Report No. DODIG-2013-041 February 6, 2013

Inspector General
United States Department of Defense

Assessment of the USAF Aircraft Accident Investigation Board (AIB) Report on the F-22A Mishap of November 16, 2010

Additional Information

The Department of Defense Office of the Deputy Inspector General for Policy and Oversight prepared this report. If you have questions, contact the signer of the report.

Suggestions for Assessments

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Acronyms and Abbreviations

AFI	Air Force Instruction
AFRL	Air Force Research Laboratory
AIB	Accident Investigation Board
DOD	Department of Defense
EOS	Emergency Oxygen System
ICAW	Indications, Cautions, and Warnings
IG	Inspector General
JBER	Joint Base Elmendorf – Richardson
MA	Mishap Aircraft
MP	Mishap Pilot
OBOGS	On-Board Oxygen Generation System
USAF	United States Air Force

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FEB - 6 2013

MEMORANDUM FOR SECRETARY OF THE AIR FORCE
JUDGE ADVOCATE GENERAL OF THE AIR FORCE

SUBJECT: Assessment of the USAF Aircraft Accident Investigation Board (AIB) Report on the F-22A Mishap of November 16, 2010 (Report No. DODIG-2013-041)

The DoD Inspector General (IG) conducted a review of the AIB for adherence to procedures set forth in Air Force Instruction (AFI) 51-503, "Aerospace Accident Investigations." This review was self-initiated and began on January 25, 2012. Our assessment also determined if the AIB conclusions were supported by the evidence of record consistent with the standard of proof established by AFI 51-503. In conducting our review, we were especially mindful of the general consideration, as stated within the AFI, that "[c]onducting a thorough and timely investigation is a high priority for the Air Force, NoK [the Next of Kin of deceased Air Force personnel], injured personnel, and the public."

We concluded that the AIB Statement of Opinion regarding the cause of the mishap was not supported by the facts within the AIB report consistent with the clear and convincing standard of proof established by AFI 51-503. Our conclusion was supported by five individual findings, and we recommended that the AIB report be reevaluated in light of our findings. On October 04, 2012, we provided a copy of our draft report to the Air Force for comment.

On December 6, 2012, the Air Force responded to our draft report. Although the Air Force agreed that some aspects of the AIB report could have been more clearly written, the Air Force stated that the AIB Board President exhausted all available investigative leads and concluded that the AIB Board President's Statement of Opinion was supported by clear and convincing evidence. In concluding that the AIB President's opinion was supportable, the Air Force relied on the findings of a special Task Force that was convened to review and respond to our draft report. This Task Force considered and analyzed information developed apart from the AIB process. Finally, the Air Force acknowledged that remedial actions would be taken to address the following deficiencies in the AIB report: the lack of detailed analysis of the non-causal or non-contributory factors, insufficient details regarding conclusions concerning Emergency Oxygen Activation and blood oxygen levels, and inaccurate references in the AIB report.

The DoD IG does not concur with the Air Force response that the AIB President exhausted all investigative leads and that the AIB President's Statement of Opinion is sufficiently supported by clear and convincing evidence, as reflected in the AIB report, consistent with the requirements of AFI 51-503. In reaching our conclusion, we note that, among other things, AFI 51-503 states that the AIB Summary of Facts present a thorough discussion of the facts relevant to the accident, be fully supported by documentary evidence, and should be self-contained.

We further note that the AFI mandates that a Statement of Opinion regarding the cause of an accident "must be supported by facts stated in the Summary of Facts, which must be supported by evidence included in the Tabs [of the AIB report], unless otherwise restricted." Furthermore, with respect to clear and convincing evidence, the AFI states that the AIB President's opinion "must be supported by credible evidence that shows it is highly probable that the conclusion is correct." Based on the deficiencies we identified in the AIB report, which the Air Force has acknowledged, we stand by our conclusion that the AIB report did not meet the requirements of AFI 51-503. Furthermore, in our view, the findings of the Task Force did not cure the deficiencies of the AIB report in light of the clear requirements of the AFI.

Although the Air Force indicates remedial actions will be taken to clarify sections of the AIB report, without a sufficient description of these actions, we cannot determine if these actions will adequately address the AIB report deficiencies. Moreover, we believe a sufficiently detailed action plan will also be especially useful in identifying and implementing appropriate departmental-wide AIB process improvements. Therefore, we request the Air Force provide a detailed description of the remedial action to be taken by February 28, 2013. Directive 7650.3, "Follow-up on General Accounting Office (GAO), DoD Inspector General (DoD IG) and Internal Audit Reports," requires that recommendations be resolved promptly.

Please send a .pdf file containing your comments to [redacted] by February 28, 2013. Copies of your comments must have the signature of the authorizing official for your organization. If you will be sending classified comments electronically, you must send them over the SECRET Internet Protocol Router Network (SIPRNET).

We appreciate the courtesies extended to the staff. For additional information on this report, please contact [redacted] at [redacted]

Randolph R. Stone
Deputy Inspector General
Policy and Oversight

cc:
Inspector General of the Air Force
Commander, Air Force Safety Center

Results in Brief: Assessment of the USAF Aircraft Accident Investigation Board (AIB) Report on the F-22A Mishap of November 16, 2010

What We Did

Our objective was to review the United States Air Force (USAF) Aircraft Accident Investigation Board (AIB) report on the F-22A mishap of November 16, 2010, for adherence to the procedures set forth in Air Force Instruction (AFI) 51-503, "Aerospace Accident Investigations." We assessed whether the AIB's conclusions were supported by facts consistent with the standards of proof established by AFI 51-503.

What We Found

The AIB Statement of Opinion regarding the cause of the mishap was not supported by the facts within the AIB report consistent with the clear and convincing standard of proof established by AFI 51-503.

The AIB report contains the following deficiencies.

a) The AIB report cites three causal factors (channelized attention, breakdown of visual scan, and unrecognized spatial disorientation) as the cause of the F-22 mishap. However, these three factors are separate, distinct, and conflicting. The AIB report does not clearly explain their interrelationship and how it is possible that all three factors concurrently caused the mishap. Failure to adequately explain this interrelationship calls into question the AIB Statement of Opinion regarding the cause of the mishap.

b) The AIB report's determination that the mishap pilot's mask was in the full up position throughout the mishap sequence was not adequately supported by the Summary of Facts or by the analysis cited in the TABs. This determination directly affected several conclusions of the AIB and precluded the analysis of other potential causes of the mishap. Failure to provide adequate facts or analysis to support this determination calls into question the AIB finding.

c) The AIB report's Non-Contributory portion of the Human Factors section inadequately analyzes the human factors listed, such as hypoxia, gravity-induced loss of consciousness, and sudden incapacitation and does not contain any references and/or supporting documentation. Without detailed analysis and proper documentation, it is unclear how the AIB determined that these factors did not contribute to the mishap.

d) The AIB report lacked detailed analysis of several areas, such as the Emergency Oxygen System activation as well as the physiological reactions to lack of oxygen.

e) Of the 109 references in the AIB report's Summary of Facts, 60 of those references were either incorrect or did not direct the reader of the AIB report to the information cited in the paragraph.

What We Recommend

We recommend that the Judge Advocate General of the Air Force reevaluate the AIB report and take appropriate action in light of the findings in this report regarding the AIB report Statement of Opinion and other deficiencies.

Air Force Comments

The Air Force concurs that aspects of the AIB report could have been more clearly written. However, the Air Force found that the AIB President's Statement of Opinion regarding the cause of the mishap was supported by clear and convincing evidence and he exhausted all available investigative leads. To conclude that the AIB's President's opinion was supportable, the Air Force relied upon the findings of a special Task Force that was convened to review and respond to DoD Inspector General (IG) draft report. The Air Force acknowledged that remedial actions would be taken to address the following deficiencies in the AIB report: the lack of detailed analysis of the non-causal or non-contributory factors; insufficient details regarding conclusions concerning Emergency Oxygen Activation and blood oxygen levels; and, inaccurate references within the AIB report.

DoD IG Response

The DoD IG does not concur with the Air Force response that the AIB President exhausted all investigative leads and that the AIB President's Statement of Opinion is sufficiently supported by clear and convincing evidence, as reflected in the AIB report, consistent with the requirements of AFI 51-503. In reaching our conclusion, we note that AFI 51-503 states that AIB Summary of Facts must present a thorough discussion of the facts relevant to the accident; be fully supported by documentary evidence; and should be self-contained. Furthermore, AFI 51-503 mandates that a Statement of Opinion regarding the cause of an accident "must be supported by facts stated in the Summary of Facts, which must be supported by evidence included in the Tabs [of the AIB report], unless otherwise restricted." With respect to clear and convincing evidence, AFI 51-503 states that the AIB President's opinion "must be supported by credible evidence that shows it is highly probable that the conclusion is correct." Based on the deficiencies we identified in the AIB report, we conclude that the AIB report did not meet the requirements of AFI 51-503.

The Air Force stated that remedial actions would be taken to address Findings C, D, and E; however, the Air Force did not provide a description as to what those actions will be or entail. Without a sufficient description of these actions, the DoD IG cannot determine if these actions will adequately address the AIB report deficiencies. Moreover, we believe a sufficiently detailed action plan will also be especially useful to identify and implement appropriate departmental-wide AIB process improvements. Additionally, the Air Force did not indicate if any actions will be taken to address Findings A and B; even though the Air Force acknowledged those sections could have been more clearly written. Therefore, the DoD IG requests the Air Force provide a detailed description of the remedial action to be taken by February 28, 2013.

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Introduction

Objectives

Our objective was to review the United States Air Force (USAF) Aircraft Accident Investigation Board (AIB) report on the F-22A mishap of November 16, 2010, for the adherence to the procedures set forth in Air Force Instruction (AFI) 51-503, "Aerospace Accident investigations," and to determine if the AIB's conclusions were supported by facts consistent with the standards of proof established by AFI 51-503.

Background

This assessment focused on the AIB report of the aircraft mishap that occurred on November 16, 2010, involving an F-22A assigned to the 525th Fighter Squadron 3rd Wing, Joint Base Elmendorf-Richardson (JBER), Alaska. The AIB stated that the mishap aircraft (MA) impacted the ground during controlled flight, destroying the aircraft and fatally injuring the mishap pilot (MP). The AIB convened on December 22, 2010, completed its investigation in July 2011, and released its final report in December 2011. The AIB President found by clear and convincing evidence,[1] that the cause of the mishap was the pilot's failure to recognize and initiate a timely dive recovery due to channelized attention, breakdown of visual scan, and unrecognized spatial disorientation. The AIB President also found, by a preponderance of evidence,[2] that organizational training issues, inadvertent operations, personal equipment interference, and controls/switches were factors that substantially contributed to the mishap.

Scope and Methodology

The assessment team consisted of two senior engineers, a fighter pilot with more than 3,000 hours in tactical aircraft, two aviation physiologists, a retired National Transportation Safety Board Investigator in Charge, and a legal advisor. During this assessment, the team reviewed in detail AFI 51-503 and the complete 928-page USAF AIB December 2011 report. The assessment team met with representatives from the Air Force Legal Operations Agency; Lockheed Martin, the prime contractor for the F-22 aircraft; the F-22 Program Office; and USAF F-22 aircraft maintenance crews and pilots. The pilot team member observed an F-22 qualified pilot, in an F-22 simulator react to malfunctions under similar flight conditions as the MP. In order to focus only on the sufficiency of the AIB report, the assessment team did not obtain or review the Safety

[1] Clear and convincing evidence means the accident investigator was able to reach a conclusion without serious or substantial doubt. The opinion must be supported by credible evidence that shows it is highly probable that the conclusion is correct. However, it does not mean that another person looking at the same facts, may not reach a different conclusion. (AFI 51-503, paragraph 8.8.4.1.2)

[2] Preponderance of evidence is the greater weight of credible evidence. That evidence that, when fairly considered, produces the stronger impression and is more convincing as to its truth when weighed against the opposing evidence. (AFI 51-503, paragraph 8.8.4.2.3)

Investigation Board (SIB) report of the mishap that was conducted in accordance with AFI 91-204, "Safety Investigations and Reports." Furthermore, the team did not consider information, such as scientific reports, studies, or news articles, generated after the accident report was released by the Air Force in December 2011.

Finding A. Conflicting Causal Factors

The AIB President's Statement of Opinion states that the cause of the mishap was the MP's failure to recognize and initiate a timely dive recovery due to channelized attention, breakdown of visual scan, and unrecognized spatial disorientation. However, unrecognized spatial disorientation conflicts with the other two causal factors, and the AIB report does not clearly state how these factors interrelate. According to AFI 51-503, statements of opinion in AIB reports "must be clear, complete, and concise" and "[a]ny opinion as to cause(s) or substantially contributing factor(s) must be supported by facts stated in the Summary of Facts, which must be supported by evidence included in the TABs, unless otherwise restricted."[3]

The AIB report cites Spatial Disorientation (Type 1) Unrecognized as a causal factor. "Spatial Disorientation in Aviation" by Previc and Ercoline (2003) states that Spatial Disorientation (Type 1) Unrecognized occurs when:

> . . . the pilot does not consciously perceive any of the manifestations of SD [Spatial Disorientation], that is, the pilot experiences no disparity between natural and synthetic (instrument-derived) orientation percepts, has no suspicion that a flight instrument has malfunctioned, and feels the aircraft is responding well to his or her control inputs.

Therefore, based on this definition, we believe it follows that a pilot must be actively flying the aircraft at the time of the mishap for unrecognized spatial disorientation to occur.

However, the facts as presented within the AIB report relating to the issue of whether or not the MP was actively flying the aircraft are inconsistent. Specifically, the AIB report states on page 24 "[t]he fact that the MP went from a controlled flight regime to an unusual attitude and did not take corrective actions for 30 seconds suggests he had unrecognized spatial disorientation." However, the AIB report then also states, "[a]t 19:42:45L intentional flight control inputs stopped and did not resume for 39 seconds" (AIB report, page 24). The latter AIB statement is inconsistent with the AIB's implied assertion that the MP was actively controlling the aircraft during this phase of the flight. Also, the AIB report's description of the aircraft's descent profile immediately after the C BLEED HOT caution ICAW (Indication, Caution and Warning) [4] (AIB report, pages 8 - 10 and 24) is not consistent with the inference that the MP was actively flying the

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[3] AFI 51-503, paragraphs 8.8 and 8.8.1. We note that the AFI also requires "that each individual mishap cause cited must be supported by clear and convincing evidence."

[4] A "C BLEED HOT" caution occurs when the heat sensors near the Center Bleed (C-Bleed) Duct register an over-temperature condition. This condition results in the closing of both bleed air vents from the engines and stops all air flow to the Environmental Control System.

aircraft. Because the AIB report does not reconcile these inconsistencies, the AIB determination that the MP was spatially disoriented is not supportable.

Moreover, the AIB determination that the MP was spatially disoriented conflicts with the other two causal factors that are cited in the AIB report; namely, channelized attention and breakdown in visual scan. These two causal factors (channelized attention and breakdown in visual scan) are factors "when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher or more immediate priority, leading to an unsafe situation" and "the individual fails to effectively execute learned/practiced internal or external visual scan patterns." (AIB report pages 23 and 24)

Because the AIB determined the MP was focused on restoring oxygen to his mask through the Emergency Oxygen System (EOS) (channelized attention), it follows he was not actively flying the aircraft (breakdown in visual scan) from the rejoin maneuver to the 7.4g recovery maneuver 3 seconds before ground impact (AIB report page 28). If the MP was not actively flying the aircraft during this time, then it is not likely the MP was spatially disoriented. The AIB report, however, does not address this issue.

Finally, from the AIB report, it is not clear to what extent, if any, the AIB carefully considered the three specialized sensory systems (visual, vestibular,[5] and proprioceptive[6] systems) in reaching its conclusion of unrecognized spatial disorientation. The AIB report is silent with respect to two sensory systems—vestibular and proprioceptive. With regard to the visual system, we noted that the AIB report reflected that multiple witnesses stated (AIB report TAB R) how bright and clear the night was with an established horizon. Such visual observations are not consistent with a finding of spatial disorientation, and the AIB report does not address this issue.

Air Force Comments

The Air Force stated "[they] agreed with the DoD IG that the AIB Report could have more clearly explained the interrelationship of the three causal factors." However, the Air Force further stated "[they] disagreed that the causes are separate, distinct, and conflicting and that the inadequate explanation calls into question the AIB Statement of Opinion regarding the cause of the mishap." Additionally, the Air Force disagrees with the DoD IG's definition of unrecognized spatial disorientation because it is not the approved definition referenced in AFI 51-503 and AFI 91-204.

DoD IG Response

Although the Air Force agrees that the three causal factors could have been more clearly explained, the Air Force does not indicate that they will take any corrective action beyond what is listed in their response. The DoD IG acknowledges the fact that the

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[5] The vestibular system consists of motion and gravity-sensing organs within the inner ear.
[6] The proprioceptive system is comprised of nerves in the skin, muscles, joints, and interorgans, along with hearing. The nerves sense pressure differentials.

approved Air Force definition of unrecognized spatial disorientation cited in the AIB report was not used in the DoD IG draft report and that the AIB used the approved definition as prescribed by AFI 51-503 and AFI 91-204. However, we do not believe this affects our overarching conclusion of the report or that the causal factors appear to be conflicting and are not clearly explained.

The Air Force response notes that the MP did not receive any visual cues by looking outside the cockpit or from flight instruments because the MP was focusing his efforts on restoring oxygen flow through the EOS ring. The Air Force also noted that during this time, the MP was twisting his body to the left and down toward his left hip, trying to activate the EOS. The MP's twisting of the head and torso while the aircraft is turning and descending without the assistance of visual cues can create significant confusion relating to the actual flight of the aircraft. There is no evidence to support the MP's actions or positively know what he was looking at or focusing on prior to the 7.4g maneuver. Thus it is unclear how the Air Force determined the MP did not look outside or reference his flight instruments and come to the conclusion the MP had unrecognized spatial disorientation. A more detailed description of how the MP was spatially disoriented without looking at his flight instruments or outside to reference the horizon should be included to explain how spatial disorientation could occur in a situation where a pilot is neither flying the aircraft nor trying to visually interpret any spatial information.

During the mishap sequence, there were 39 seconds of either unintentional or no flight control inputs just prior to the 7.4 g "recovery" maneuver. What is not explained in the AIB report is how the cited cause of unrecognized spatial disorientation was determined. The Air Force response implies that the MP was not actively flying the aircraft because he did not "focus on the flight instruments or look outside the cockpit" and had the MP done so, he would have recognized his extreme situation and recovered. By stating that the "breakdown in visual scan resulted in the MP not recognizing the temporal and altitude orientation of the aircraft," the Air Force response implies the MP ceased to use any spatial cues during this portion of the descent because he had, "prioritized restoring oxygen flow and was not deliberately controlling the MA." Given these circumstances, the DoD IG reasoned that the MP was not misperceiving spatial information, since he was not receiving any spatial information and that under these conditions, it would be more credible to conclude that the MP would have most likely been experiencing a loss of situational awareness (SA) rather than unrecognized spatial disorientation because he was not receiving any special information.

Additionally, The Unrecognized (Type I) Spatial Disorientation definition found in AFI 91-204, which also appears in the Department of Defense Human Factors Analysis and Classification System (DoD HFACS), does not clearly describe the mishap situation. In order to add more investigative insight to this mishap, consideration should be given to addressing the differences between loss of situational awareness and spatial disorientation.

In conclusion, we believe that the AIB did not present enough information to support the claim that the MP was spatially disoriented and not actively flying the aircraft.

