation in Burnsville, Minnesota, the manufacturer of the B-2 PTU assemblies. One PTU, lower gust load alleviation #4, was unrecoverable. All twenty-three PTU's were received in sufficient condition to allow inspection and none of the pneumatic passageway components were found to be totally obstructed. All heater elements had proper resistance values (Tab J2A-2). Analysis indicates all PTU's were functioning normally, though at least three had received a correction during the air data calibration that was distorted by moisture.

g. Onboard Test System (OBTS)

OBTS provides continuous monitoring of aircraft systems during operation. OBTS provides aircrews with system health and status information concerning safety of flight, mission accomplishment capability and redundancy management. OBTS provides maintenance crews with identification of failed Line Replaceable Units (LRUs), Line Replaceable Modules (LRMs) and Shop Replaceable Units (SRUs). Extensive data, including information on aircraft operating parameters for diagnosis, shop level repair, and tracking of system performance and history are recorded. OBTS data is recorded on the MWC, then transferred to an OBTS computer for off aircraft analysis. This system was functioning normally and survived the impact. The system provided valuable data that was used to help determine the sequence of events in this mishap (Tabs J-5, DD-3 thru DD-21).

h. Maintenance Write Cartridge (MWC) and OBTS Ground Processor (OGP)

The MWC was retrieved from MA wreckage and the OBTS data was recoverable. Data recovered from the MA was subsequently processed on the OGP system for analysis. Data from the MA was continuously recorded from the time avionics was powered up and integrated to approximately 1 second after impact. An additional 4 seconds of OBTS data was manually retrieved from the MWC DDU buffer. This data proved critical to the investigation (Tab DD-3 thru DD-21).

OGP is a ground-based piece of aircraft support equipment which processes the data recorded on the MWC during flight or ground maintenance operations. Subsystem failure information and related air vehicle parameters are displayed on the OGP screen for immediate review. Various types of reports are available from the OGP for use by maintenance, engineering and contractor personnel in analyzing system operation and trouble shooting system failures. These reports include flight and ground maintenance data on nearly all of the B-2 systems to include but not limited to avionics, electrical, propulsion, environmental, weapons and mechanical (Tab DD-3 thru DD-21).

i. Crash Survivable Memory Unit (CSMU) Data

The CSMU was recovered from the MA and downloaded by the Air Force Safety Center. A raw data file was subsequently processed on the OGP system for analysis. Data from the MA CSMU continued to record for 2 seconds after impact (Tab J-37, J-54).

7. WEATHER

a. Forecast Weather

Weather conditions at scheduled takeoff time were forecast to be: 22° Celsius; with winds from 060° magnetic at 15 knots gusting to 25 knots; the altimeter setting was 30.03; with scattered clouds at 2,000 feet and 5,000 feet; visibility was 7 miles, and the pressure altitude was 526 feet (Tab F-3).

b. Observed Weather

The 23:59:59Z Automatic Terminal Information Service weather conditions were 27° Celsius, winds were 050° magnetic at 15 knots, the altimeter setting was 29.95, the pressure altitude was 660 feet, clouds were scattered at 1,400 feet, and visibility was 7 miles (Tab F-8). Video analysis of the mishap and the resulting smoke plume, as well as witness testimony indicates the winds had shifted from a projected slight left crosswind to straight down the runway or a slight right crosswind at takeoff time (Tab V-24.10 thru V-24.13).

c. Space Environment

Not applicable.

d. Conclusions

The mission was flown IAW AFI 11-202 Vol. 3, *General Flight Rules,* weather requirements. These observed weather conditions are typical for the region and time of year; they presented no remarkable challenges to the mishap crew.

8. CREW QUALIFICATIONS

At the time of the mishap, MP1 was a qualified Instructor Pilot in the B-2A. All necessary flight currencies were up-to-date and all required training for the planned mission was current IAW AFI 11-2B-2 Vol. 1, *B-2 Aircrew Training* (Tab G-3 thru G-16). MP1 performed his last mission/instrument/qualification evaluation on 16 July 2007. He was rated qualified with no discrepancies; his mission planning and instructor performance were evaluated as Commendable (Tab G-32 thru G-34).