Furthermore, the Air Force claims that the MP was twisting in the cockpit with his head down trying to activate the EOS, which accurately describes channelized attention and breakdown in visual scan, but conflicts with spatial disorientation. We believe that a pilot must be actively scanning flight instruments or referencing outside cues in order for spatial disorientation to occur. A majority of a pilot's spatial orientation is provided by visual cues (horizon, flight instruments). The other portions come from vestibular and proprioceptive cues. If the majority of the MP spatial orientation cues are not being utilized as described in the Air Force response, it becomes difficult to understand how the MP was spatially disoriented. Finally, there is no evidence to support the Air Force's belief that the MP was focused for 39 seconds on activating the EOS without looking up once to reference his flight instruments or visual cues outside the cockpit.

Finding B. Unsupported Oxygen Mask Determination

The AIB report's determination that the MP's mask was in the full up position throughout the mishap sequence was not adequately supported in the Summary of Facts or in the analysis cited in the TABs. AFI 51-503, paragraph 8.7.4, states that "[t]he Summary of Facts shall be fully supported by documentary evidence in the TABs." The AIB's determination regarding the orientation of the MP's mask is significant because this determination directly impacted the consideration by the AIB of numerous factors concerning the Statement of Opinion as well as the basis for other AIB conclusions.

The F-22 pilot helmet has two female bayonet receivers, one on each side of the helmet, into which the oxygen masks' male bayonet fittings slide and lock in place. The bayonet receiver and fittings allow the pilot to properly adjust and secure his oxygen mask, which provides supplemental oxygen to the pilot during flight operations. From time to time, a pilot may release one of the bayonet fittings from the receiver, allowing the mask to drop to one side during ground operations, during non-tactical flight operations, or during rare instances of restricted or abnormal oxygen flow. Releasing the bayonet fitting will allow the pilot to breathe ambient cockpit air.

The right-side bayonet receiver was recovered at the accident site. However, neither the left-side bayonet receiver nor either of the male bayonet fittings were recovered. The recovered right-side bayonet receiver was sent to the Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base for analysis. The results of the analysis are in Evaluation Report SA103002, July 12, 2011 (AIB report TABs J 67-77).

The AFRL report states that the purpose of their analysis was to "[d]etermine if the Emergency Oxygen System was activated and if the pilot's mask was in the up or down position at the time of ground impact." The discussion section of the AFRL report states "the contact damage and material smearing towards the entry side observed to the teeth where the bayonet tangs engage, along with the tooth root cracking, suggests the pilot's mask bayonet was in the up position at the time of ground impact." The Conclusion section of the AFRL report further states "the pilot's mask bayonet was most likely engaged with the bayonet receiver (in the up position) at the time of ground impact."

However, the AFRL statements are based only upon analysis of the recovered right-side bayonet receiver. As previously noted, the left-side receiver and both male bayonet fittings were not recovered. Therefore, based upon the limited data available from the right-side bayonet receiver and relying upon the AFRL conclusion, the AIB determined that the MP's mask was in the up position with the oxygen mask sealed to the MP's face during the last minute of flight. Neither the AFRL report nor the AIB report address the possibility that the left-side male bayonet fitting may have been disengaged from the left-side receiver by the pilot. In other words, it appears the AIB did not consider the possibility that the MP may have dropped his mask from the left side. Therefore, the AFRL report's conclusion that the "mask bayonet was most likely engaged with the bayonet receiver at the time of ground impact" does not mean that the mask was in the full up position and sealed to the MP's face. At most, the AFRL's conclusion only means that the recovered right-side receiver had a bayonet fitting in place at the time of impact.

To the extent the AIB relied upon the AFRL conclusion, we believe the facts in the AIB report are insufficient to conclude that the MP's mask was fully engaged at the time of impact. Further, the AIB report does not clearly explain how the AIB reached the conclusion that the MP's mask was fully engaged. By accepting the AFRL conclusion regarding the position of the MP's mask, the AIB excluded consideration of other scenarios and events as discussed in Finding C.

Air Force Comments

The Air Force agreed with the analysis in the AIB report that the mask was up and that the AIB President was justified in making that decision based on the information provided in the AFRL report. Furthermore, the Air Force indicated that in discussions with the AIB President, he did consider that the MP dropped his mask from the left bayonet, but determined it was unlikely due to communication and bladder connection on the left side of the helmet, thus not allowing the mask to completely drop away. The Air Force further stated that the position of the mask (up or down) was irrelevant for purposes of determining the cause of the mishap. If the MP had his mask down, the Air Force stated that the MP would have been breathing ambient cockpit air which did not exceed 20,000 feet during the mishap sequence. The effective performance time under those conditions would be approximately 17 minutes if the MP dropped his mask; thus, the MP would not be incapacitated due to hypoxia. However, if the mask was up the Air Force asserts the MP would have been breathing 90-94 percent oxygen and thus could have held his breath for longer than 1 minute and 9 seconds. Finally the MP attempted a dive recovery 3 seconds before impact, the Air Force concurs with the AIB report that hypoxia did not play a role in the mishap.

DoD IG Response

The DoD IG believes the analysis within the AIB report is inadequate. The executive summary of the AFRL report in TAB J (page 68) states, "The bayonet receiver is from the right side and witness marks indicate the pilot's mask was most likely in the up position (engaged with the receiver) at the time of ground impact." The analysis portion on page 76 states that, "the pilot's mask bayonet was in the up position at the time of ground impact" and the conclusion section on page 77 states that, "[the] bayonet receiver

is from the right side of the helmet" and "[witness] marks suggest the pilot's mask bayonet was most likely engaged with the bayonet receiver at the time of ground impact." The DoD IG does not dispute the AFRL report; however, the AFRL report does not state that the MP's mask was up and sealed to the MP's face (both bayonet fittings locked in each bayonet receiver), but concludes only that the right side bayonet receiver had a bayonet fitting installed at the time of aircraft impact.

The DoD IG offered a scenario in which the MP could have dropped the left-side bayonet when the MP's oxygen supply ceased, noting that this is this least preferred way to drop the mask due to the communication cord that connects from the left side. However, the DoD IG team observed a qualified F-22 pilot use this method to look down the left side of the ejection seat to the EOS ring. While this method is least preferred for ease of breathing, it afforded less restrictive visibility from the pilot to the EOS ring than if the right side was dropped. Because neither the left-side bayonet receiver nor the bayonet fittings were found at the crash site and the AFRL report does not state that the mask was up and sealed to the MP's face, the DoD IG does not believe this reaches the threshold of clear and convincing evidence that the MP's mask was up and sealed to his face and that he experienced suffocation.

Furthermore, the DoD IG believes that the position of the mask would be a contributory factor and could have inhibited the full analysis of other possible causal and contributory factors. In the AIB, the position of the mask was mentioned as a factor in the Channelized Attention causal factor, the Organizational Training Issues/Programs and Controls and Switches contributory factors, and the Hypoxia non-contributory factor sections of the report. Had the AIB determined that the MP did not have his mask sealed to his face, these four factors would have had different analyses and could have affected the outcome of the AIB.

The Air Force response, relying on the analysis of the Task Force separate from the AIB report, discusses how the MP could have held his breath in excess of 69 seconds after having breathed 90-94 percent oxygen. The Air Force response, however, did not address the DoD IG's assertion that it is most likely the MP's first indication that he had lost oxygen flow would be after he had exhaled and then tried to inhale only to receive no oxygen flow. The OBOGS light is an indication to the pilot that he will lose oxygen flow, but the actual time that oxygen flow will cease varies and the C BLEED HOT emergency procedure in the "TO 1F-22A-1 Flight Manual" does not direct the pilot to hold his breath or drop his mask if he cannot activate the EOS to restore oxygen flow.

In addition, the Air Force response introduces new information and analysis that was not inherent in the AIB report. The AIB noted multiple times that the mask was up and sealed to the MP's face and that he experienced suffocation. While the Air Force response concurs with the AIB, the Air Force explains that the mask position doesn't matter for the outcome of the mishap and notes that the Board President considered that the MP may have dropped his mask at some point but did not think it was likely. Additionally, the Air Force response concluded, "there is no way of knowing whether the MP's mask was in the full-up position throughout the mishap" even though the Air Force

concurred with the AIB's determination that the "MP's mask was in the full up position at the time of impact."

The Air Force did not indicate that they planned to address this finding beyond what is written in their response. However, based on the additional analysis completed by the Air Force Task Force on the mask position of the MP, the DoD IG believes the AIB determination with regard to the MP's oxygen mask should be reconsidered.

Finding C. Inadequate Analysis and Documentation of Human Factors

The Non-Contributory portion of the Human Factors section in the AIB report on page 28 inadequately analyzes the human factors such as sudden incapacitation or unconsciousness, gravity-induced loss of consciousness, and hypoxia that may have contributed to the mishap. In addition, the Human Factors section of the AIB report does not contain references to the supporting documentation as required by AFI 51-503, paragraph 8.7.4. Without a detailed analysis and the proper documentation, it is unclear how the AIB determined that these factors did not contribute to the mishap.

Sudden Incapacitation or Unconsciousness

The AIB report did not provide a detailed analysis describing why sudden incapacitation or unconsciousness was not considered a contributory factor. There was no reference to supporting documentation on page 28 of the AIB report for the statement:

> The MP was actively flying the MA during the rejoin maneuver when he deliberately placed the MA in a right banked turn with 30 degrees ND. Additionally, intentional aft stick inputs commanding the MA into a 7.4g pull up maneuver occurred 3 seconds prior to impact, further demonstrating the MP was consciously flying the MA.

The AIB report contains no detailed analysis addressing what might have occurred during the 39-second interval between the two instances of the MP actively flying the aircraft from the rejoin maneuver to the 7.4g pull-up maneuver. A number of events during the descent, which include the CABIN PRESSURE caution ICAW aural tone at 18,500 feet and the AIR COOLING caution ICAW aural tone at 13,000 feet, should have alerted the MP to his situation, but no apparent reaction from the MP was noted. Furthermore, we noted that the MP did not communicate with the lead aircraft from the initiation of the C BLEED HOT caution ICAW to aircraft impact with the ground, and the AIB report does not reflect whether this fact was considered during the AIB's analysis. Thus, it is unclear how sudden incapacitation or unconsciousness was determined to be a non-contributory factor by the AIB, or why levels of partial incapacitation or impairment were not considered.

As part of our review, we observed a qualified F-22 pilot in an F-22 simulator who was placed in a similar scenario as the mishap flight demonstrate the proper reactions to a C BLEED HOT caution ICAW. While conducting the procedures for the C BLEED HOT

caution ICAW, the simulator pilot was observed to visually scan his instruments or visually acquire the horizon no less than once every 7 seconds while the aircraft was in critical flight regimes (>20 degrees nose down or >45 degrees angle of bank). It was also noted that when the AIR COOLING caution ICAW aural tone occurred, the pilot was "heads down" demonstrating proper EOS activation to the DoD IG pilot. The F-22 pilot immediately ceased manipulating the EOS ring, upon hearing the aural tone, to check the new indicated malfunction and scan his flight instruments.

The AIB report (at TABs R-80 and R-88) noted that the MP was one of the best pilots in the squadron and an instructor pilot. Thus, it is reasonable to expect that if the MP had a similar habit pattern to the qualified F-22 pilot we observed in the F-22 simulator, the MP would have scanned his instruments more often than the 39 seconds noted in the AIB report and would have positively reacted to the two ICAWs present during the mishap flight descent.

Effects of G Forces (Gravity-Induced Loss of Consciousness)

Although the AIB report contained a short summary regarding the MP's centrifuge training, there was no reference to documentation that would support the AIB's claim that G forces did not affect the mishap.

Hypoxia

The AIB report did not provide a detailed analysis describing why hypoxia was not considered a contributory factor. As noted above in Finding B, the AIB determined that the MP did not remove his mask and that "the MP most likely experienced a sense similar to suffocation." (AIB report page 25) To explain why the AIB discounted hypoxia, the AIB report states:

> Prior to OBOGS [Onboard Oxygen Generation System] FAIL caution ICAW, the MP should have been receiving adequate supply of oxygen. Due to the high affinity of oxygen to hemoglobin, the MP would have had adequate reserve blood oxygen supply after the OBOGS failed. (AIB report page 29)

However, the AIB assertion suggesting that the MP would have had an adequate reserve blood oxygen supply after the OBOGS failure is not referenced to supporting documentation, nor is it supported by data in the AIB report.

If we accept as correct the AIB's determination that the MP's mask was in the full up position throughout the mishap sequence, we believe it is more likely the MP's first indication that he had no oxygen flow was after he had exhaled and tried to inhale, receiving no oxygen due to the seal of the oxygen mask to his face, leaving his lungs essentially empty. Studies indicate that if a subject is holding his breath after exhaling, the subject has significantly less time of useful consciousness and is likely to experience

a strong sensation of oxygen starvation with cognitive impairment in less than 60 seconds.[7]

Furthermore, as noted in Finding B above, because the AIB determined that the MP had not removed or loosened his mask at any time prior to ground impact, there was no AIB analysis evaluating the possibility that the MP may have intentionally broken the mask seal at some point following the OBOGS failure. This lack of AIB analysis resulted in the AIB failing to consider other possible levels of physiological incapacitation or cognitive impairment, which could have affected the factors of Sudden Incapacitation and Hypoxia.

Air Force Comments

The Air Force concurred with the DoD IG assessment that the narrative portions of the AIB could have provided a more detailed analysis of the non-causal or non-contributory factors. The Task Force provided additional analyses on the three stated non-contributory factors: sudden incapacitation/unconsciousness, effects of G Forces (G-LOC, etc.), and hypoxia. The Air Force has recommended to the Convening Authority to take the necessary remedial actions to provide a more full explanation of the AIB President's reasoning regarding the non-causal or non-contributory factors.

DoD IG Response

The Air Force noted that there is no requirement in the AFI 51-503 for the AIB Report to address every theory the AIB considered but ultimately rejected. However, the AIB included some of those "rejected" factors but did not adequately explain why they were rejected. The DoD IG recommends that the Air Force AIB process be revised to ensure that future AIB reports thoroughly analyze non-contributory and non-causal factors. This analysis should be thoroughly documented in the report or the TABs and clearly explain the disposition or elimination of causal or contributory factors with adequate explanations so the final AIB product is a more complete and understandable document.

The DoD IG requests a more detailed description of the actions taken by the Air Force to provide a more detailed explanation and discussion of how the non-causal or non-contributory factors were incorporated within the AIB report.

Finding D. Lack of Details and Analysis

The Summary of Facts section of the AIB report lacked detailed analysis in multiple areas as required by AFI 51-503, paragraph 8.7.6., which states the "Summary of Facts should be self-contained. A reader should not have to refer to any other documents to understand the complete story of the accident." If the report does not contain a detailed analysis, it becomes difficult to show how the stated conclusions are supported, which undermines the credibility of the report.

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[7] Regarding this point, DoD IG aviation physiologists considered Campbell EJM, Freedman S, Clark TJ, Robson JG & Norman J (1967). The effect of muscular paralysis induced by tubocurarine on the duration and sensation of breath-holding. Clin Sci 32, 425–432.

The AIB report lacked detail in several areas. These areas lacked sufficient detail to allow the reader to fully understand the AIB methodology used to reach the conclusions stated in the Statement of Opinion. Below are three examples.

a. The AIB report states on 23, "post mishap forensic analysis determined the EOS was not activated." However, the main body of the AIB report contained no analysis or explanation of how this conclusion was reached. Causal factors should be documented and clearly state how the conclusion was reached, beyond simply stating, "forensic analysis determined."

b. The AIB report states on page 26, "[t]he AFRL report identified that if the EOS wedge block had been incorrectly installed, the wedge block would be unable to move or rotate during manual EOS ring activation. However during ground simulation the board members were able to initiate the EOS in the incorrectly installed position." The report does not explain why the AIB was concerned with an incorrectly installed wedge block. The report also does not provide a detailed analysis or the test parameters used by the AIB to verify EOS ring activation. This brings into question why the AIB analyzed only the wedge block for incorrect placement and did not analyze other components for incorrect installation.

c. The AIB report states on page 29, "Due to high affinity of oxygen to hemoglobin, the MP would have had adequate reserve blood oxygen supply after the OBOGS failed." There is no discussion or analysis that supports this statement in the AIB report or in any of the TABs.

Air Force Comments

The Air Force concurred with the DoD IG assessment that the AIB report could have provided a more complete discussion supporting its conclusions. The Air Force has recommended that the Convening Authority take necessary remedial actions to provide a more detailed explanation of the AIB President's reasoning in the AIB report.

DoD IG Response

The DoD IG requests a more detailed description of the actions taken by the Air Force to ensure a more detailed explanation and discussion supporting the conclusions made in the AIB report.

Finding E. Inadequate References

We reviewed all 109 references in the Summary of Facts and found that 60 of those references were either incorrect or did not direct the reader of the report to the information cited in the paragraph. These deficiencies are contrary to paragraph 8.7.4 of AF51-503.

Many facts were incorrectly referenced or the references did not adequately cite source documentation. Appendix B contains a list of all references in the AIB report and any corresponding deficiencies associated with the references.

Air Force Comments

The Air Force agreed that that these errors detract from a reader's ability to accurately associate TAB data to the report. The Air Force recommended that the Convening Authority take the necessary remedial actions to correct the inaccurate references in the AIB report.

DoD IG Response

The DoD IG requests a detailed description of the actions taken by the Air Force to provide correct the references within the AIB report.

Conclusion

The AIB Statement of Opinion regarding the cause of the mishap is not supported by the facts within the AIB report consistent with the clear and convincing standard of proof established by AFI 51-503. Furthermore, the AIB report contains other deficiencies that call into question the AIB report conclusions.

Recommendation

We recommend that the Judge Advocate General of the Air Force reevaluate the AIB report and take appropriate action in light of the findings in this report regarding the AIB report Statement of Opinion and other deficiencies.

Air Force Comments

The Air Force concurs that the aspects of the AIB report could have been more clearly written. However, the Air Force found that the AIB President's Statement of Opinion regarding the cause of the mishap was supported by clear and convincing evidence and he exhausted all available investigative leads.

DoD IG Response

The DoD IG does not concur with the Air Force response that the AIB President exhausted all investigative leads and that the AIB President's Statement of Opinion is sufficiently supported by clear and convincing evidence, as reflected within the AIB report, consistent with the requirements of AFI 51-503. In reaching our conclusion, we note that AFI 51-503 states that the AIB Summary of Facts present a thorough discussion of the facts relevant to the accident, be fully supported by documentary evidence, and should be self-contained. Furthermore, AFI 51-503 mandates that a Statement of Opinion regarding the cause of an accident "must be supported by facts stated in the Summary of Facts, which must be supported by evidence included in the Tabs [of the AIB report], unless otherwise restricted." Finally, with respect to clear and convincing

evidence, AFI 51-503 states that the AIB President's opinion "must be supported by credible evidence that shows it is highly probable that the conclusion is correct." Based on the deficiencies we identified in the AIB report, we conclude that the AIB report did not meet the requirements of AFI 51-503.

Although the Air Force indicated remedial actions would be taken to clarify sections of the AIB report, without a sufficient description of these actions the DoD IG cannot determine if these actions will adequately address the AIB report deficiencies. Moreover, we believe a sufficiently detailed action plan will also be especially useful in identifying and implementing appropriate departmental-wide AIB process improvements.

Appendix A. Scope and Methodology

We conducted this technical assessment from January 2012 through September 2012 in accordance with the Council of the Inspectors General on Integrity and Efficiency, "Quality Standards for Inspection and Evaluation." Those standards require that we plan and perform the assessment to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our assessment objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our assessment objectives.

Use of Computer-Processed Data

We did not use computer-processed data to perform this assessment

Appendix B. Accident Investigation Board Report Reference List

Page of Report	Reference TAB	Support (Y/N)	Comments
	Y	Y	All appointment letters are in order. Appointment letters clearly state the opinion of the board president "must be supported by clear and convincing evidence".
	DD	Y	All information is properly summarized in the report (Background on Fighter Wing).
3	R 4, 60-61	N	Tabs do not support the basic mission description. While the interview text on R-4 does briefly describe the mission and notes the delay, this is not the appropriate tab to quote the baseline mission. It is not clear to a nonaviator what an apposed SAT m
4	R 60-61	N	The tabs do not support the paragraph and do not discuss the flight qualifications.
4	K 5-9	Y	Information supports the paragraph.
4	K-10, K-13-16, R 53	N	The tabs do not support the paragraph. While tabs K 10, 13-16 support the flight schedule and operations, there is no evidence supporting the briefing that was given and what was emphasized during the brief.
4	R 84-85	N	The tabs support most of the paragraph except for the callout on the night vision goggles. There was no description of the NVGs being focused by the pilots.
4	R 84, H-50-55	N	The listed tab does not state the information in the paragraph; however, Tab R 85 does. While TAB H 50-55 outline what the cold weather gear is and when it is required, there should also be a reference to the weather and temperature (TAB F-3)
4	K 17	Y	Shows the high ORM sheet.
4	R 84	Y	Supports the decision to fly.
4	R-85	N	The listed tab does not discuss the required preflight inspections nor does it reference anyone who observed the MP accomplish the preflight IAW 1F-22A-1 and 1F-22A-34 checklists.
5	K-5, F 3	N	The reference is unclear to nonpilots as to how the flight, take-off times were determined because the actual times were recorded by the pilots in Zulu time and do not match the local times printed on the sheet. The evidence is not clear. The reference d
5	R 46	N	The reference does not mention the mission as explained in paragraph written in the AIB. A better reference would have been R-58.
5	R 5	Y	Supports the paragraph.
5	R 5-6	Y	Supports the paragraph.
5	J2	N	The tab does not support the paragraph; however, it doesn't say 1.6M, it states 1039 knots True Airspeed which must be converted to mach. The report should have referenced J4.
5	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
6	J 4	Y	Supports the paragraph.
6	J 4	N	The statement " … the fire protection system (FPS) detected a bleed air leak in the center bleed air ducting from both engines…" is not supported by the information listed on J4 but on J12. Thus, this reference is incorrect.
6	J223	N	This is a typo. This should be TAB J23, which supports the paragraph
6	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
7	J 12 & J 23	Y	Supports paragraph.

Page of Report	Reference TAB	Support (Y/N)	Comments
7	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
8	BB 29	N	Supports the paragraph.
8	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
8	J 43	N	Does not clearly support the evidence because of how the chart uses a conversion time and does not link it back to the mishap timeline.
8	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
9	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
9	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
10	J 13	N	The timeline does not show support of the stick input assessment.
11	J 13	N	There is no altitude reference in this TAB.
11	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
12	J 4-6	Y	The reference does support the paragraph within the AIB, however, it does not reference where the 735KCAS number is calculated or where it can be found.
12	J 4-6	Y	Supports the paragraph.
14	H 17-23	Y	Supports the claim.
14	R 117-121	Y	Supports the paragraph.
14	H 5-9	Y	Supports the claim.
15	J 75-76 & 98-105	N	The referenced document outlines the analysis of the helmet bayonet clip. It is unclear why the assumption was made that the mask was engaged on both sides of the helmet without locating the second bayonet clip or full mask assembly.
15	AA 4	Y	Supports the statement.
15	J 5	Y	Supports the statement.
15	CC 15	N	The reference does not support the paragraph.
15	D 4-6	Y	Supports the paragraph.
15	D 7-9	Y	Supports the paragraph.
15	D 5	N	The referenced tab does not fully support the paragraph and needs to show documentation to verify the number of flights.
16	D 4-5	Y	Supports the paragraph.

Page of Report	Reference TAB	Support (Y/N)	Comments
16	U 4-5	N	The referenced tab does not support the paragraph. There is no mention of TCTO 1F-22A-122 or maintenance on the horizontal tail surfaces.
16	D 3	N	The referenced tab does not support the paragraph. There is no reference to the TO1F-22A-6 requirement and according to the referenced TAB, there should be 410 hours to the next inspection, not 431.
16	G 2	N	The referenced tab does not support the paragraph, however, TAB G, taken as a whole, can support the paragraph.
16	D 25 -41	Y	Supports the paragraph.
17	J 34	N	Does not fully support the paragraph as written. It does support the maintenance performed but does not support how it was conducted.
17	J-3	N	Does not support, however, information from J 4-5 does support the statement.
17	L 3-7 & J 10	Y	Supports the paragraph.
17	J 14	Y	Supports the paragraph.
17	J 20	Y	Supports the paragraph.
17	J 20	Y	Supports the paragraph.
18	D 1-2 & J 30	N	Do not support the claim; however, D-3 does provide some support to the claim.
18	J 30	N	Does not support the claim. Need to also reference the CSMU data.
18	J 30	N	Does not support the claim. The support is cited in J21.
18	J 24	N	Does not support the claim.
18	H 3	N	Does not support the claim; however, Tab H-5 does support.
19	J 19	N	The reference only partially supports the paragraph, the reference should be J 19-20
19	J 71-74	N	The reference describes the bayonet clip, however, it is unclear how the conclusion that the whole mask was engaged without obtaining all the associated pieces listed as missing, was reached.
19	D 5	N	Does not support the paragraph.
19	D 5, CC-13	N	Tab D-5 does not support the claim. Tab CC-13 also does not support the claim; however, it shows how the analysis was conducted but not the results.
19	J 60-66	N	The reference states there was insignificant contamination of CO2, however, it is unclear how this translates to the OBOGS not being at fault. The TAB does support the claim, secondary contamination from jet fuel was not a cause.
19	J 137 -146 & C 13	Y	The two references together support the claim that the materials were contaminated during exposure to the environment.
19	CC 13	N	The reference on its own does not support the claim and should include actual data supporting what is described in TAB CC 13.
20	F 14	Y	Supports the paragraph.
20	F 3	Y	Supports the paragraph.
20	F 3	Y	Supports the paragraph.
20	R 83-85	Y	Supports the paragraph.
20	F 5	Y	Supports the paragraph.
20	R 45 - 46	Y	Supports the paragraph.
20	G 3 & 10-12	Y	Supports the paragraph.
21	T 3	Y	Supports the paragraph.

Page of Report	Reference TAB	Support (Y/N)	Comments
21	V 8.5 - 8.6	Y	Supports the paragraph. Only one reference to his supervisor; should have more to reference peers as well to fully support.
21	G 10	N	Reference material lists 16 November as last flight before the mishap, and not 15 November as stated on p 21 of the AIB report.
21	G 56-57	Y	Supports the paragraph.
21	G 3 & 30-31	Y	Supports the paragraph.
21	G 28	N	Reference material list 16 November as last flight before the mishap, and not 15 November as stated on p 21 of the AIB report.
21	G 56-57	Y	Supports the paragraph.
22	X 3	Y	Supports the paragraph.
22	X 3	Y	Supports the paragraph.
22	X 3	Y	Supports the paragraph.
22	X 3	N	The reference does not support the statement of toxicology testing on additional flight crew members or maintenance personnel.
22	BB 4	N	Only references the front page of AFI 11-202 vol 3 and does not direct the reader to the section pertaining to crew rest.
22	R 139-154	N	The reference reviews sleeping habits of the mishap pilot, but does not specifically address crew rest.
23	V 8.5	Y	Supports the paragraph.
23	R 53	N	The referenced tab does not support the paragraph and does not discuss the mission briefing.
23	BB 5	Y	Supports the paragraph.
23	BB 5	N	Does not provide detailed information on Channelized Attention, which isn't listed until BB-12.
23	J 76	N	The reference states that the EOS was "most likely" not activated, which does not mean it wasn't activated. This is a misinterpretation of the data.
24	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
24	CC-3	Y	Supports the paragraph, however, claim of "less than 1g" in the AIB should have a more precise number to be fully supported.
24	BB-5	N	Does not provide the definition of breakdown of visual scan, which isn't listed until BB-11.
24	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
24	BB-5	N	Does not provide the definition of spatial disorientation, which isn't listed until BB-13.
24	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.

Page of Report	Reference TAB	Support (Y/N)	Comments
25	BB 5	N	Does not describe training issues.
25	BB 5	N	Does not discuss personal equipment.
25	H 53-58	N	The reference does not support whether or not the pilot was wearing cold weather gear. It states only what is considered cold weather gear.
25	CC 5	Y	Supports the paragraph
25	BB 5	N	Does not discuss controls and switches
26	BB 17	N	This is not accurately quoted and does not reference the denent.
26	U 4	Y	Supports the paragraph.
27	CC 5	Y	Supports the paragraph.
28	BB 5	N	Does not describe Inadvertent Operations and isn't listed until BB-11.
28	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.
28		N	The entire section on non-contributing factors is undocumented.
# of references not supported		**60**	
Total # of references		**109**	

Appendix C. Aircraft Accident Investigation Board Report

The version of the AIB report used for this assessment has been included in this report as a reference material.

UNITED STATES AIR FORCE
AIRCRAFT ACCIDENT INVESTIGATION BOARD REPORT

F-22A, T/N 06-4125

3RD WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

LOCATION: JOINT BASE ELMENDORF-RICHARDSON, ALASKA
DATE OF ACCIDENT: 16 NOVEMBER 2010
BOARD PRESIDENT: BRIG GEN JAMES S. BROWNE
CONDUCTED IAW AIR FORCE INSTRUCTION 51-503

EXECUTIVE SUMMARY

AIRCRAFT ACCIDENT INVESTIGATION

F-22A, T/N 06-4125
JOINT BASE ELMENDORF-RICHARDSON, ALASKA
16 NOVEMBER 2010

On 16 Nov 2010, at approximately 19:43:27 hours local time (L), an F-22A, tail number 06-4125, assigned to the 525th Fighter Squadron, 3rd Wing, Joint Base Elmendorf-Richardson (JBER), Alaska, impacted the ground during controlled flight approximately 120 nautical miles (NM) northeast of JBER. The mishap pilot (MP) did not attempt ejection and was fatally injured upon impact. The mishap aircraft (MA) was destroyed. There was no damage to private property. A damage cost of $147,672,000.00 includes the total destruction of the MA along with its internal stores.

The mishap occurred on a 3-ship night opposed surface attack tactics training mission, during the return-to-base portion of the mission while the MP was attempting to rejoin with his flight lead. At approximately 19:42:18L, the MA experienced an engine bleed air leak malfunction. The MP began a descent and retarded the throttles to IDLE power. At 19:42:53L, the MA entered a 240 degree roll through inverted, and the nose down (ND) pitch attitude increased. At approximately 19:43:24L, the MP initiated a dive recovery. Three seconds later, the aircraft impacted the ground in a left bank at approximately 48 degrees ND at a speed greater than 1.1 Mach.

The board president found, by clear and convincing evidence, the cause of the mishap was the MP's failure to recognize and initiate a timely dive recovery due to channelized attention, breakdown of visual scan, and unrecognized spatial disorientation.

Additionally, the board president found, by preponderance of evidence, organizational training issues, inadvertent operations, personal equipment interference, and controls/switches were factors that substantially contributed to the mishap.

SUMMARY OF FACTS AND STATEMENT OF OPINION
F-22A, T/N 06-0125
16 NOVEMBER 2010

TABLE OF CONTENTS

COMMONLY USED ACRONYMS AND ABBREVIATIONS

3WG	3rd Wing
AF	Air Force
AFB	Air Force Base
AFE	Air Flight Equipment
AFI	Air Force Instruction
AFIP	Air Force Institute of Pathology
AFPAM	Air Force Pamphlet
AGL	Above Ground Level
AIB	Aircraft Investigation Board
AK	Alaska
ATAGS	Advanced Tactical Anti-G System
BRAG	Breathing Regulator/Anti-G
Capt	Captain
CAUT	Caution
CIP	Core Integrated Processor
Col	Colonel
CSMU	Crash Survivable Memory Unit
DoD	Department of Defense
ECS	Environmental Control System
EOS	Emergency Oxygen System
EPS	Emergency Power System
FL	Flight Lead
FLCS	Flight Control System
FPM	Feet Per Minute
FPS	Fire Protection System
FRC	Fault Reporting Codes
FS	Fighter Squadron
ft	Feet
g	Gravitational Force
HUD	Heads up Display
IAW	In Accordance With
ICAWS	Integrated Caution, Advisory and Warning System
IFDL	Intra-Flight Data Link
IMIS	Integrated Maintenance Information System
IP	Instructor Pilot
IVSC	Integrated Vehicle Subsystem Controller
JBER	Joint Base Elmendorf-Richardson
JDAM	Joint Direct Attack Munitions
K	Thousand
KCAS	Knots Calibrated Airspeed
KTAS	Knots True Airspeed
kts	Knots
L	Local
LM-Aero	Lockheed Martin Aeronautics Company
Lt Col	Lieutenant Colonel
LWD	Left Wing Down
M	Mach
MA	Mishap Aircraft
Maj	Major
MAJCOM	Major Command
MFL	Mishap Flight Lead
MOA	Military Operating Area
MP	Mishap Pilot
MS	Mishap Sortie
MSL	Mean Sea Level
ND	Nose Down
NM	Nautical Miles
NOTAMS	Notices to Airmen
NVGs	Night Vision Goggles
OBIGGS	On-board Inert Gas Generating System
OBOGS	On-board Oxygen Generating System
OG	Operations Group
OPR	Officer Performance Report
Ops Tempo	Operations Tempo
ORM	Operational Risk Management
OSS	Operation Support Squadron
PA	Public Affairs
P&W	Pratt and Whitney
PAO	Polyalphaolefin
PACAF	Pacific Air Forces
PHA	Physical Health Assessment
PMP	Packaged Maintenance Plan
PR	Pre Flight
PSI	Pounds Per Square Inch
QA	Quality Assurance
RTB	Return-To-Base
RWD	Right Wing Down
SAR	Search and Rescue
SAT	Surface Attack Tactics
SII	Special Interest Item
SOF	Supervisor of Flying
TCTO	Time Compliance Technical Order
T/N	Tail Number
TOD	Tech Order Data
VVI	Vertical Velocity Indication

The above list was compiled from the Summary of Facts, the Statement of Opinion, the Index of Tabs, and Witness Testimony (Tab V).

SUMMARY OF FACTS

1. AUTHORITY AND PURPOSE

a. Authority

On 22 Dec 2010, General Gary L. North, Commander, Pacific Air Forces (PACAF), in accordance with (IAW) Air Force Instruction (AFI) 51-503, appointed Brigadier General James S. Browne to conduct an aircraft accident investigation of a mishap that occurred on 16 Nov 2010 involving an F-22A Raptor aircraft, tail number (T/N) 06-4125, at Joint Base Elmendorf-Richardson (JBER), Alaska (AK). The investigation was conducted at JBER, from 4 Jan 2011 through 14 Jan 2011, 3 Jun 2011 through 13 Jun 2011, and 11 Jul 2011 through 21 Jul 2011. Board members were [AIB Pilot Member], [AIB Maintenance Officer Member], [Original AIB Legal Advisor], [AIB Medical Advisor], [AIB Human Factor Advisor], [AIB Maintenance Enlisted Member], and [AIB Recorder]. (Tab Y-3 through Tab Y-9) On 10 Feb 2011, General North, appointed [New AIB Legal Advisor] as substitute Legal Advisor for [Original AIB Legal Advisor]. (Tab Y-10)

b. Purpose

This is a legal investigation convened to inquire into the facts surrounding the aircraft or aerospace accident, to prepare a publicly-releasable report, and to gather and preserve all available evidence for use in litigation, claims, disciplinary actions, administrative proceedings, and for other purposes.

2. ACCIDENT SUMMARY

At 18:17 hours local time (L), 16 Nov 2010, the mishap pilot (MP), Capt Jeffrey Haney, flying F-22A, T/N 06-4125, the mishap aircraft (MA), departed JBER as number 3 of a 3-ship formation for an opposed surface attack tactics (SAT) training mission. The weather in the area was clear with unlimited visibility and 74% moon illumination over snow covered terrain. The tactical mission portion of the flight was completed uneventfully. At 19:39:57L, during the return-to-base (RTB) portion of the flight, data from the mishap flight lead's (MFL) intra-flight data link (IFDL) showed the MA in front of the MFL bearing 131 degrees at 13 nautical miles (NM), heading 183 degrees, 1,039 knots true airspeed (KTAS) at 38,400 feet (ft) above mean sea level (MSL). At some time after that, the MFL directed the MP to rejoin. According to the recovered crash survivable memory unit (CSMU), at 19:40:44L the MA entered a climbing right turn to commence the rejoin. At 19:42:18L a C BLEED HOT caution integrated caution, advisory, and warning (ICAW) asserted. The MP began a descent and retarded the throttles to IDLE power. At 19:42:53L, the MA entered a 240 degree roll through inverted, and the nose down (ND) pitch attitude increased. At 19:43:24L the MP initiated a dive recovery. Approximately three seconds later, the aircraft impacted the ground 48 degrees ND at a speed greater than 1.1 Mach (M) and was destroyed. A damage cost of $147,672,000.00 includes the

total destruction of the MA along with its internal stores. The MP did not eject and was fatally injured.

3. BACKGROUND

The MA belonged to the 3rd Wing (3WG) at JBER. It was operated by the 525th Fighter Squadron (FS). The MA took off from the JBER airfield and impacted approximately 120 NM north of the base.

a. Pacific Air Forces

Pacific Air Forces' (PACAF) primary mission is to provide ready air and space power to promote US interests in the Asia-Pacific region during peacetime, through crisis and war. The command's vision is to be the most respected air warrior team employing the full spectrum of air and space power, with our Asia-Pacific partners, to ensure peace and advance freedom. PACAF's area of responsibility extends from the west coast of the United States to the east coast of Africa and from the Arctic to the Antarctic, more than 100 million square miles. The area is home to nearly two billion people who live in 44 countries. PACAF maintains a forward presence to help ensure stability in the region. (Tab DD-3)

b. Unit Information

(1) 11th Air Force, Joint Base Elmendorf-Richardson, Alaska

The 11th Air Force (11AF) plans, conducts, controls and coordinates air operations IAW the tasks assigned by the PACAF commander, and is the force provider for Alaskan Command, the Alaskan Aerospace Defense Command Region, and other unified commands. Its units provide a network of critical air surveillance and command, control and communications functions necessary to perform tactical warning and attack assessment in defense of Alaska. (Tab DD-5)

(2) 3rd Wing, Joint Base Elmendorf-Richardson, Alaska

The 3WG trains and equips an Air Expeditionary Force lead wing comprised of more than 2,400 Airmen and F 22A, E-3B, C-17, C-12, and C-130 aircraft. It is located on JBER in Anchorage, AK. Its mission is to support and defend U.S. interests in the Asia Pacific region and around the world by providing units who are ready for worldwide air power projection and a base that is capable of meeting the Pacific Command's theater staging and throughput requirements. (Tab DD-9)

(3) 525th Fighter Squadron

The 525th Fighter Squadron (525FS) is a combat-ready fighter squadron prepared for rapid worldwide deployment. Flying the AF's premier aircraft, the F-22A Raptor, the 525th provides air dominance for the United States and its allies.