MP1 was an experienced pilot with over 2,330 hours of military flying time. Specifically, MP1 had 336.8 hours in the B-2A with 66.2 hours of instructor time (Tab

G-4, G-5). Recent flight time is as follows (Tab G-6):

	Hours	Sorties
30 Days	5.8	2
60 Days	19.5	5
90 Days	37.8	6

At the time of the mishap, MP2 was a qualified Pilot in the B-2A. All necessary flight currencies were up-to-date and all required training for the planned mission was current IAW AFI 11-2B-2 Vol. 1, *B-2 Aircrew Training* (Tab G-23 thru G-31). MP2 performed his last mission/instrument/qualification evaluation on 15 January 2008. He was rated qualified with no discrepancies; on his initial qualification checkride his mission planning, briefing and tactical plan were evaluated as Commendable (Tab G-41 thru G-48).

MP2 was an experienced pilot with over 2,660 hours of military flying time. Specifically, MP2 had 279.8 hours in the B-2A (Tab G-18, G-19). Recent flight time is as follows (Tab G-20):

	Hours	Sorties
30 Days	12.7	3
60 Days	24.7	6
90 Days	36.5	9

9. MEDICAL

a. Qualifications

MP1 and MP2 were medically qualified for flight duty. MP1's last flight physical was accomplished 11 September 2007 and was valid through 30 September 2008 as indicated on Medical Recommendation for Flying or Special Operational Duty, AF Form 1042, dated 11 September 2007 (Tab X-3). MP2's last flight physical was accomplished on 11 September 2007 and was valid through 30 November 2008 as indicated on Medical Recommendation for Flying or Special Operational Duty, AF Form 1042, dated 11 September 2007 (Tab X-4).

b. Health

Review of MP1 and MP2's medical records revealed no preexisting or currently existing illness or medical treatment that contributed to the mishap. Nuclear Weapon Personnel Reliability Program records, maintained IAW Department of Defense Directive 5210.42, were current for both aircrew and demonstrated no psychological or behavioral concerns.

MP1 was treated locally and then released following the mishap without serious injury. Post accident radiology imaging of MP2's back revealed a moderate compression fracture of the thoracic spine with no significant nerve involvement or damage. MP2 was transferred to a military medical facility in Hawaii where he was evaluated by orthopedic specialists and fitted with a custom brace to facilitate a safe and full recovery. MP2's injury is consistent with the vertical forces experienced in an ejection or a hard parachute landing though the exact timing and cause of the injury cannot be determined (Tab X-5).

c. Pathology

Not applicable.

d. Toxicology

Toxicological examination of the MC's blood and urine immediately following the incident was negative for carbon monoxide, ethanol, amphetamine, barbiturates, benzodiazepines, cannabinoids, cocaine, opiates, and phencyclidine. Blood and urine screening of 56 personnel associated with maintaining the aircraft was unremarkable and no tests were abnormal (Tab X-6).

e. Lifestyle

There is no indication through interview or medical record review that either MP1 or MP2 engaged in any unusual habits, behaviors or stressors that contributed to the accident (Tabs V-2.4, V-3.5 thru V-3.7, V-8.4 thru V-8.5, V-9.4, V-23.10 thru V-23.11, V-24.4 thru V-24.5, V-24.8, V-25.4).

f. Crew Rest and Flight Duty Period

Both MP1 and MP2 complied with crew rest requirements prior to the mishap. Interviews with the MC and witness testimony indicated that mission planning was completed two days prior to the mishap. The day prior was utilized almost entirely as crew rest due to a 24-hour departure delay due to inclement weather at the destination (Tabs V-2.4 thru V-2.5, V-3.5 thru V-3.7, V-8.4 thru V-8.5, V-23.10, V-24.7). The requirements for crew rest and flight duty period (FDP) are found in AFI 11-202, Volume 3, *General Flight Rules* paragraph 9.3.5 which states:

> Crew rest is required prior to inflight duties. The crew rest period is normally a minimum 12-hour non-duty period before the FDP begins. Its purpose is to ensure the aircrew member is adequately rested before performing flight or flight related duties. Crew rest is free time, which includes time for meals, transportation, and rest. Rest is defined as a condition that allows an individual the opportunity to sleep.

Testimony indicated that both MP1 and MP2 presented for duty on the morning of the mishap alert and behaving in their usual manner (Tabs V-2.4, V-3.5 thru V-3.7, V-8.4 thru V-8.5, V-9.6, V-23.10 thru V-23.11).