The 525FS originally activated as the 309th Bombardment Squadron (Light) on 10 Feb 1942. The 525th Tactical Fighter Squadron inactivated on 1 Apr 1992. After 15 years of inactivation, PACAF redesignated and activated the 525FS at Elmendorf Air Force Base, AK, on 29 Oct 2007. The 525FS is now armed with the Air Force's premier fighter aircraft -- the F-22A Raptor.

Currently, the squadron trains in the fighter missions of offensive and defensive counter air (air-to-air), as well as strategic attack and offensive counter attack (air-to-surface). (Tab DD-11)

c. F-22A Raptor

The F-22A Raptor is a single seat, multi-role fighter aircraft. Its combination of stealth, supercruise, maneuverability, and integrated avionics represents an exponential leap in warfighting capabilities and make it the world's most advanced fighter. The Raptor performs both air-to-air and air-to-ground missions allowing it to project air dominance and defeat threats attempting to deny access to our nation's Air Force, Army, Navy and Marine Corps. This capability provides a critical edge to joint force commanders and acts as an effective deterrent to future adversaries. (Tab DD-15)

4. SEQUENCE OF EVENTS

a. Mission

The mishap sortie (MS) was scheduled and briefed as a night opposed SAT mission with aerial refueling. The mission involved six F-22As with callsigns Jake 01 through 03 and Rocky 01 through 03. These six were joined by four F-16s from Eielson AFB, callsigns Mig 01 through 04. The pilot of Rocky 01 was the MFL and the pilot of Rocky 03 was the MP. Originally, the F-22As were to proceed to a tanker, conduct aerial refueling, fight an opposed SAT mission, aerial refuel once more, and then conduct an additional unopposed SAT mission. Due to a delay in the takeoff time for high winds at JBER, the F-22As only refueled a single time after they executed their first SAT mission. (Tab R-4, R-60 through R-61)

Jake and Rocky flights took off 10 minutes apart and operated as two separate flights of friendly forces (Blue Air) fighting Mig flight acting as enemy forces (Red Air). Opposed SAT missions

typically consist of F-22As fighting their way into a target area protected by enemy forces and dropping Joint Direct Attack Munitions (JDAM) on specified targets. The purpose of this mission was a night flight lead (FL) upgrade mission for Jake 01 with Jake 03 as his qualified instructor pilot (IP) and a night continuity training sortie for Rocky 01 through 03. (Tab R-4 through R-5, R-60 through R-61, Tab K-10)

The mishap mission was flown in Dice and Paxson Airspace scheduled by 3WG for these training purposes. Dice and Paxson are over land designated military operating areas (MOAs) north of JBER. The 525FS Director of Operations properly authorized the mission. (Tab K-5, K-9)

b. Planning

Jake 01 planned and briefed the mission as a SAT FL upgrade sortie in accordance with 3WG Administrative Standards, F-22A In-Flight Guide Supplement, and applicable Tactics, Techniques and Procedures. All Jake flight and Rocky flight members attended the entire brief at 15:15L, including the 525FS commander who was the IP of record for the upgrade sortie. The flight briefing covered all administrative flight information, weather, Notices to Airmen (NOTAMS), training rules, Special Interest Items, tanker operations, deconfliction between the two F-22A flights, and all items necessary to safely conduct the planned SAT training mission. Additionally, extra emphasis was placed on night operations and the use of night vision goggles (NVGs). (Tab K-10, K-13 through K-16, Tab R-53)

c. Preflight

In accordance with 3WG Administrative Standards, all flight members focused their NVGs prior to the brief in order to prepare for the night mission. All six pilots arrived at the operations desk at 16:35L for a final update briefing on weather, NOTAMS and other pertinent safety-of-flight information prior to going to their aircraft. Pilots were delayed approximately 20 minutes due to crosswinds at JBER. After the winds were within limits, the operations supervisor ("Top 3") gave the pilots their final update briefing. (Tab R-84 through R-85) This was the first mission of the season where Category III (cold weather gear) winter clothing was required based on the low temperature in the airspace. (Tab R-84, H-50 through H-55) Additionally, the pilots used Operational Risk Management (ORM) to evaluate mission risk. ORM is a decision-making process to systematically evaluate possible courses of action, identify risks and benefits, and determine the best course of action for any given situation. The ORM category for the mission was in the "High" range based on night operations, the changes to the mission due to a delayed takeoff for winds, and the fact that the MS was the MP's second event of the day. The MP's first event of the day was acting as the supervisor of flying (SOF). (Tab K-17) The Top 3 and the squadron commander made the decision to continue with the mission based on clear weather, diminishing winds, and minimal changes to the mission. (Tab R-84)

The pilots went to life support, donned the appropriate winter clothing and flight gear, and proceeded to their aircraft. The MP accomplished pre-flight inspections IAW 1F-22A-1 and 1F-22A-34 checklists. Ground and taxi operations were uneventful. (Tab R-85)

d. Summary of Accident

Jake flight took off at 18:05L; Rocky flight departed 10 minutes later. (Tab K-5) Departure and entrance into the Dice MOA was uneventful, and the weather in the airspace was clear with high moon illumination. (Tab F-3) As Rocky flight entered the airspace, Jake flight completed their first mission and proceeded to the KC-135 air refueling tanker as briefed. After refueling, Jake flight returned to the airspace, executed their second opposed SAT mission, and returned to JBER. (Tab R-46)

Rocky flight's first opposed SAT mission against Mig flight was uneventful. Rocky 02 reached a previously briefed fuel quantity prior to the MFL and MP, and proceeded to the tanker as a single aircraft. The MFL and MP followed Rocky 02 to the tanker to refuel. While on the tanker, Rocky 02 was troubleshooting minor, non safety-of-flight related avionics issues. The MFL directed Rocky 02 to return to Dice MOA to continue troubleshooting. Once the issues were resolved, the MFL directed Rocky 02 to fly an unopposed SAT mission as a single aircraft and RTB. (Tab R-5)

After receiving fuel, the MFL and MP executed a second unopposed SAT mission. In accordance with the brief, the MFL directed the flight to execute a high-altitude/high-airspeed SAT profile, followed by a safe escape maneuver to the south. Upon completion of tactical maneuvering, the flight proceeded towards the airspace exit point to RTB. (Tab R-5 through R-6)

At 19:39:57L, the last recorded data from the MFL IFDL showed the MA 13 NM in front of the MFL bearing 131 degrees, heading 183 degrees, 1.6 M at 38,400 ft MSL. (Tab J-2)

The MFL then directed the MP to rejoin to a 2 NM trail formation. The MP acknowledged the MFL's directive to rejoin and made no further communications. The MP began a climbing right hand turn to rejoin. The MA climbed to a maximum altitude of 51,720 ft MSL, crossed the MFL's projected flight path and then began a descent to the north. (Tab EE)

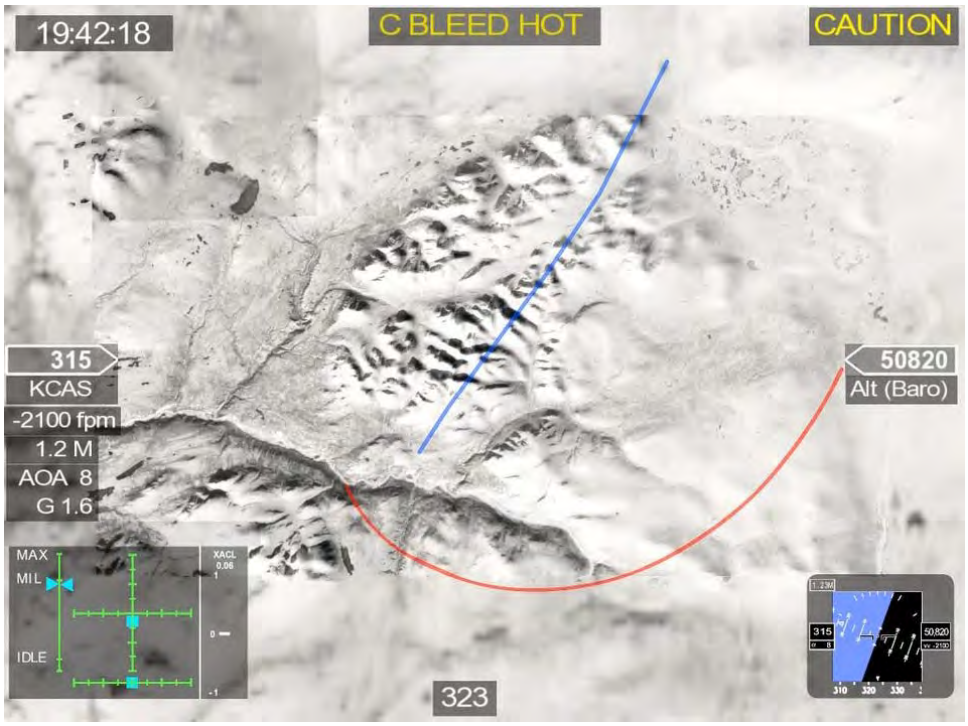

Figure 1 19:42:18L -- Relative position between MFL (blue) and MP (red) at the assertion of the C BLEED HOT caution ICAW. (Tab EE)

At 19:42:18L the fire protection system (FPS) detected a bleed air leak in the center bleed air ducting from both engines. In response to the FPS, the Integrated Vehicle Subsystem Controller (IVSC) asserted the C BLEED HOT caution ICAW while it requested the Environment Control System (ECS) to isolate the center bleed system. "CAUT" was displayed in the heads up display (HUD) advising the MP of the caution ICAW. (Tab J-4) When the C BLEED HOT caution ICAW asserted, the following functions were lost:

1) ECS
2) Air Cycle System (ACS) forced air cooling
3) On-board oxygen generating system (OBOGS)
4) On-board inert gas generating system (OBIGGS)
5) Cabin pressure

(Tab J-223)

The MA was at 50,870 ft MSL, 315 knots calibrated airspeed (KCAS), 1.23 M, with an attitude of 1 degree nose up, 69 degrees right wing down (RWD), heading 323 degrees, 1.5 g, and with a vertical velocity indication (VVI) of -1,700 ft per minute (fpm). (Tab EE)

Figure 2 19:42:18 -- MA parameters at assertion of C BLEED HOT caution ICAW. (Tab EE) See Tab Z-10 for a diagram explaining the symbology in the Figures.

The C BLEED HOT caution ICAW cleared at 19:42:21L indicating the overtemperature condition no longer existed after the IVSC commanded the bleed air ducts to the closed position and stopped the flow of bleed air to the ECS. Due to the ECS no longer supplying pressure to OBOGS, the pressure dropped below the 10 pounds per square inch (psi) minimum threshold and displayed an OBOGS FAIL caution ICAW at 19:42:23L. (Tab J-12 and J-23)

Figure 3 19:42:23 – MA parameters at assertion of OBOGS FAIL caution ICAW. (Tab EE)

At the assertion of this ICAW until 19:42:45L, the MP retarded the throttles to IDLE power and deliberately continued a controlled, descending right hand turn to descend to a lower altitude IAW the checklist. (Tab BB-29) At this time the MA was at 41,460 ft MSL, 390 KCAS, 1.29M, 30 degrees ND, 44 degrees RWD, 1.7 g, and with a VVI of -33,700 fpm. (Tab EE)

Figure 4 19:42:45 – MP deliberately flew to a controlled attitude of 30 degrees ND and 44 degrees RWD in order to descend to a lower altitude IAW the checklist. (Tab EE)

The CSMU mishap data discrete signal showed partial pressure to the MP's oxygen mask stopped shortly after 19:42:37L, which would lead to severely restricted breathing. (Tab J-43) From 19:42:45L until 19:42:53L, the MP made no inputs to the stick, pedals, or throttles, and the MA maintained a relatively stable bank angle and attitude. The MA was at 37,110 ft MSL, 470 KCAS, 1.35M, 30 degrees ND, 46 degrees RWD, 0.8 g, with a VVI of -37,700 fpm. (Tab EE)

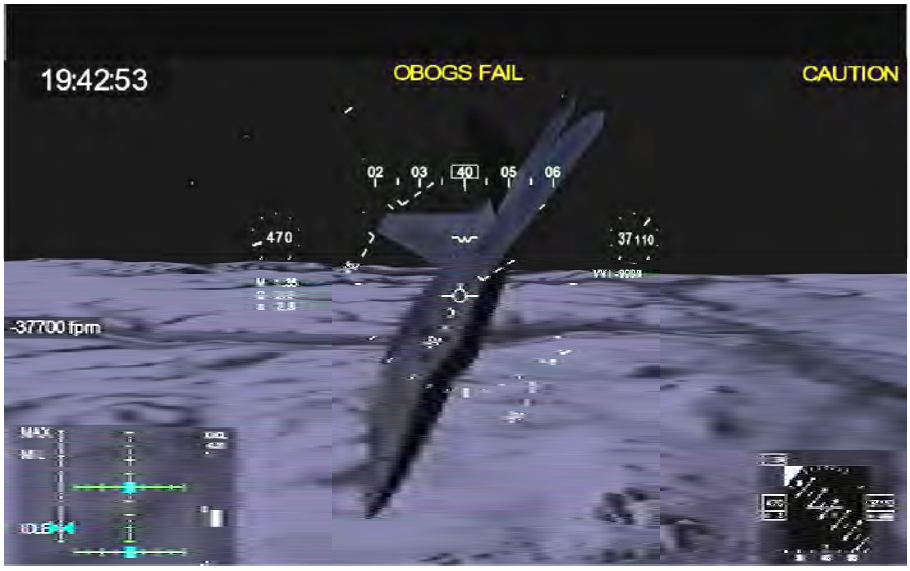

Figure 5 19:42:53 – MA parameters after 8 seconds of zero MP inputs to stick, pedals, or throttles. (Tab EE)

At 19:42:53L, the MP input a combination of right forward stick and right pedal which initiated a 240 degree descending right roll at greater than 45 degrees per second. (Tab EE)

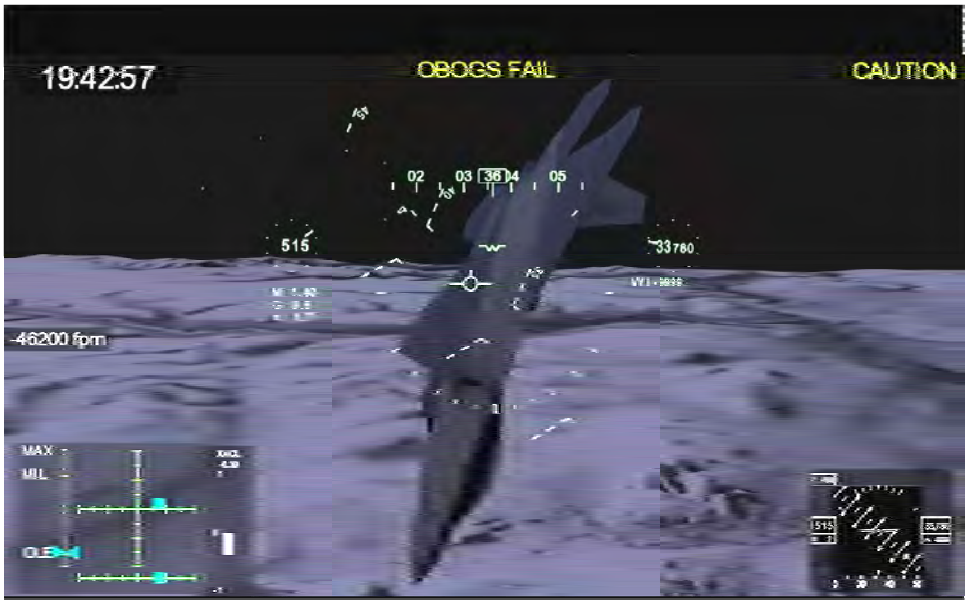

Figure 6 19:42:57 – MA parameters during MA 240 degree roll to the right resulting from stick and pedal inputs. (Tab EE)

At the completion of these stick and pedal inputs at 19:43:08L, the MA had rolled through inverted, experienced less than 1 g of gravitational force, and went from a RWD to Left Wing Down (LWD) attitude, and the descent rate of the aircraft significantly increased. The parameters at this time were 24,070 ft MSL, 627 KCAS, 1.39M, 44 degrees ND, 81 degrees LWD, 0.8 g, with a VVI of -57,800 fpm. (Tab EE)

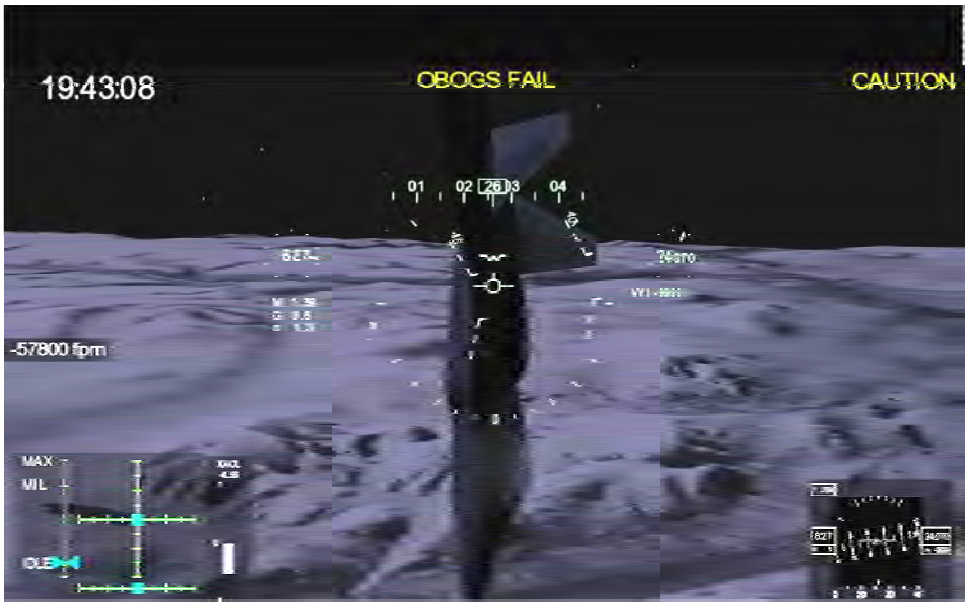

Figure 7 19:43:08 – MA parameters when stick and pedal inputs cease after the 240 degree roll. (Tab EE)

After 19:43:08L, there were no stick inputs and only very minor pedal inputs for the next 15 seconds. At 19:43:13L, passing approximately 19,000 ft MSL, a CABIN PRESSURE caution ICAW asserted based on cockpit pressurization exceeding its normal schedule. (Tab J-13)

Figure 8 19:43:13 – MA parameters at assertion of CABIN PRESS caution ICAW. No stick or pedal inputs. (Tab EE)

At 19:43:18L, passing 12,400 ft MSL, an AIR COOLING caution ICAW asserted. This ICAW would assert 60 seconds after a C BLEED HOT caution ICAW if the aircraft were not receiving an adequate cooling air source to its avionics. (Tab J-13)

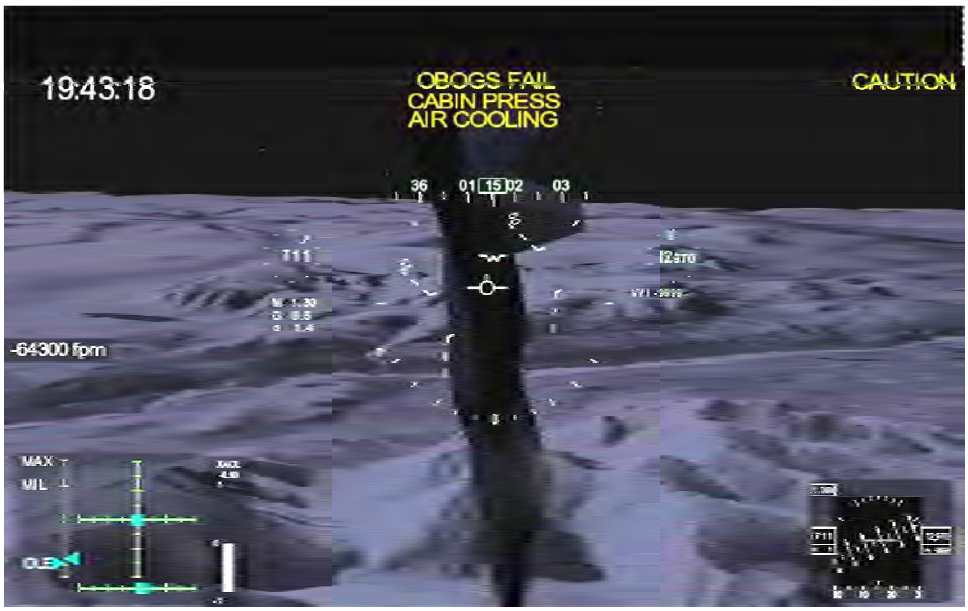

Figure 9 19:42:18 – MA parameters at assertion of AIR COOLING caution ICAW. No stick or pedal inputs. (Tab EE)

At 19:43:24L the MP performed a dive recovery at 5,470 ft MSL by pulling aft on the stick, producing a 7.4 g pull up maneuver. The MA impacted the ground 3 seconds later, inflicting fatal injuries to the MP and destroying the MA. (Tab EE)

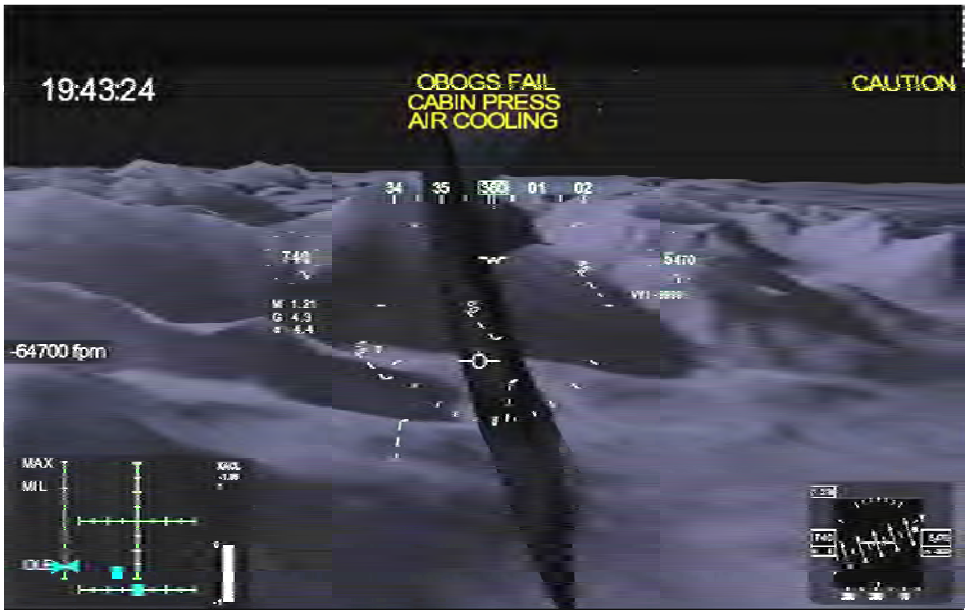

Figure 10 19:43:24 – MP initiates full aft stick pull to start dive recovery at 5,470 ft MSL. (Tab EE)

e. Impact

At 19:43:27L, the MA impacted the ground at 735 KCAS, 1.17M, 48 degrees ND, 47 degrees LWD, 7.4 g, with a VVI of -57,900 fpm. The impact site is approximately 120 NM north of JBER, AK, in the Talkeetna Mountain range. The site is approximately 3,100 ft MSL near the edge of a south-west to north-east running valley. The impact crater is located at the valley floor where it begins to slope upwards towards the southeast. The valley floor is approximately one-half mile wide at this point and has a stream running through it approximately 60 yards west of the impact point. (Tabs J-4 through J-6)

The debris field consisted of small aircraft and engine pieces extending approximately one-quarter mile from the crater. The upslope wall of the crater and aircraft impact angle appear to have focused the debris pattern in a 60 – 80 degree wide arc from west to north. (Tabs J-4 through J-6)

Figure 11 Impact Crater 17 Nov 2010 (Tab S-7)

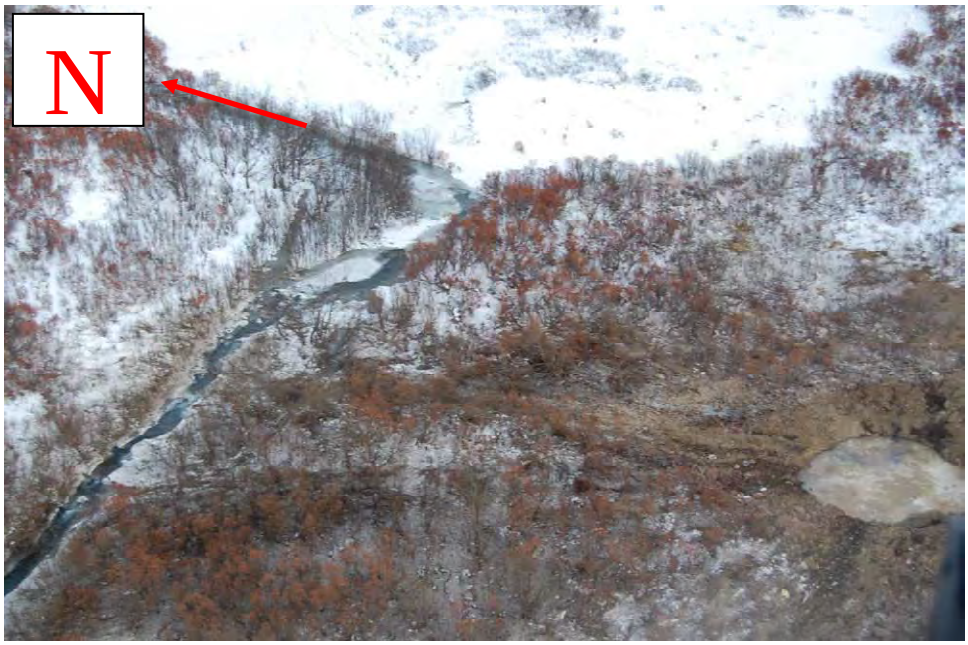

Figure 12 Impact Site. 17 Nov 2010 (Tab S-7)

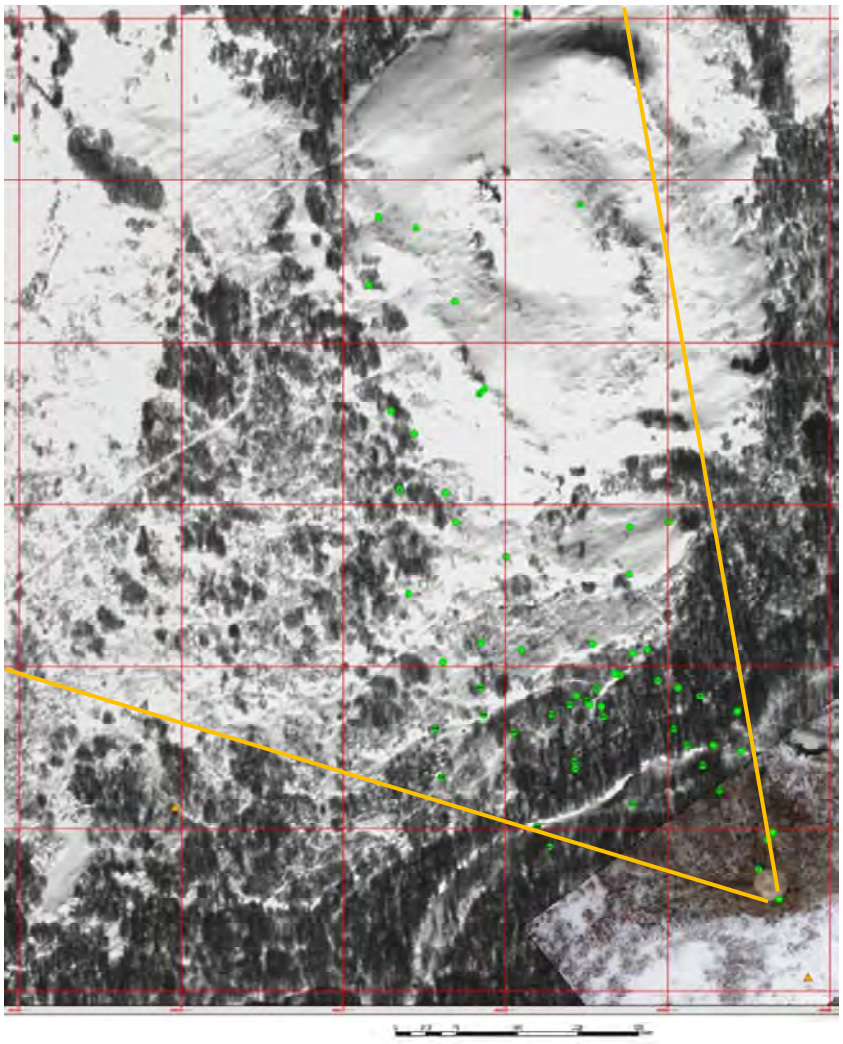

Figure 13 Aircraft Parts Scatter Diagram. Parts represented by green dots. (Tab S-4)

f. Egress and Aircrew Flight Equipment (AFE)

All life support equipment onboard the MA had current inspection dates and were deemed serviceable by 3 Operational Support Squadron (3OSS) AFE members. (Tab H-17 through H-23) The MP had two repairs performed on his advanced tactical anti-g system (ATAGS) on both the preceding day and the day of the mishap. All repairs, modifications, testing, and fittings were performed by qualified AFE members IAW all applicable technical orders (TO). (Tab R-117 through R-121)

Based on analysis of the escape system and life support equipment located in the debris field, an ejection did not occur and therefore, there was no opportunity for the MP to use survival gear or life support equipment. (Tab H-5 through H-9)

Additionally, based on forensic analysis of the right bayonet clip of the MP's helmet recovered in the debris field, it appears the MP had his oxygen mask on and secured at the time of impact. (TAB J 75, 76 and 98 through 105)

g. Search and Rescue (SAR)

At 20:10L on 16 Nov 2010, 11AF Rescue Coordination Center received notification of an overdue aircraft. Initial on scene and search and rescue efforts were conducted by the MFL, Alert F-22As, and a KC-135. Alaska Air National Guard HH-60s and HC-130s located the crash site the following morning. SAR team analysis of the crash site determined that the MP did not eject from the aircraft. (Tab AA-4) Significant snowfall with sub-freezing temperatures began the following week, covering the aircraft wreckage and making location and identification of aircraft wreckage more difficult. (Tab J-5)

h. Recovery of Remains

JBER personnel were responsible for recovery operations. Crash, fire, rescue personnel, and civil engineers were pivotal to recovery efforts. Remains were recovered during the initial recovery beginning 17 Nov 2010 and additionally when the recovery team reconvened at the site in May 2011. The remains were transferred to the Air Force Institute of Pathology (AFIP) Mortuary Affairs. (TAB CC-15)

5. MAINTENANCE

a. Forms Documentation

The 3rd Maintenance Group, JBER, maintained the aircraft forms for the MA. The F-22A aircraft maintenance records are stored in an electronic management database referred to as the Integrated Maintenance Information System (IMIS). IMIS tracks all scheduled and unscheduled maintenance activities, repairs, aircraft flying hours, maintenance personnel activity, and Technical Order Data (TOD). A detailed 90-day maintenance records review in IMIS was completed. The historical aircraft forms revealed no major documentation errors. (Tab D-4, D-5, D-6)

b. Inspections

Time Compliance Technical Orders (TCTOs) are inspections or maintenance procedures required before specific dates or flight. No TCTOs restricted the MA from flying. Historical records located in IMIS showed all TCTO accomplishment IAW applicable guidance. There were no overdue component time changes or TCTOs. (Tab D-7, D-8, D-9)

The MA flew 31 flights totaling 44.3 hours within 90 days of the mishap. There were no major maintenance discrepancies that would have prevented the MA from accomplishing the training flight on 16 Nov 2010. Also, historical records did not reveal any recurring or repeating maintenance problems. (Tab D-5)

A Pre-Flight (PR) is a flight preparedness inspection performed prior to flight and is a valid inspection for 72 hours once completed. The PR inspection is governed by TO 00-20-1 and is performed in accordance with the F-22A PR inspection TO. The purpose of this inspection is to visually inspect and operationally validate various areas and systems of the aircraft in preparation for a flying period. The maintenance technician reported no discrepancies on PR performed on 15 Nov 2010 at 20:50L, approximately 21.5 hours prior to the incident. The PR did not contribute to the mishap. (Tab D-4, D-5)

c. Maintenance Procedures

The most recent major maintenance procedure performed on the MA was the Contract Field Team accomplishment of TCTO 1F-22A-1222 on 5 through 27 Oct 2010. The TCTO consisted of maintenance performed on both horizontal tail surfaces. All documentation was reviewed. The TCTO actions did not contribute to the mishap. (Tab U-4 through U-5)

A major maintenance inspection for the F-22A is the Packaged Maintenance Plan (PMP) concept. The PMP is scheduled maintenance tasks determined by airframe hours specified by TO 1F-22A-6. According to TO 1F-22A-6, the first PMP is due at the 900 airframe hour mark. The MA was not due for its first PMP for another 431 hours. The PMP did not contribute to the mishap. (Tab D-3)

d. Maintenance Personnel and Supervision

The 3rd Maintenance Group, JBER, maintained the MA. All pre-mission activities were normal and all personnel involved in the PR and launch of the MA were experienced and competent. A thorough review of maintenance training records in the electronic Training Business Area (AF Form 623s and AF Form 797s) revealed all involved personnel were properly trained and qualified. (Tab G-2)

e. Fuel, Hydraulic and Oil Inspection Analyses

The Fuels Laboratory from JBER and Eielson AFB sent fuel samples to the Air Force Petroleum Agency, Wright-Patterson AFB, OH, IAW TO 42B-1-1. The two R-11 refuel trucks from JBER and fuel samples taken from the KC-135 aircraft that refueled the MA were sent for testing. All fuel samples were within limits and were satisfactory for use. (Tab D-25 through D-41)

The following aircraft ground support equipment samples were taken: Polyalphaolefin (PAO), hydraulic, and oil cart. All samples were tested and found to be within limits and satisfactory for use. (Tab D-21 through D-25)

The impact destroyed both engine reservoirs, gearboxes, and other containers that held PAO, hydraulic, and oil fluid preventing post-impact sample retrieval.

f. Unscheduled Maintenance

Review of the maintenance records for MA indicates that both engines were replaced one week before the mishap by the 3rd Maintenance Group at JBER. The #1 engine (E0123) required

removal because the engine oil sample showed high iron during a routine oil analysis sample. The #2 engine (E0316) required removal to complete a heat exchanger time change replacement. The ECS bleed air duct disconnection and reconnection were performed during engine removal and installation tasks. A journeyman technician, a craftsman technician, and a Quality Assurance (QA) inspector performed engine bay inspections on both left and right sides with no defects noted. Following engine installations, a journeyman technician, a craftsman technician, and a QA inspector verified installation with no defects noted. Engine operational checks were accomplished with no maintenance issues reported. No other ECS maintenance was performed on the MA within the 90-day maintenance review. (Tab J-34) All maintenance actions were in order, appropriate, and did not contribute to the mishap.

6. AIRFRAME, MISSILE, OR SPACE VEHICLE SYSTEMS.

a. Structures and Systems

The high rate of speed at impact destroyed a majority of components from the aircraft. A thorough inspection of all recovered and identified aircraft parts was completed. Due to the extreme destruction of the aircraft and the engines, analysis was difficult. (Tab J-3)

(1) Crash Survivability Memory Unit

The recovered CSMU, manufactured by L3 Communications, was sent to Lockheed Martin Aeronautics Company (LM-Aero) for evaluation. LM-Aero was able to compile a chronological summary of significant events and aircraft system integrity using the CSMU data. (Tab L-3 through L-7, J-10)

(2) Flight Control System (FLCS)

The CSMU mishap data indicated normal operation of the FLCS. The Initiated Built-In Test passed prior to flight, and no other fault report codes (FRC) were reported in the mishap CSMU file. (Tab J-14)

(3) Electrical Power System (EPS)

The CSMU mishap data indicated normal operation of the EPS. There were no EPS failures throughout the flight. (Tab J-20)

(4) Auxiliary Power Generating System (APGS)

The APGS, via the auxiliary power unit (APU) provides bleed air for use by the ECS and for airframe-mounted accessory drive (AMAD) motoring. Upon review of the CSMU data, the APGS was functioning normally. (TAB J-20)

(5) Engines

The CSMU mishap data indicated both engines responded to pilot input and operated normally throughout the flight envelope. Both engines were Pratt and Whitney (P&W) F119-PW-100 turbofan engines. The #1 engine (PW0E730305) had 595.5 hours. The #2 engine (PW0E70296) had 685.4 hours. There were no overdue inspections or time changes on either engine. (TAB D-1, D-2, J-30)

(6) Hydraulic Power System

The CSMU mishap data indicated normal operation of the hydraulic power system. (TAB J-30)

(7) Fuel System

Review of the CSMU mishap data revealed normal fuel system performance as designed during normal flight operations and emergency operations. (TAB J-30)

(8) Environmental Control System

When the ECS system IVSC logic detected a manifold bleed air leak, a C BLEED HOT caution ICAW asserted. In this case, the logic commanded all bleed air regulating shutoff valves to close. This action protects against a bleed air induced aircraft fire. Closing all the valves results in the immediate loss of all ECS bleed and conditioned air flow, removing air flow to the OBOGS unit. The air bleed valves will remain closed for the duration of the flight, even if the caution ICAW clears. (TAB J-24) Due to the extensive damage and limited evidence recovered, the cause of the bleed air leak could not be determined. Review of the MA wreckage and CSMU data revealed the ECS performed as designed throughout the flight.

(9) Escape System

The CSMU data showed that the canopy was down and the seat armed for the entire mishap flight. Physical evidence of the recovered components concluded the canopy was in the down and locked position and the ejection sequence was not initiated prior to impact. (TAB H-3)

(10) Integrated Vehicle Subsystem Controller

The IVSC provides control and/or monitoring of all aircraft utilities and subsystems in a centralized computer system. The following is an analysis of the IVSC fault data. Both the mishap and APU Time History (AT file) data were used for this analysis. The mishap data contained three Global Manager reported faults:

1. 4622 19 073 – Data Transfer/Mass Memory Video Recorder Not Responding on the Avionics System 1553 Bus ‘B’
2. 4622 04 076 – ECS Air Cooled Avionics Manifold Delta Pressure
3. 4622 04 331 – ECS Warm Air Manifold Delta Pressure

These faults did not contribute to the mishap. All IVSC assemblies appear to have been fully operational throughout the MS and did not contribute to the mishap. (TAB J-19)

b. Evaluation and Analysis

(1) Emergency Oxygen System

Analysis was conducted to determine if the EOS achieved activation and if the MP's oxygen mask was secured at the time of ground impact. Various components from the ECS, EOS, OBOGS, and a portion of the MP's helmet that included one bayonet receiver were submitted to the Air Force Research Laboratory Materials Integrity Branch (AFRL/RXSA) for evaluation. Based on the report findings the EOS did not activate and the MP's oxygen mask bayonet was up and secured in place at the time of ground impact. (TAB J-71 through 74) Due to the severe break-up of the MA, the following items were not recovered and therefore not available for analysis: left side bayonet, MP's oxygen mask, and ejection seat EOS assembly.