10. OPERATIONS AND SUPERVISION

a. Operations

The 509 BW regularly deploys to Andersen AFB, Guam in support of PACAF's continuous bomber presence. The expeditionary bomb squadron deploys with pilots from the other squadrons at Whiteman AFB, providing valuable deployment experience. While deployed, the pilots fly at a slightly higher sortie rate than home station flying.

b. Supervision

The mishap sortie was mission planned as scheduled; the sortie was slipped 24 hours at crew show time the day before due to weather at the destination base. On the day of the mishap the MC was thoroughly briefed by the operations supervisor and the flight lead re-briefed the high points of the planned sortie (Tab V-2.6, V-3.6, V-8.4, V-9.6). Supervision and oversight were proper and adequate for the mission.

11. HUMAN FACTORS

Human factors contribute to the majority of aircraft mishaps. Analysis indicates that human error is identified as a causal factor in 80 to 90 percent of mishaps, and is present but not causal in another 50 to 60 percent of all mishaps, and is therefore the single greatest mishap hazard (Tab BB-8). The Department of Defense Human Factors Analysis and Classification System includes a list of the potential human factors that are contributory to a mishap. All factors within the guide were assessed for relevancy regarding the mishap. The following is a discussion of the relevant human factors broken down into aircrew actions, maintenance actions, and organizational and supervision elements.

a. Aircrew Actions

Human Factors considerations of MP2's decision to continue the takeoff following the Master Caution cockpit indication included the following; Caution/Warning-Ignored (Tab BB-11), Decision Making During Operation (Tab BB-11), and Procedural Error (Tab BB-9). MP1 and MP2's testimony, corroborated by recovered aircraft data indicated that the Master Caution was acknowledged by MP2 who then referenced the appropriate information displays to determine what system had triggered the caution indication (Tabs V-3.18 thru V-3.20, V-2.14 thru V-2.15). The status display indicated a FCS caution which prompted MP2 to reference the FCS systems display where he recalls seeing a row of fault indications in the Air Data Matrix section of the display that vanished just at the moment he looked at the display (Tab V-2.14 thru V-2.15, V-3.20). Subsequently, and within six seconds of origination, the FCS caution disappeared (Tab V-3.20 thru V-3.21).

Within the B-2 community a defacto decision speed of 100 KIAS is utilized to determine whether to abort a takeoff or to continue into the air with an error, fault, or failure (Tab

V-2.13 thru V-2.14, V-3.18 thru V-3.19, V-8.8 thru V-8.9, V-9.20, BB-6). In addition, B-2 pilots distinguish between serious concerns meriting an aggressive decision to abort a takeoff presented by a red Master Warning light, and yellow Master Caution lights that are "analyzed" prior to taking action. Since the yellow Master Caution, rather than a red Master Warning, occurred after accelerating past 100 KIAS, the MC did not reflexively initiate an abort. MP2 turned his attention to the appropriate displays to analyze the cause of the Master Caution and was presented with the brief fault indications in the Air Data Matrix rapidly followed by the original FCS Caution being rescinded, which the aircrew interpreted as the aircraft's systems were capable of normal flight (Tab V-3.20 thru V-3.21).

Human Factors consideration of MP1's efforts to maintain control of the aircraft focused on Overcontrol/Undercontrol (Tab BB-9). MP1's testimony, recovered aircraft data, video analysis of the mishap, and recreation of the mishap flight from the Mishap Analysis and Animation Facility provided insight into his reactions to the unfamiliar control characteristics that existed at the time of the mishap. The abrupt pitchup was caused by an excessive negative AOA computed at liftoff; not by any control inputs by MP1 (Tabs J-57, DD-6 thru DD-7, DD-22, DD-24). Analysis also demonstrated that MP1's efforts to maintain control of the aircraft were prompt and accurate, though ineffective due to the unrecoverable slow speed, low altitude and degraded flight controls response affected by loss of all air data (Tab J-57, DD-6 thru DD-7, DD-22, DD-24). The life-saving decision to eject was executed after a rapidly worsening, uncommanded roll and yaw to the left that brought the left wingtip in contact with the ground (Tabs V-2.16 thru V-2.18, V-3.23 thru V-3.25, DD-9, MAAF video). Two experienced B-2 pilots were placed in similar situations in a B-2 flight simulator and both described the deteriorated flight control and aircraft response that MP1 encountered on the day of the mishap and both simulated scenarios ended in uncommanded impact with the ground (Tabs V-6.5, V-7.7).