(2) Canopy Seal/Anti-G suit Air Regulating Valve

The canopy seal/anti G suit regulating valve is manufactured by Honeywell Aerospace and was analyzed by a Honeywell Aerospace investigator. This analysis was conducted to determine if the canopy seal and anti-G suit air regulating valve were properly functioning prior to impact. Due to bleed air pressure loss caused by the C BLEED HOT caution ICAW, the valve remained open as designed. The valve did not contribute to the mishap. (Tab D-5)

(3) On Board Oxygen Generation System

Honeywell Aerospace manufactures the OBOGS unit. The unit was evaluated by the Human System Department, Naval Warfare Center, Patuxent River, MD. The purpose of the evaluation was to assess a possible contamination of the OBOGS unit. The OBOGS analysis showed evidence of carbon dioxide that was determined to be medically insignificant. (Tab D-5, CC-13) Additionally, the canister test included detection of JP-5, JP-8 and PAO. JP-8 jet fuel detected in the sample was considered to be high; however, the canister was found opened and exposed to the environment during the recovery operations. Therefore secondary contamination was likely. Contamination of the oxygen system did not contribute to the mishap. (Tab J-60 through 66)

(4) Gas Chromatograph Analysis

Forensic swab collection was performed on the CRU-94, Breathing Regulator/Anti-G (BRAG) valve, canopy seal/anti-G suit air regulating valve, anti-g suit connector, O2 bulkhead fitting, OBOGS connector fitting, and OBOGS pressure regulator. These samples were analyzed by the University of Dayton. The BRAG valve dry swab contained the presence of materials that are components of jet fuel. The BRAG valve recovery location and exposure to the environment upon impact caused secondary contamination. (TAB J-137 through 146, CC-13) All other components tested were determined to have medically insignificant contaminants. (Tab CC-13) Therefore, contamination did not contribute to the mishap.

7. WEATHER

a. Forecast Weather

The weather forecast for JBER on 16 Nov 2010 predicted a scattered cloud layer at 7,000 ft above ground level (AGL), unlimited visibility, winds at 360 degrees at 12 knots gusting to 18 knots, light turbulence from surface to 3,000 ft, and a minimum altimeter setting of 30.23 inches of mercury. There was a temporary forecast until 18:00L for winds to be 010 degrees at 15 knots gusting up to 18 knots and decreasing to 12 knots at 20:00L. (Tab F-14) Additionally, there were weather warnings for wind gusts at 35 knots but less than 50 knots, and wind shear at 1,500 ft at 040 degrees at 44 knots until 18:00L. (Tab F-3)

The weather forecast in the Dice MOA predicted scattered clouds at 5,000 ft and 10,000 ft AGL, 7 statute miles of visibility, winds at 40,000 feet out of the north at 50 knots, and the contrail level from 25,000 to 39,000 ft. The moonrise was at 14:34L, and the illumination was 74%. (Tab F-3)

b. Observed Weather

The sorties earlier that day were canceled due to crosswinds out of limits, and the night sorties were delayed by 20 minutes until the winds were within limits. (Tab R-83 through R-85) The observed weather at JBER at takeoff time was as follows: winds at 030 degrees at 17 knots gusting up to 21 knots, 10 miles of visibility, clear skies, and a minimum altimeter setting of 30.42 inches of mercury. (Tab F-5) From pilot testimonies, there was no adverse weather in the airspace with clear skies, good illumination, and "one of the nicest" nights of the winter. (Tab R-45 through R-46)

c. Space Environment

Not applicable.

d. Operations

Weather did not affect operations and was not contributory to the mishap.

8. CREW QUALIFICATIONS

a. Mishap Pilot

The MP was a current and qualified IP and mission commander (MC) with 303.5 hours in the F-22A, 98.1 hours as an IP, and 812.4 total hours in fighter aircraft. Prior to his assignment to the F-22A, the MP accumulated 508.9 hours as a FL in the F-15C. The MP had 31.4 NVG hours in the F-22A, 41.7 total NVG hours, and 47.6 total night hours. (Tab G-3, G-10 through G-12)

The MP was recognized throughout his career for exceptional performance. He received numerous accolades and awards including: Distinguished Graduate, AETC Commanders Trophy winner, and Flying Excellence Award winner from Undergraduate Pilot Training; Top Overall Graduate and Distinguished Graduate from F-15C Fighter Training; and most recently, 525FS Flight Lead of the Year, Warrior of the Year, Turkey Shoot Top Flight Lead, Instructor Pilot of the Quarter, and selection as an alternate to the F-22A Weapons Instructor Course. (Tab T-3) He was regarded as one of the top pilots in the squadron among his peers and supervision. (Tab V-8.5 through V-8.6)

The MP flew four sorties in the two weeks prior to the mishap (Tab G-10), two of which were night missions with NVGs. The MP flew on 15 Nov 2010, the night prior to the mishap.

The MP's flight time and sortie count during the 90 days before the mishap are as follows:

	Hours	Sorties
Last 30 Days	8.1	5
Last 60 Days	18.6	13
Last 90 Days	29.7	21

(Tab G-56 through G-57)

MP qualifications were not contributory to this mishap.

b. Mishap Flight Lead

At the time of the mishap, the MFL was a current and qualified FL and MC with 272.8 hours in the F-22A, and 880.7 total hours in fighter aircraft. Prior to his assignment to the F-22A, the MFL accumulated 607.9 hours in the F-15C. The MFL has 18.4 NVG hours in the F-22A, 57.4 total NVG hours, and 69.2 total night hours. (Tab G-3, G-30 through G-31)

The MFL flew three sorties in the two weeks prior to the mishap, two of which were night missions with NVGs. The MFL flew on 15 Nov 2010, the night prior to the mishap. (Tab G-28)

The MFL's flight time and sortie count during the 90 days before the mishap are as follows:

	Hours	Sorties
Last 30 Days	7.7	4
Last 60 Days	16.2	11
Last 90 Days	27.6	20

(Tab G-56 through G-57)

MFL qualifications were not contributory to this mishap.

9. MEDICAL

a. Qualifications - Mishap Pilot

A review of the MP's medical record showed he was medically qualified for flight and worldwide duty. His most recent annual flight physical and Periodic Health Assessment were both performed on 23 Nov 2009. No waivers were identified. (Tab X-3)

b. Health

Medical records and individual history revealed the MP was in good health. After thoroughly reviewing the material described above, there was no evidence that any preexisting medical condition contributed to this mishap. (Tab X-3)

c. Pathology

The partial remains of the MP were recovered and positively identified. Injuries sustained by the MP were consistent with the nature of the mishap. The MP died instantly upon impact. (Tab X-3)

Toxicology testing was performed on the MP, FL, 2 Life Support and 69 ground support personnel. Samples were submitted to the AFIP for analysis. All results were negative with the exception of one civilian and one active duty maintenance member who each tested positive for a single substance. Further investigation revealed both individuals held valid prescriptions and appropriate diagnoses for the medication detected during testing. Drug use was not a factor in the mishap. (Tab X-3)

d. Lifestyle

No lifestyle factors were found to be relevant to the mishap.

e. Crew Rest and Crew Duty Time

All Air Force pilots are required to have "crew rest" IAW AFI 11-202, Vol. 3, prior to performing in-flight duties. AFI 11-202 states, in part, "Air Force aircrews require at least 10 hours of continuous restful activities including an opportunity for at least 8 hours of uninterrupted sleep during the 12 hours immediately prior to the FDP (Flight Duty Period) … 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." (Tab BB-4)

There is no evidence to suggest inadequate crew rest was a factor in this mishap. (Tab R-139 through R-154)

10. OPERATIONS AND SUPERVISION

a. Operations

The 525FS did not have an elevated operations tempo in the month leading up to the mishap. The squadron had completed a Unit Compliance Inspection in Oct 2010 and was not scheduled to deploy until Jan 2011. All witnesses described the operations tempo as average and asserted that it did not negatively affect their ability to perform the mission. Operations tempo was not contributory to this mishap. (Tab V-8.5)

b. Supervision

The MS was flown as scheduled and planned with only minor deviations due to a delayed takeoff. The squadron commander was the IP of record for the MS and noted that all safety of flight items were covered thoroughly in the mission brief. (Tab R-53) Supervision was not contributory to this mishap.

11. HUMAN FACTORS

AFI 91-204, *Safety Investigations and Reports*, 24 September 2008, Attachment 5, contains the Department of Defense Human Factors Analysis and Classification System which lists potential human factors that can play a role in aircraft mishaps. (Tab BB-5) The following human factors were relevant to this mishap:

a. Causal

PC102 Channelized Attention

Channelized attention is a factor when the individual is focusing all conscious attention on a limited number of environmental cues to the exclusion of others of a subjectively equal or higher or more immediate priority, leading to an unsafe situation. This factor may be described as a tight focus of attention that leads to the exclusion of comprehensive situational information. (Tab BB-5)

In the F-22A Emergency Procedures OBOGS FAIL checklist, the pilot is to activate the EOS if he "is experiencing hypoxia or other physiological symptoms." Severely restricted breathing is a physiological symptom which would have prompted the MP to activate the EOS; however, post-mishap forensic analysis determined the EOS was not activated. (Tab J-76)

The MP displayed channelized attention when the OBOGS stopped airflow to the MP's oxygen mask and caused severe restrictive breathing. Based on the sequence of events, the fact that the EOS was never activated, and the fact the MP's oxygen mask was up and secured, it was most likely the MP channelized his attention on restoring airflow to his oxygen mask.

During the sequence of events, the pilot experienced a discernible 45 degree per second roll rate, a discernible linear acceleration change, and less than 1 g. (Tab EE) These forces were well above the minimally detectible thresholds and should have been recognized by the MP. (Tab CC-3) However, due to channelized attention, the MP appeared unaware of these discernible stimuli.

The MP's channelized attention caused a breakdown in his visual scan. This delayed recognition of the MA's attitude and thereby delayed the corrective actions necessary to recover the MA.

AE105 Breakdown in Visual Scan

Breakdown in visual scan is a factor when the individual fails to effectively execute learned/practiced internal or external visual scan patterns. The breakdown can lead to an unsafe situation. (Tab BB-5)

At 19:42:45L intentional flight control inputs stopped and did not resume for approximately 39 seconds. During this period, the MA performed a 240 degree right roll and increased to 53 degrees ND. (Tab EE) Had the MP continued to perform an effective visual scan, he would have recognized the unusual attitude of the MA and would have had adequate time to take corrective actions.

PC508 Spatial Disorientation (Type 1) Unrecognized

Spatial Disorientation is a failure to correctly sense a position, motion, or attitude of the aircraft or of oneself within the fixed coordinate system provided by the surface of the earth and the gravitational vertical. Spatial Disorientation (Type 1) Unrecognized is a factor when a person's cognitive awareness of one or more of the following varies from reality: attitude, position, velocity, direction of motion or acceleration. Proper control inputs are not made because the need is unknown. (Tab BB-5)

IAW the OBOGS FAIL checklist, the MP was in a deliberate and controlled descent to a lower altitude after the assertion of the OBOGS FAIL caution ICAW. However, at 19:42:53L the MP input stick and pedal movements for approximately 20-seconds, culminating in a 240 degree descending right roll. (Tab EE) At the completion of these stick and pedal inputs at time 19:43:08L, the MA had rolled through inverted, experienced less than 1 g of gravitational force, transitioned from a RWD to LWD attitude, and significantly increased the descent rate of the MA.

The fact that the MP went from a controlled flight regime to an unusual attitude and did not take corrective actions for 30 seconds suggests he had unrecognized spatial disorientation. At 19:43:24L the MP recognized the MA's position and attempted to perform a dive recovery by pulling aft on the stick, producing a 7.4 g pull up maneuver. The MA impacted the ground 3 seconds later, inflicting fatal injuries to the MP and destroying the MA.

b. Contributory

OP004 Organizational Training Issues/Programs

Organizational Training Issues/Programs are a factor when one-time or initial training programs, upgrade programs, transition programs or other training that is conducted outside the local unit is inadequate, unavailable, etc. creating an unsafe situation. Failure of an individual to absorb the training material in an adequate training program does not indicate a training program problem. (Tab BB-5)

USAF aircrew are highly trained to handle multiple and/or severe aircraft emergencies, but not with all forms of physiological duress. Additionally, the 525FS supervised emergency procedure training for the month of Nov 2010 included a review of the C BLEED HOT emergency procedures. Evidence showed the MP's oxygen mask was up and secured in place and the MP had not activated the EOS. Because of these factors, the MP most likely experienced a sense similar to suffocation. This was likely the MP's first experience under such physiological duress. The unique and added stress of the breathing restriction contributed to the MP's channelized attention and break down of visual scan that occurred on the night of the MS. This gap between aircrew training and real world physiological duress was contributory to this mishap.

PE207 Personal Equipment Interference

Personal Equipment Interference is a factor when the individual's personal equipment interferes with normal duties or safety. (Tab BB-5)

The MP was wearing CAT III cold weather gear and NVGs during the MS. (Tab H-53 through H-58) Ground simulation demonstrated reduced mobility in the cockpit due to the bulkiness of CAT III gear. Additionally, the NVGs hit the canopy, interfering with the pilot's ability to look from side to side and down at the consoles. In order to obtain head/canopy clearance, the pilot had to shift his torso by bracing himself on various areas in the cockpit. (Tab CC-5) These bracing actions and limited tactile sensation due to the CAT III gear demonstrated how inadvertent flight control inputs could occur.

PE204 Controls and Switches

Controls and Switches is a factor when the location, shape, size, design, reliability, lighting, or other aspect of a control or switch is inadequate and this leads to an unsafe situation. (Tab BB-5)

The lack of airflow to the MP's oxygen mask and the fact that the mask was up and secured in place at the time of impact suggests the MP would have attempted to activate the EOS for continued airflow. However, analysis of the EOS from the wreckage determined it was not activated.

1F-22A-1 states: “To manually activate the EOS, pull the green ring up and out of the retaining slot (approximately 33 pound pull), then pull directly forward minimizing inboard/outboard and upward motion. The pull force required to activate the EOS may be in excess of 40 lbs. The green ring will travel approximately two inches and will not release from the seat side. There is no obvious detent to indicate that the EOS has been activated.” (Tab BB-17)

The AFRL report identified that if the EOS wedge block had been incorrectly installed, the wedge block would be unable to move or rotate during manual EOS ring activation. However, during ground simulation the board members were able to initiate the EOS in the incorrectly installed position. (Tab U-4)

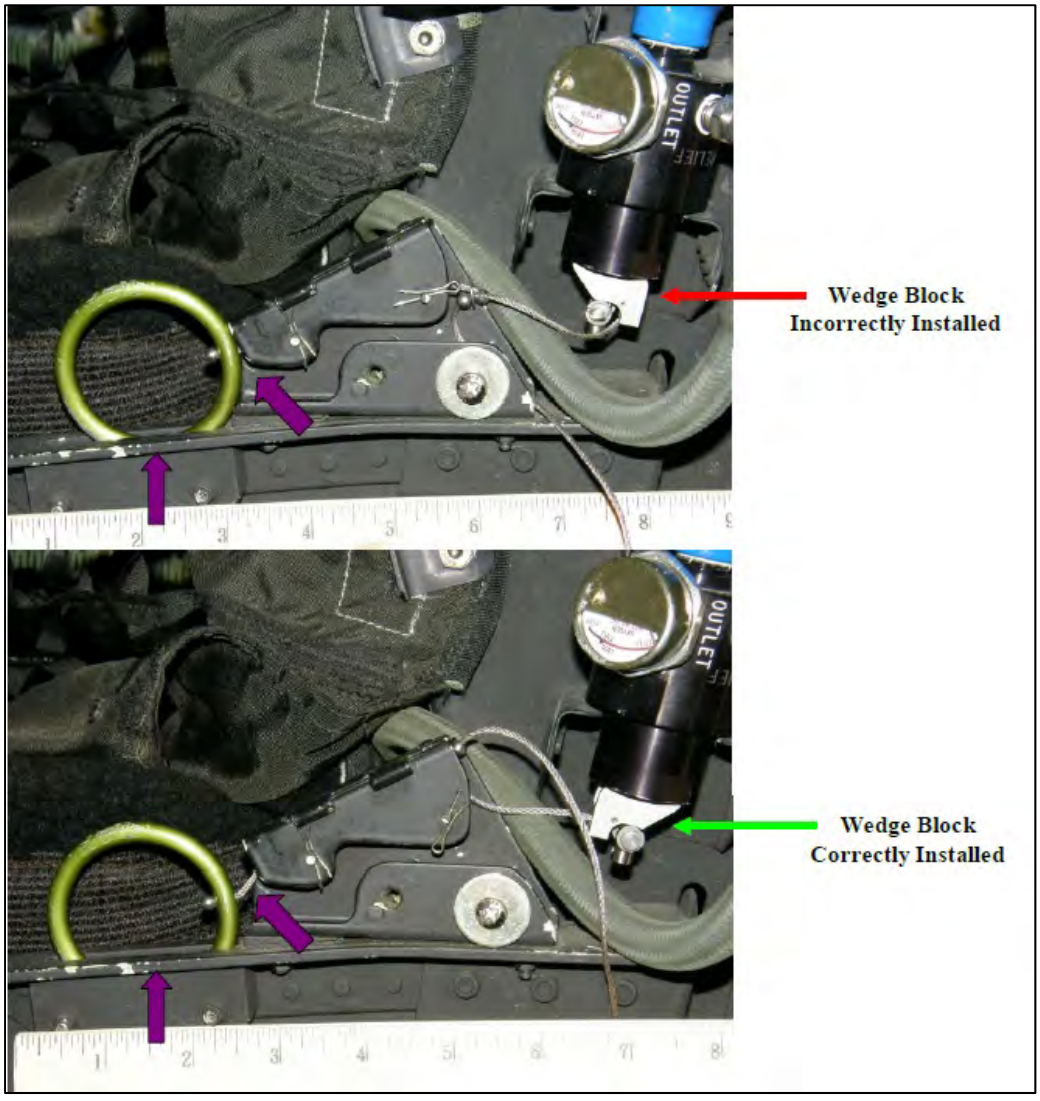

Figure 14- The wedge block installed incorrectly (red arrow) and correctly (green arrow). Notice the position of the ring within the seat (purple arrows) based on wedge block position. (Tab Z-6)

During ground simulation, the manual EOS activation ring was unseated and dropped between the seat and console prior to EOS activation. This was done to simulate a failed initial pull,

which may have occurred for various reasons, including: the EOS activation ring was dropped or the EOS cable jammed during an attempted manual activation. Retrieval of the ring from between the seat and console would be difficult based on the seat position, night environment, and with personal equipment interference (as discussed in the next section). (Tab CC-5)

Figure 15 - Pilot pulling EOS activation ring. NVG interfering with EOS ring visualization. (Tab CC-5 and Tab Z-7)

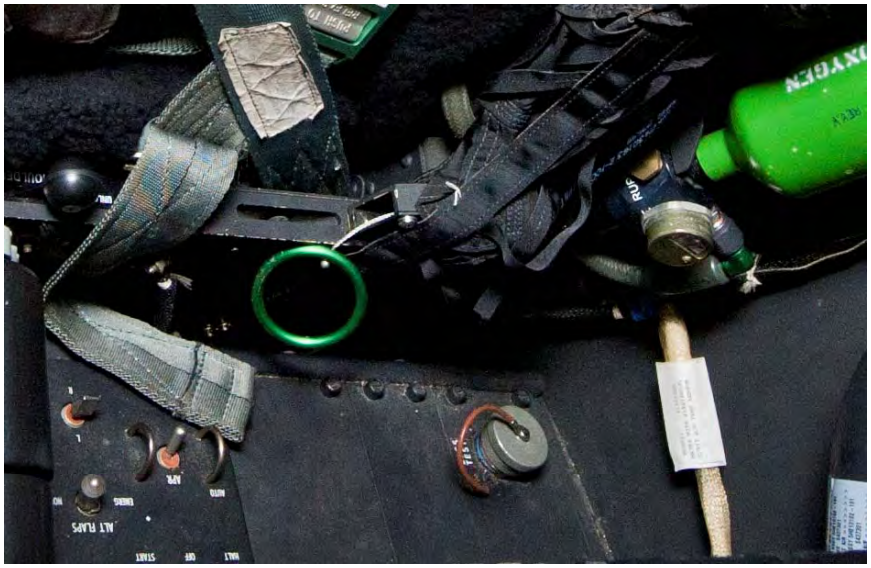

Figure 16- Manual EOS activation ring fallen below lip of seat. (Tab CC-5 and Tab Z-8)

AE101 Inadvertent Operation

Inadvertent Operation is a factor when individual's movements inadvertently activate or deactivate equipment, controls, or switches when there is no intent to operate the control or device. This action may be noticed or unnoticed by the individual. (Tab BB-5)

At 19:42:53L, the MP input a combination of right forward stick and right pedal which initiated a 240 degree descending right roll at greater than 45 degrees per second. At the completion of these stick and pedal inputs at 19:43:08L, the MA had rolled through inverted, experienced less than 1 g of gravitational force, and went from a RWD to LWD attitude, and the descent rate of the aircraft significantly increased. (Tab EE)

These control inputs appeared to be inadvertent because:

1) they had no clear goal or objective.
2) they resulted in an unusual attitude.
3) during ground simulation, when the pilot member repositioned his torso to visually acquire the manual EOS activation ring, he inadvertently actuated the stick and pedals.
4) the MP made no attempt to correct the MA's unusual attitude for 30 seconds after completion of these inputs.

The inadvertent operation of the flight controls placed the MA in an unusual attitude which was unnoticed by the MP. This resulted in the MP's unrecognized spatial disorientation (type 1).

c. Non-Contributory

All human factors were considered for their possible contribution to the mishap sequence. High interest non-contributory human factors include:

PC304 Sudden Incapacitation/Unconsciousness
PC301 Effects of G Forces (G-LOC, etc)
PC312 Hypoxia.

Sudden incapacitation/unconsciousness was considered as a possible human factor. Evidence supports the MP was active in the cockpit during the mishap sequence. The MP was actively flying the MA during the rejoin maneuver when he deliberately placed the MA in a right banked turn with 30 degrees ND. Additionally, intentional aft stick inputs commanding the MA into a 7.4 g pull up maneuver occurred 3 seconds prior to impact, further demonstrating the MP was consciously flying the MA. Sudden incapacitation/unconsciousness was not a factor in this mishap.

The effects of G-Force was considered as a possible human factor. The rejoin maneuver was a low-g maneuver not exceeding 2.5 g until the 7.4 g pull up maneuver 3 seconds prior to impact. Review of the MP's centrifuge training tape demonstrated adequate anti-g strain maneuver and a

resting g tolerance 4.8 g. Furthermore, the MP was a highly trained and experience pilot, familiar with and physiologically conditioned to the effects of high-g maneuvering. The effects of G Forces/G-LOC was not a factor in this mishap.

Hypoxia was considered as a possible human factor. The MP had adequate oxygen supply until 19:42:37L. At that time, the pilot would have experienced restrictive breathing through the oxygen mask. Prior to OBOGS FAIL caution ICAW, the MP should have been receiving adequate supply of oxygen. Due to the high affinity of oxygen to hemoglobin, the MP would have had adequate reserve blood oxygen supply after the OBOGS failed. During the mishap sequence, the MP never activated the EOS or removed his oxygen mask. If the MP had been hypoxic due to the restrictive breathing, the condition would have persisted throughout the mishap and he would not have recovered consciousness to place the aft stick inputs to attempt dive recovery prior to impact. It was concluded that the late recognition of the MA's unusual attitude and appropriate corrective actions attempted by the MP demonstrates that hypoxia was not a factor in this mishap.

12. GOVERNING DIRECTIVES AND PUBLICATIONS

a. Available Directives and Publications Relevant to the Mishap

(1) Air Force Policy Directive (AFPD) 11-2, Aircraft Rules and Procedures, 14 January 2005
(2) AFI 90-901, *Command Policy*, 1 April 2000
(3) AFI 11-202, Volume 3, *General Flight Rules, Flying Operations*, 5 April 2006
(4) AFI 11-401, *Aviation Management*, 7 March 2007
(5) AFI 90-901, *Operational Risk Management, Command Policy*, 1 April 2000
(6) AFPAM 11-419, *G-Awareness for Aircrew*, 1 December 1999, certified current 29 January 2010
(7) TO 1F-22A-1, *Flight Manual F22A Raptor*, 3 September 2007, change 6 20 September 2010

b. Other Directives and Publications Relevant to the Mishap

(1) AETC Handout, *Flying Training, Introduction to Aerodynamics*, January 2002
(2) Air Force Handbook 203, Volume 1, *Flying Operations, Weather for Aircrews*, 1 March 1997
(3) TO 00-20-1, *Aerospace Equipment Maintenance Inspection, Documentation, Policies, And Procedures*, 30 April 2003, Change 4 - 1 September 2006
(4) Department of Defense Human Factors Analysis and Classification System, 11 January 2005

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. ADDITIONAL AREAS OF CONCERN

None

21 July 2011

JAMES S. BROWNE, Brig Gen, USAF
President, Accident Investigation Board

STATEMENT OF OPINION

F-22A, T/N 06-4125
JOINT BASE ELMENDORF-RICHARDSON, ALASKA
16 NOVEMBER 2010

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the 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.

1. OPINION SUMMARY

On 16 Nov 2010, at approximately 19:43:27 hours local time (L), an F-22A, Tail Number 06-4125, assigned to the 525th Fighter Squadron, 3rd Wing, Joint Base Elmendorf-Richardson (JBER), Alaska, impacted the ground during controlled flight approximately 120 nautical miles (NM) north of JBER. The mishap pilot (MP) did not attempt ejection and was fatally injured upon impact. The mishap aircraft (MA) impacted near the edge of a valley floor in the Talkeetna Mountain range and was destroyed.

The mishap occurred on a 3-ship night opposed surface attack tactics training mission during the return-to-base portion while the MP was attempting to rejoin with his flight lead. At approximately 19:42:18L, the MA experienced an engine bleed air leak malfunction. The MP began a descent and retarded the throttles to IDLE power. At 19:42:53L, the MA entered a 240 degree roll through inverted and the nose down (ND) pitch attitude increased. At approximately 19:43:24L, the MP initiated a dive recovery. Three seconds later, the aircraft impacted the ground in a left bank at approximately 48 degrees ND at a speed greater than 1.1 Mach (M).

By clear and convincing evidence, I find the cause of the mishap was the MP's failure to recognize and initiate a timely dive recovery due to channelized attention, breakdown of visual scan and unrecognized spatial disorientation.

By preponderance of the evidence, I also find organizational training issues, inadvertent operations, personal equipment interference, and controls/switches were factors that substantially contributed to the mishap.

I developed my opinion by analyzing factual data from historical records, Air Force directives and guidance, engineering analysis, witness testimony, and information provided by technical experts. In addition, the AIB obtained an animation provided by the Aeronautical Systems Center Studies & Analysis Division. I used the animation in conjunction with Lockheed Martin engineering analysis and crash survivable memory unit (CSMU) data to determine the mishap sequence of events.

2. DISCUSSION OF OPINION

a. Cause:

There are several key links in the chain of events that led to this mishap. First, the MA experienced a malfunction. The C BLEED HOT caution ICAW asserted indicating a bleed air leak in the engine bay. According to 1F-F22A-1, a caution ICAW message warns of an aircraft operation that could result in damage to the aircraft, and corrective procedures may be required, but not immediately. The MA isolated the leak and operated as designed throughout the remainder of the MS. The MP appropriately initiated a reduction in power and entered a controlled increased descent.

Second, the MP experienced a restricted breathing condition due to loss of bleed air to the OBOGS as a result of the C BLEED HOT caution ICAW. This required the MP to take action to eliminate the breathing restriction by either manually activating the EOS or lower his oxygen mask. However, recovered evidence indicated the MP had not activated the EOS and the MP's oxygen mask was up and secured in place. The MP demonstrated channelized attention while attempting to rectify the breathing restriction. During the 50 seconds from no airflow to the MP's oxygen mask to initiation of the dive recovery, the board determined the MP prioritized restoring oxygen flow and was not deliberately controlling the MA.

Third, while attempting to rectify the breathing restriction, the MP inadvertently input stick and pedal movements. Although the resulting roll rate, linear acceleration, and less than 1 g gravitational forces were above the perceptible threshold, the MP experienced unrecognized spatial disorientation caused by these inputs due to channelized attention. The resulting increase in ND attitude decreased the time available to recover prior to impact. Figure 17 illustrates the actual descent rate of the MA along with a projected descent rate the MP deliberately intended.

Fourth, the MP's channelized attention led to a breakdown in visual scan. In a single seat aircraft, the pilot is solely responsible for maintaining aircraft control while managing other cockpit tasks. A continuous cross-check of in-flight parameters via cockpit instruments or outside references would have alerted the MP to the MA's attitude and increased descent rate.

Fifth, the MP was late to recognize the necessity for a dive recovery. At 19:43:27L, the MP impacted the ground because his channelized attention and breakdown in visual scan resulted in unrecognized spatial disorientation. When the MP recognized the MA attitude and altitude, he was below minimum recovery altitude. Figure 17 shows the actual initiation of the attempted dive recovery altitude along with the 1F-22A-1 minimum recovery altitude.

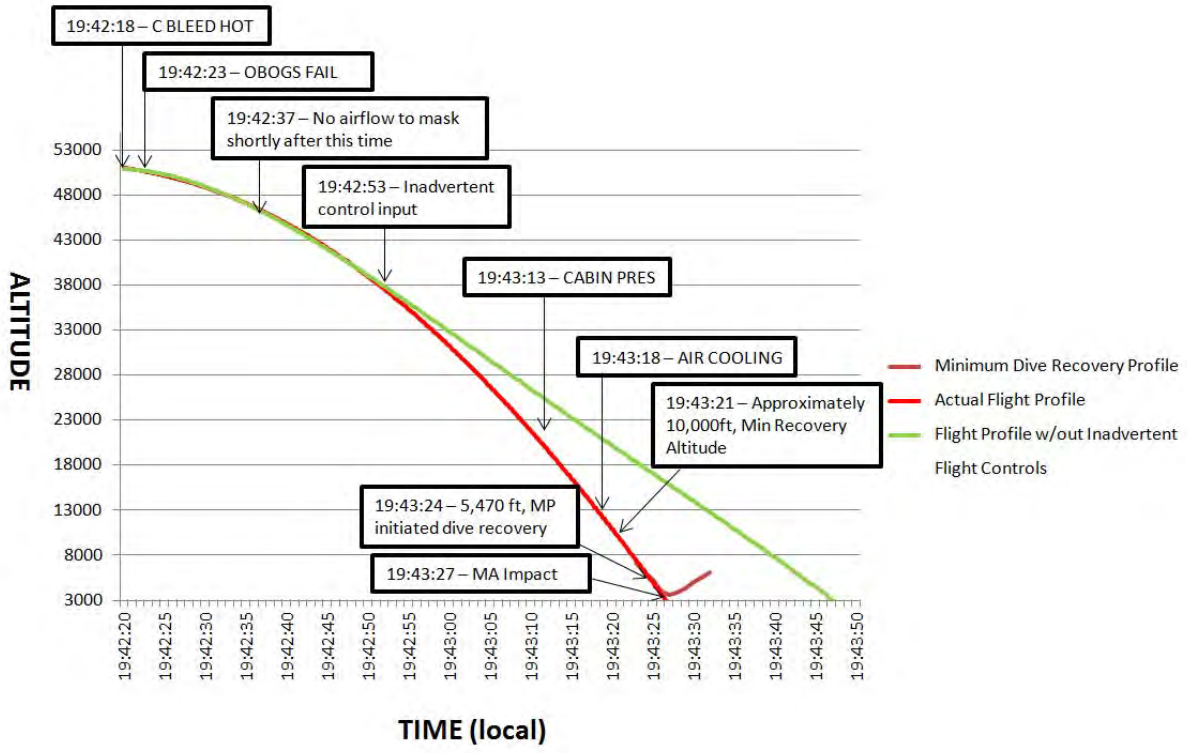

Figure 17 Flight profiles for MS. Actual flight profile (red), flight profile without inadvertent flight control inputs (green), and minimum altitude dive recovery profile (maroon) shown.

b. Contributing Factors.

Numerous additional factors substantially contributed to this mishap, including:

(1) Organizational Training Issues

The MP was an experienced fighter pilot and was highly trained to handle complex aircraft emergencies. The MP had recently reviewed the procedures for the MA malfunction during monthly Supervised Emergency Procedure Training. However, procedure training does not simulate the physiological stressors of real world in-flight and cockpit conditions during emergency situations, for example, restricted breathing, gravitational forces, cockpit pressurization, etc.

Recovered evidence indicated the MP's oxygen mask was up and secured in place, and the MP had not activated the EOS. During the MS, the MP most likely experienced a sense similar to suffocation when airflow to the oxygen mask stopped. This was likely the MP's first experience under such physiological duress. The unique and added stress of the breathing restriction contributed to the MP's channelized attention.

(2) Inadvertent Operations

At 19:42:53L, the MP began a 20-second series of stick and pedal movements which resulted in the previously discussed unusual attitude. The board determined these inputs to be inadvertent because they had no deliberate goal or objective. The movements caused:

- The ND attitude to increase, accelerating the descent rate to greater than 1,000 feet per second,
- Less than 1 g gravitational force in the cockpit,
- Reversed the MP's intended turn direction while rolling through inverted flight.

In addition, the movements would be disorienting during nighttime flight conditions. The board determined that the MP inadvertently made flight control inputs while attempting to restore airflow to the oxygen mask.

(3) Personal Equipment Interference

The MP was wearing CAT III cold weather gear and NVGs during the MS. Ground simulation demonstrated reduced mobility in the cockpit due to the bulkiness of CAT III gear. Additionally, the NVGs hit the canopy, interfering with the pilot's ability to look from side to side and down at the consoles. In order to obtain head/canopy clearance, the pilot had to shift his torso by bracing himself on various areas in the cockpit. These bracing actions and limited tactile sensation due to the CAT III gear demonstrated how inadvertent flight control inputs could occur.

(4) Controls and Switches

The EOS activation ring is seated on the left aft edge of the ejection seat. A two-step process is required to manually activate the EOS system. The pilot must unseat the ring and pull directly forward with a force that may be in excess of 40 lbs. The ring travels approximately two inches and remains connected to the seat via a lanyard. During ground simulation, the EOS manual activation ring was unseated and dropped between the seat and console prior to EOS activation. This was done to simulate a failed initial pull, which may have occurred for various reasons, including: the EOS activation ring was dropped or the EOS cable jammed during an attempted manual activation. Retrieval of the ring from between the seat and console would be difficult based on the seat position, night environment, and with personal equipment interference.

3. CONCLUSION

By clear and convincing evidence, I find the cause of the mishap was the MP's failure to recognize and initiate a timely dive recovery due to channelized attention, breakdown of visual scan and unrecognized spatial disorientation. Further, I find by preponderance of evidence, organizational training issues, inadvertent operations, personal equipment interference, and controls/switches were factors that substantially contributed to the mishap.

21 July 2011

JAMES S. BROWNE, Brig Gen, USAF
President, Accident Investigation Board

Under 10 U.S.C. 2254(d), any opinion of the accident investigators as to the cause of, or the factors contributing to, the accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the 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.

Air Force Comments

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, DC

06 DEC 2012

MEMORANDUM FOR DEPUTY INSPECTOR GENERAL, POLICY AND OVERSIGHT
DEPARTMENT OF DEFENSE

FROM: HQ USAF/JA
1420 Air Force Pentagon
Washington, DC 22030-1420

SUBJECT: Draft Assessment of the USAF Aircraft Accident Investigation Board (AIB) Report on the F-22A Mishap of November 16, 2010 (Project No. D2012-DTOTAD-0006)

I. INTRODUCTION

On October 4, 2012, your office sent me the DoD Office of the Inspector General's Draft Assessment of the AIB Report on the F-22 Mishap of November 16, 2010 for review and comment. The Draft Assessment identified five deficiencies upon which it based its conclusion that the AIB's Statement of Opinion regarding the cause of the mishap was not supported by clear and convincing evidence. You requested comment, either agreeing with or disagreeing with the deficiencies identified in the Draft Assessment, as well as any action I plan to take.

In response to the Draft Assessment, PACAF/CC chartered a Task Force (led by Major General Lyon, ACC/A3) to conduct an analysis of the five deficiencies. On November 13, 2012, Major General Lyon briefed you, Lt Gen Mueller, and me on the Task Force's findings. The Task Force comprehensively addressed each of the five discrepancies and agreed with the Board President's (BP) conclusions regarding the cause of the mishap. According to Air Force Instruction (AFI) 51-503, paragraph 10.4, the Convening Authority "has discretion to reopen the AIB upon discovery of additional evidence that could affect the Statement of Opinion." The Task Force's analysis supported the BP's Statement of Opinion and did not provide any new evidence indicating the BP's opinion as to the cause of the mishap was not supported by clear and convincing evidence. As discussed herein, I intend to recommend the Convening Authority take actions necessary to address Deficiencies 3, 4 and 5, identified in the Draft Assessment.

II. TASK FORCE'S ANALYSIS

A. Task Force Timeline

In addition to addressing the five deficiencies identified in the Draft Assessment, the Task Force prepared a detailed timeline of the mishap. The Task Force's timeline, which was presented during the November 13 briefing, is compelling and supports the BP's conclusion as to the cause of the accident:

The Task Force found that 13 seconds after the C BLEED HOT integrated caution, advisory, and warning (ICAW), the mishap pilot (MP) began a controlled downward, 30-degree, right-hand turn to descend to a lower altitude in accordance with the emergency checklist. However, 35 seconds after the initial C BLEED HOT ICAW, the MP made a combination of right forward stick and right pedal inputs, initiating a 240-degree descending right roll resulting in the aircraft being in a 53-degree nose-down position. Based on their simulations, the Task Force believes these were inadvertent flight control inputs that occurred when the MP, wearing bulky CAT III cold weather gear in the tight cockpit, rotated his head and torso to the left in an attempt to pull the emergency oxygen bottle activation located to the left of his seat. When doing so, the MP unknowingly moved the stick forward and stepped on the right pedal. The Task Force believes these inputs to have been inadvertent because they do not reflect reasonable or intentional inputs to maintain basic aircraft control. There were no stick inputs and only very minor pedal inputs for the final 34 seconds on the flight until 3 seconds prior to impact when the MP initiated a proper dive recovery by pulling aft on the stick, producing a 7.4 g pull up maneuver. Unfortunately, by the time the MP recognized the aircraft's position, he was already below the minimum recovery altitude.