b. Maintenance Actions

Human Factors considerations of flightline maintenance actions focused on Procedural Error (Tab BB-9) with regard to the air data calibration procedure. Testimony from the technician who performed the air data calibration and MP1 indicates that the appropriate procedures were followed (Tab V-2.10 thru V-2.11, V-5.10 thru V-5.15, V-10.13). As a quality control check of the air data calibration procedure prior to takeoff, the actual field elevation is compared with the aircraft instrument indications following completion of the calibration to ensure they are in agreement. Following the procedure, the comparison of the actual and indicated altitudes was within tolerances indicating successful completion of the air data calibration (Tabs V-2.10 thru V-2.11, V-3.12, V-5.15).

c. Organizational and Supervision Elements

Organizational and Supervision elements of greatest relevance included the following; Local Training Issues/Programs (Tab BB-12), Perceptions of Equipment (Tab BB-14), Operations Management (Tab BB-13), and PP106 Communicating Critical Information (Tab BB-10).

Training was not deficient as existing technical orders and procedures regarding maintenance and flight operations were adhered to (Tabs V-2.10 thru V-2.11, V-3.12, V-5.10 thru V-5.15, V-10.13). Perceptions of Equipment were investigated and while there is considerable trust in the quad-redundancy of the flight control system, no evidence suggested that unsafe operations would be executed because of a belief that the redundant FCCs would ultimately correct the situation.

Operations Management is a factor when a supervisor fails to correct known hazardous practices, conditions or guidance that allows for hazardous practices within the scope of his/her command. In this case the existence of a hazardous condition that could result in complete air data loss shortly after takeoff was not known. In over 15 years of operational flight prior to this mishap, an increased requirement for ADCs had not presented itself as an issue worthy of organizational or supervisory adjustments and the potential for introducing distorted data via moisture tainted air data calibrations was not understood (Tab DD-34 thru DD-37, V-6.6, V-7.8, V-13.8, V-14.4 thru V-14.5, V-14.8 thru V-14.9, V-14.13). Air data calibrations were considered to be a benign recalibration of altimeter settings that were accomplished with no adverse mission impact. Even though ADC frequency had increased while deployed, that fact did not make the "Top 10" list of aircraft related concerns as they did not significantly delay takeoffs, cancel missions, or pose a known hazard (Tab V-5.16 thru V-5.18, V-13.11, V-14.10 thru V-14.11, V-17.16, V-18.7).

d. Communicating Critical Information

According to the DoD HFACS, Attachment 1, Page 15: "Communicating critical information is a factor when known critical information was not provided to appropriate individuals in an accurate or timely manner" (Tab BB-10).

The human factor of communicating critical information was a contributing factor to this mishap. Increased air data calibration requirements that occurred almost exclusively while deployed prompted a dialogue that could have resulted in a process to mitigate the primary cause of this mishap. Communications between flight line technicians and systems engineers that occurred in 2006 regarding air data calibrations was appropriate and led to a suggested technique of turning on pitot heat prior to performing an air data calibration. However, this technique was never formalized in a technical order change or captured in "lessons learned" reports. Hence, only some pilots and some maintenance technicians knew of the suggestion to use pitot heat prior to air data calibrations (Tab V-12.9, V-12.18, V-13.16, V-16.5, V-17.14, V-18.8, V-26.5 thru V-26.6). While many of the flight controls specialists continued to use this technique during the most recent deployment to Guam, MP1, MP2 and the flight controls specialist that responded to the call for an air data calibration on the MA on 23 February 2008, were unaware of this technique (TAB V-2.23, V-3.34, V-18.8). Likewise, the board found very few maintenance supervisors above the shop level who had heard of an increased requirement for air data calibrations while deployed, and only one who was aware of a suggestion to alleviate the requirement (TAB V-12.10 thru V-12.11, V-17.14, V-18.7 thru V-18.8).

Three factors contributed to ineffective communication of critical information. First, the increased requirement for air data calibrations was intermittent, only surfacing as an issue during deployments that lasted a few months a year. Second, a requirement for an air data calibration never caused an aircraft to miss a takeoff. While maintenance supervisors were concentrating on issues that grounded jets, air data calibrations never made it to their "Top 10" items of concern (TAB V-5.16 , V-5.19, V-12.18, V-17.16, V-18.7). Third, maintenance and operations personnel interviewed had a functional understanding of the air data system, but lacked an appreciation for the potential to induce catastrophic errors into air data sensors. Most of the individuals interviewed by the board viewed the air data calibration as a mechanism to correct the aircraft altimeters and nothing more. The board had to consult aircraft design engineers who had not been associated with the B-2 program for over 10 years to find a level of understanding in the system that raised concerns over a need to calibrate PTUs on the aircraft (TAB V-5.19, V-10.13, V-11.12, V-12.11, V-12.14 thru V-12.16, V-13.11, V-13.17, V-14.10 thru V-14.11, V-16.6, V-16.9 thru V-16.10, V-17.13, V-17.16 thru V-17.17, V-18.7, V-25.8 thru V-25.9, DD-33 thru DD-37).

Calibration process improvements were investigated and implemented with some success during deployments. As supervision remained unaware of the issue, the suggested technique to mitigate an increased requirement for air data calibrations remained undocumented and non-standard in application. The result was ineffective communication of critical information regarding a suggested technique of turning on pitot heat in order to remove moisture in the PTUs prior to performing an air data calibration.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Primary Operations Directives and Publications

1. Air Force Instruction (AFI) 11-2B-2, Volume 1, *B-2--Aircrew Training,* 10 November 2006
2. AFI 11-2B-2, Volume 2, *B-2--Aircrew Evaluation Criteria,* 31 January 2002
3. AFI 11-2B-2, Volume 3, *B-2--Operations Procedures,* 30 September 2002
4. AFI 11-202, Volume 1, *Aircrew Training,* 17 May 2007
5. AFI 11-202, Volume 2, *Aircrew Standardization/Evaluation Program,* 8 December 2006 with Change 1 dated 19 September 2007
6. AFI 11-202, Volume 3, *General Flight Rules,* 5 April 2006
7. AFI 11-301, Volume 1, *Aircrew Life Support (ALS) Program,* 19 July 2002
8. AFI 11-401, *Aviation Management,* 7 March 2007 with Change 1 dated 13 August 2007
9. AFI 11-403, *Aerospace Physiological Training Program,* 20 February 2001
10. AFI 11-418, *Operations Supervision,* 21 October 2005 with Change 1 dated 20 March 2007
11. AFI 11-421, *Aviation Resource Management,* 1 November 2004

12. AFI 48-123, Volume 3, *Medical Examinations and Standards Volume 3-Flying and Special Operational Duty,* 5 June 2006
13. AFI 51-503, *Aerospace Accident Investigations,* 16 July 2004 with Change 2 dated 11 February 2008
14. AFI 91-204, *Safety Investigations and Reports,* 14 February 2006
15. Technical Order (T.O.) 1B-2A-1, *Flight Manual, USAF Series B-2A Aircraft,* 15 April 2007

b. Maintenance Directives and Publications

1. AFI 21-101, *Aerospace Equipment Maintenance Management*, 29 June 2006
2. AFI 21-124, *Oil Analysis Program*, 04 April 2003
3. T.O. 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies and Procedures*, 30 April 2003 Change 4 dated 1 September 2006.
4. T.O. 33-1-37-1, *Joint Oil Analysis Program Manual, Volume I*, 1 July 2005
5. T.O. 33-1-37-2, *Joint Oil Analysis Program Manual, Volume II*, 1 July 2005
6. T.O. 33-1-37-3, *Joint Oil Analysis Program Manual, Volume III,* 1 August 2007

NOTICE: The AFIs listed above are available digitally on the AF Departmental Publishing Office internet site at: **http://www.e-publishing.af.mil.**

c. Known or Suspected Deviations from Directives or Publications

None.

13. NEWS MEDIA INVOLVEMENT

a. Initial Queries and Reports

According to the Whiteman AFB public affairs office, initial media interest related to the mishap was very high. Reporters from local television stations in Guam and Missouri covered the mishap, in addition to worldwide coverage from mass news media reporters. Written media, both national and international, also covered the mishap. Samples of media coverage retrieved from the worldwide web are attached at Tab CC-3 thru CC-48.

b. Media Visits to the Crash Site

Video of the mishap site and smoke plumes from the MA were recorded from locations surrounding Anderson AB, Guam and were released by the media.

c. Subsequent Media Interest

Media interest has been moderate to high in regard to the mishap's impact on the B-2 mission. Examples of this coverage are attached at Tab CC-3 thru CC-48.

14. ADDITIONAL AREAS OF CONCERN

No additional areas of concern contributed to this mishap.

FLOYD L. CARPENTER
Major General, USAF
President, Accident Investigation Board