B. Task Force Review of Deficiencies

The Task Force offered the following specific responses to the Draft Assessment's five deficiencies set forth in bold type below:

Deficiency #1: The AIB report cites three causal factors (channelized attention, breakdown of visual scan, and unrecognized spatial disorientation) as the cause of the F-22 mishap. However, these three factors are separate, distinct, and conflicting. The AIB report does not clearly explain their interrelationship and how it is possible that all three factors concurrently caused the mishap. Failure to adequately explain this interrelationship calls into question the AIB Statement of Opinion regarding the cause of the mishap.

Although the Task Force agreed that the AIB Report could have more clearly explained the interrelationship of the three causal factors, the Task Force disagreed that the causes are separate, distinct, and conflicting, and that the inadequate explanation calls into question the AIB Statement of Opinion regarding the cause of the mishap. During the briefing, Maj Gen Lyon explained how the MP's channelized attention led to a breakdown of visual scan, resulting in unrecognized spatial disorientation.

Specifically, Maj Gen Lyon explained that data from the Crash Survivable Memory Unit (CSMU) showed periods of time where the MP failed to make deliberate inputs to correct for the inadvertent stick and pedal movements that caused the aircraft to roll 240 degrees, increased the descent rate, and significantly increased the Calibrated Air Speed (KCAS) from 470 to 627 knots. This was caused by the three causal factors stated in the AIB Report. First, the MP exhibited channelized attention on restoring oxygen. This was evidenced by the fact that the Emergency Oxygen System (EOS) was not activated, which is a practiced checklist item during a C BLEED HOT ICAW malfunction. The EOS is activated by pulling the activation ring which, as the AIB Report and Task Force pointed out, may have been difficult in the mishap situation. Channelized attention on the activation ring led to a breakdown in visual scan, the

second causal factor. Had the MP focused on the flight instruments or looked outside the cockpit (based on high moon-illumination and a discernable horizon), the MP would have recognized the unintentional flight parameters and made corrective flight control inputs, although visual recognition may have been more difficult given that the attitude of the aircraft coming out of the roll was a mirror image of what it was going in. The breakdown of visual scan resulted in the MP not recognizing the temporal and altitude orientation of the aircraft, which is unrecognized spatial disorientation (the third causal factor) as defined in the DoD Human Factors Analysis and Classification System (DOD HFACS). Had the MP recognized the flight parameters, he would have taken corrective action. The Task Force concluded that, rather than calling into question the cause of the mishap, the interrelationship between the three causal factors provided a coherent explanation of how the mishap occurred.

In addition, the Task Force disagreed with the Draft Assessment's definition of unrecognized spatial disorientation. The Draft Assessment did not use the approved definition in the DOD HFACS referenced in AFIs 51-503 and 91-204 and upon which the AIB was obligated to rely. Instead, the Draft Assessment team substituted a definition excerpted from a treatise published in 2004 by the American Institute of Aeronautics and Astronautics that is incomplete relative to the situation under analysis, leading the Draft Assessment to the incorrect conclusion that "a pilot must be actively flying the aircraft for unrecognized spatial disorientation to occur." Thus, the AIB Report relied on the correct information, and the Draft Assessment's criticism is misplaced.

Deficiency #2: The AIB report's determination that the mishap pilot's mask was in the full up position throughout the mishap sequence was not adequately supported by the Summary of Facts or by the analysis cited in the tabs. This determination directly affected several conclusions of the AIB and precluded the analysis of other potential causes of the mishap. Failure to provide adequate facts or analysis to support this determination calls into question the AIB finding.

The Task Force concurred with the AIB's determination that MP's mask was in the full up position at the time of impact. This determination was based primarily on the results of the forensic analysis performed by the expert personnel at the Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base on the Emergency Oxygen System, the MP's mask, and other evidence recovered from the crash site. The Task Force found that the BP was justified in relying on the expert opinion of AFRL personnel, who are trained in and have the expertise required to perform the analysis on the MP's flight gear, when he made his determination that the MP's mask was likely in the full up position.

The Task Force also addressed the Draft Assessment's concern that "it appears the AIB did not consider the possibility that the MP may have dropped his mask from the left side." The Task Force noted that the discussions with the BP revealed he did consider the possibility the MP may have dropped his mask from the left side, but determined it is unlikely an F-22 pilot would have disconnected the left side bayonet and kept the right side secured. The Task Force agreed with this conclusion. As demonstrated at the Task Force briefing, there are communication and helmet air bladder connections on the left side of the helmet, and simply disconnecting the left

bayonet would not drop the oxygen mask completely, which would still have caused restricted breathing.

That said, the Task Force concluded that there is no way of knowing whether the MP's mask was in the full-up position throughout the mishap. Although unlikely, the Task Force speculated that the MP could have disconnected his mask at some point during the mishap then reattached it or perhaps he pulled it from his face or inserted his fingers under it to break the seal. The Task Force did not believe there was sufficient evidence to conclusively determine the position of the mask throughout the mishap.

Even though the Task Force concluded that they did not know the position of the MP's mask throughout the mishap, they found the position of the mask to be irrelevant for purposes of determining the cause of the mishap. The Task Force found that if the mask were down, the pilot would have been breathing ambient air (approximately 21 percent oxygen) at a pressure altitude that did not exceed 20,000 feet at any time during the 69 second mishap sequence. The AIB Report's tabbed material includes a chart that shows the effective performance time under these conditions would be approximately 17 minutes. Thus, the MP would have been conscious, and hypoxia could not possibly have occurred in just over a minute.

On the other hand, if the mask were up, the fact the MP had been breathing high concentrations of oxygen during the mission would have provided adequate reserve blood oxygen supply throughout the mishap sequence. Studies have shown that increased oxygen concentration increases breath-holding time. The average breakpoint at 16,000 feet cabin pressure after having breathed 100 percent oxygen is 2 minutes, 16 seconds, and simple extrapolation shows the MP could have held his breath well beyond 1 minute, 9 seconds at 20,000 feet after having breathed the 90 to 94 percent oxygen generated by the OBOGS.

The Task Force bolstered its conclusion that hypoxia did not play a role in the mishap because the MP attempted recovery from his dive at the end of that 69 second period, indicating he was conscious, actively flying the aircraft, and not suffering from hypoxia.

Deficiency #3: The AIB report's Non-Contributory portion of the Human Factors section inadequately analyzes the human factors listed, such as hypoxia, G-LOC, and sudden incapacitation and does not contain any references and/or supporting documentation. Without detailed analysis and proper documentation, it is unclear how the AIB determined that these factors did not contribute to the mishap.

In addressing this deficiency, the Task Force reiterated that there is no requirement for the AIB Report to address every theory the BP considered but ultimately rejected as non-contributory. AFI 51-503 requires that a BP's determination of the cause of the mishap be supported by clear and convincing evidence and that conclusions as to contributing factors be supported by a preponderance of the evidence. See AFI 51-301, para. 8.8.4. However, AFI 51-503 does not require the BP to discuss non-contributory factors. The Task Force noted that it is ironic that the BP is being criticized for exceeding the AFI requirement and for trying (although unsuccessfully) to provide a richer explanation of the mishap.

Even though the Task Force recognized that the BP did not need to discuss non-contributory factors, the Task Force concurred with the Draft Assessment's conclusion that the AIB Report inadequately analyzed the human factors related to the accident. As a result, the Task Force performed its own analysis of the various human factors referred to in the AIB Report (hypoxia, G-LOC, and sudden incapacitation). As stated in the previous response, the Task Force concluded that hypoxia was not a contributing factor to the mishap. The Task Force also concluded that G-LOC was not a contributing factor because the MP did not experience more than 3 gs until immediately prior to impact when he attempted to recover the aircraft. Finally, the Task Force concluded it was extremely unlikely the MP suffered sudden incapacitation. The Task Force looked at the possibility the pilot suffered a cardiovascular (e.g., heart attack) or neurologic (e.g. seizure) problem. Based on the MP's physical condition, age, lack of personal risk factors, and lack of medical waivers, the Task Force concluded that the risk the MP suffered sudden incapacitation was 0.0188%.

I concur with the Draft Assessment and the Task Force that the narrative portions of the AIB could have provided a more detailed analysis of these non-causal or non-contributory factors. I have discussed this with PACAF/CV and have recommended that the Convening Authority take necessary remedial actions to provide a more full explanation of the BP's reasoning regarding the non-causal or non-contributory factors.

Deficiency #4: The AIB report lacked detailed analysis of several areas, such as the Emergency Oxygen System (EOS) activation as well as the physiological reactions to lack of oxygen.

The Draft Assessment states, "If the report does not contain a detailed analysis, it becomes difficult to show how the stated conclusions are supported, which undermines the credibility of the report." The Draft Assessment goes on to state the AIB Report lacks detail in several areas, including not explaining in the main body of the report how it reached the conclusion that the EOS was not activated, not explaining why it was concerned about an incorrectly installed wedge block, and not explaining why the pilot would have an adequate reserve blood oxygen supply after the OBOGS failed.

Although the Task Force concurred with these observations, neither the Draft Assessment nor the Task Force found that the AIB Report reached an incorrect conclusion regarding these matters; they merely observed that the BP could have done a better job explaining his conclusions. The Task Force concluded from information in the tabbed section of the AIB Report that experts at the Air Force Research Laboratory (AFRL) at Wright-Patterson AFB conducted a forensic analysis of the EOS and correctly determined that the EOS was not activated. The Task Force also agreed that the AIB Report did not explain the BP's concern with the possibility of an incorrectly installed wedge block on the EOS bottle, but it further found that a more complete discussion of the wedge block concern was of little value because, whether the wedge block was installed properly or improperly, the MP could have pulled the EOS activation ring. Finally, the Task Force agreed there was not sufficient discussion supporting a high affinity of oxygen to hemoglobin in the MP. However, as the Task Force explained, at the pilot's oxygen saturation rate, the MP would have had adequate reserve blood oxygen supply after the OBOGS failed.

I concur with the Draft Assessment and the Task Force that the AIB report could have provided a more complete discussion supporting its conclusions in the areas identified in the Draft Assessment. I have discussed this with PACAF/CV and have recommended the Convening Authority take necessary remedial actions to provide a more full explanation of the BP's reasoning in the AIB report regarding the areas identified in the Draft Assessment.

Deficiency #5: Of the 109 references in the AIB report's Summary of Facts, 60 of those references were either incorrect or did not direct the reader of the AIB report to the information cited in the paragraph.

The Task Force counted a total of 128 references in the Summary of Facts, rather than 109. Also, the DoD IG spreadsheet listing the 60 citations alleged to be incorrect actually contained 63. Of the 63 entries on the spreadsheet, the Task Force concurred on 44 references, concurred with comment on five references, and non-concurred on 14 references. The Task Force found that these administrative errors detract from a reader's ability to associate accurate Tab data to the report.

Again, I agree with the Draft Assessment and with the Task Force. I have discussed this with PACAF/CV and have recommended the Convening Authority take necessary remedial actions to correct the inaccurate references in the AIB report.

III. CONCLUSION

I find that the BP's Statement of Opinion regarding the cause of this mishap is supported by clear and convincing evidence. I also find that it appears that the BP exhausted all available investigative leads. Finally, as stated about, I concur that some aspects of the AIB report could have been more clearly written.

Thank you for the opportunity to provide input to the Draft Assessment. If you have questions, please contact [redacted] at DSN [redacted]

RICHARD C. HARDING
Lieutenant General, USAF
The Judge Advocate General

Item #	Report Page	Ref TAB	Support (Y/N)	Comments	Concur (Y/N/C)	F-22 LSS TF Response
A		Y	Y	All appointment letters are in order. Appointment letters clearly state the opinion of the board president "must be supported by clear and convincing evidence".		
B		DD	Y	All information is properly summarized in the report (Background on Fighter Wing).		
1	3	R 4, 60-61	N	Tabs do not support the basic mission description. While the interview text on R-4 does briefly describe the mission and notes the delay, this is not the appropriate tab to quote the baseline mission. It is not clear to a non aviator what an apposed SAT mission is.	Y	Concur. Mission description should include more info from Tab K with explanation of an opposed SAT.
2	4	R 60-61	N	The tabs do not support the paragraph and do not discuss the flight qualifications.	Y	Concur. AIB uses pilot testimony to explain intent of the mission. However Tabs that include the training records detail the pilot's qualifactions
3	4	K 5-9	Y	Information supports the paragraph.		
4	4	K-10, K-13-16, R 53	N	The tabs do not support the paragraph. While tab K 10, 13-16 support the flight schedule and operations, there is no evidence supporting the briefing that was given and what was emphasized during the brief.	Y	Concur. AIB could have included additional information from K-20 flight lead mission materials to show emphasis items on night sorties. Including mission material references could add credibility to pilot testimony.
5	4	R 84-85	N	The tabs support most of the paragraph except for the callout on the night vision goggles. There was no description of the NVGs being focused by the pilots.	Y	Concur. Not in Top 3 testimony and on page R-87 Top 3 states he didn't see him focus his NVGs.
6	4	R 84, H-50-55	N	The listed tab does not state the information in the paragraph; however, Tab R 85 does. While TAB H 50-55 outline what the cold weather gear is and when it is required, there should also be a reference to the weather and temperature (TAB F-3)	Y	Concur
7	4	K 17	Y	Shows the high ORM sheet.		
8	4	R 84	Y	Supports the decision to fly.		
9	4	R-85	N	The listed tab does not discuss the required preflight inspections nor does it reference anyone who observed the MP accomplish the preflight IAW 1F-22A-1 and 1F-22A-34 checklists.	Y	Concur. AIB should have referenced R131-133, mishap aircraft crew chief testimony.
10	5	K-5, F 3	N	The reference is unclear to non pilots as to how the flight, take-off times were determined because the actual times were recorded by the pilots in Zulu time and do not match the local times printed on the sheet. The evidence is not clear. The reference did not clearly support the phrase "Departure and entrance into the Dice MOA was uneventful" on page 5 of the AIB report.	Y	Concur. AIB could have included a zulu to local time conversion reference. Also, AIB should have referenced flight lead/wingman testimony to confirm first part of flight was uneventful.
11	5	R 46	N	The reference does not mention the mission as explained in paragraph written in the AIB. A better reference would have been R-58.	N	Non-concur. AIB summarizes what is captured in this reference and it is sufficient even though there may be better references.
12	5	R 5	Y	Supports the paragraph.		
13	5	R 5-6	Y	Support the paragraph.		
14	5	J2	N	The tab does not support the paragraph; however, it doesn't say 1.6M, it states 1039 knots True Airspeed which must be converted to mach. The report should have referenced J4.	Y	Concur
15	5	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
16	6	J 4	Y	Supports the paragraph.		
17	6	J 4	N	The statement " … the fire protection system (FPS) detected a bleed air leak in the center bleed air ducting from both engines…" is not supported by the information listed on J4 but on J12. Thus, this reference is incorrect.	Y	Concur.
18	6	J223	N	This is a typo. This should be TAB J23, which supports the paragraph	Y	Concur.
19	6	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
20	7	J 12 & J 23	Y	Supports paragraph.		
21	7	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
22	8	BB 29	N	Supports the paragraph.	N	Believe this should be a "Y" vs "N" on IG Appendix B reference matrix. OBOGS checklist could be more accurately referenced by stating BB28-29 vs just BB29.
23	8	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
24	8	J 43	N	Does not clearly support the evidence because of how the chart uses a conversion time and does not link it back to the mishap timeline.	Y	Concur with IG asserting a disconnect in the evidence. AIB addendum attempts to correct timing of restrictive breathing. Our team has additional concern on timing.

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25	8	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
26	9	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
27	9	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
28	10	J 13	N	The timeline does not show support of the stick input assessment.	Y	Concur. AIB does not provide reference for no stick inputs. Should reference animation or other tab data.
29	11	J 13	N	There is no altitude reference in this TAB.	Y	Concur.
30	11	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
31	12	J 4-6	Y	The reference does support the paragraph within the AIB however it does not reference where the 735KCAS number is calculated or where it can be found		The last frame of the animation shows the final recorded airspeed at the time of the impact.
32	12	J 4-6	Y	Supports the paragraph.		
33	14	H 17-23	Y	Supports the claim.		
34	14	R 117-121	Y	Supports the paragraph.		
35	14	H 5-9	Y	Supports the claim.		
36	15	J 75-76 & 98-105	N	The referenced document outlines the analysis of the helmet bayonet clip. It is unclear why the assumption was made that the mask was engaged on both sides of the helmet without locating the second bayonet clip or full mask assembly.	Y	Concur. Reference partually supports the paragraph, but the AIB can't draw from this tab that the mask is secured on both sides.
37	15	AA 4	Y	Supports the statement.		
38	15	J 5	Y	Supports the statement.		
39	15	CC 15	N	The reference does not support the paragraph	Y	Concur
40	15	D 4-6	Y	Supports the paragraph.		
41	15	D 7-9	Y	Supports the paragraph.		
42	15	D 5	N	The referenced tab does not fully support the paragraph and needs to show documentation to verify the number of flights.	Y	Concur, Tab reference does not include IMDS run with 30-day history.
43	16	D 4-5	Y	Supports the paragraph.		
44	16	U 4-5	N	The referenced tab does not support the paragraph. There is no mention of TCTO 1F-22A-122 or maintenance on the horizontal tail surfaces.	Y	Concur, the TCTO and description of work performed is not included in this tab.
45	16	D 3	N	The referenced tab does not support the paragraph. There is no reference to the TO1F-22A-6 requirement and according to the referenced TAB, there should be 410 hours to the next inspection, not 431.	Y	Concur. There should be an IMIS print out of the -6 inspections coming due and there is conflicting tab data showing a difference in flight hours.
46	16	G 2	N	The referenced tab does not support the paragraph, however TAB G taken as a whole can support the paragraph.	Y	Concur
47	16	D 25 -41	Y	Supports the paragraph.		
48	17	J 34	N	Does not fully support the paragraph as written. It does support the maintenance performed but does not support how it was conducted.	Y	Concur. J-34 directly supports the sentence "No other ECS Maintenance was preformed on the MA within the 90-day maintenance review".
49	17	J-3	N	Does not support however information from J 4-5 does support the statement.	Y	Concur
50	17	L 3-7 & J 10	Y	Supports the paragraph.		
51	17	J 14	Y	Supports the paragraph.		
52	17	J 20	Y	Supports the paragraph.		
53	17	J 20	Y	Supports the paragraph.		
54	18	D 1-2 & J 30	N	Do not support the claim; however, D-3 does provide some support to the claim.	Y	Concur, better examples of the CSMU data should have been provided
55	18	J 30	N	Does not support the claim. Need to also reference the CSMU data.	Y	Concur
56	18	J 30	N	Does not support the claim. The support is cited in J21	Y	Concur
57	18	J 24	N	Does not support the claim.	Y	Concur - Other data in Tabs should have been referenced
58	18	H 3	N	Does not support the claim; however, Tab H-5 does support	Y	Concur
59	19	J 19	N	The reference only partially supports the paragraph, the reference should be J 19-20	Y	Concur
60	19	J 71-74	N	The reference describes the bayonet clip, however, it is unclear how the conclusion that the whole mask was engaged without obtaining all the associated pieces listed as missing, was reached.	Y	Concur - The AIB should have just stated that the right bayonet clip was found in the up position at the time of impact.
61	19	D 5	N	Does not support the paragraph.	Y	Concur
62	19	D 5, CC-13	N	Tab D-5 does not support the claim. Tab CC-13 also does not support the claim; however, it shows how the analysis was conducted but not the results.	Y	Concur. Should have referenced tab J Data

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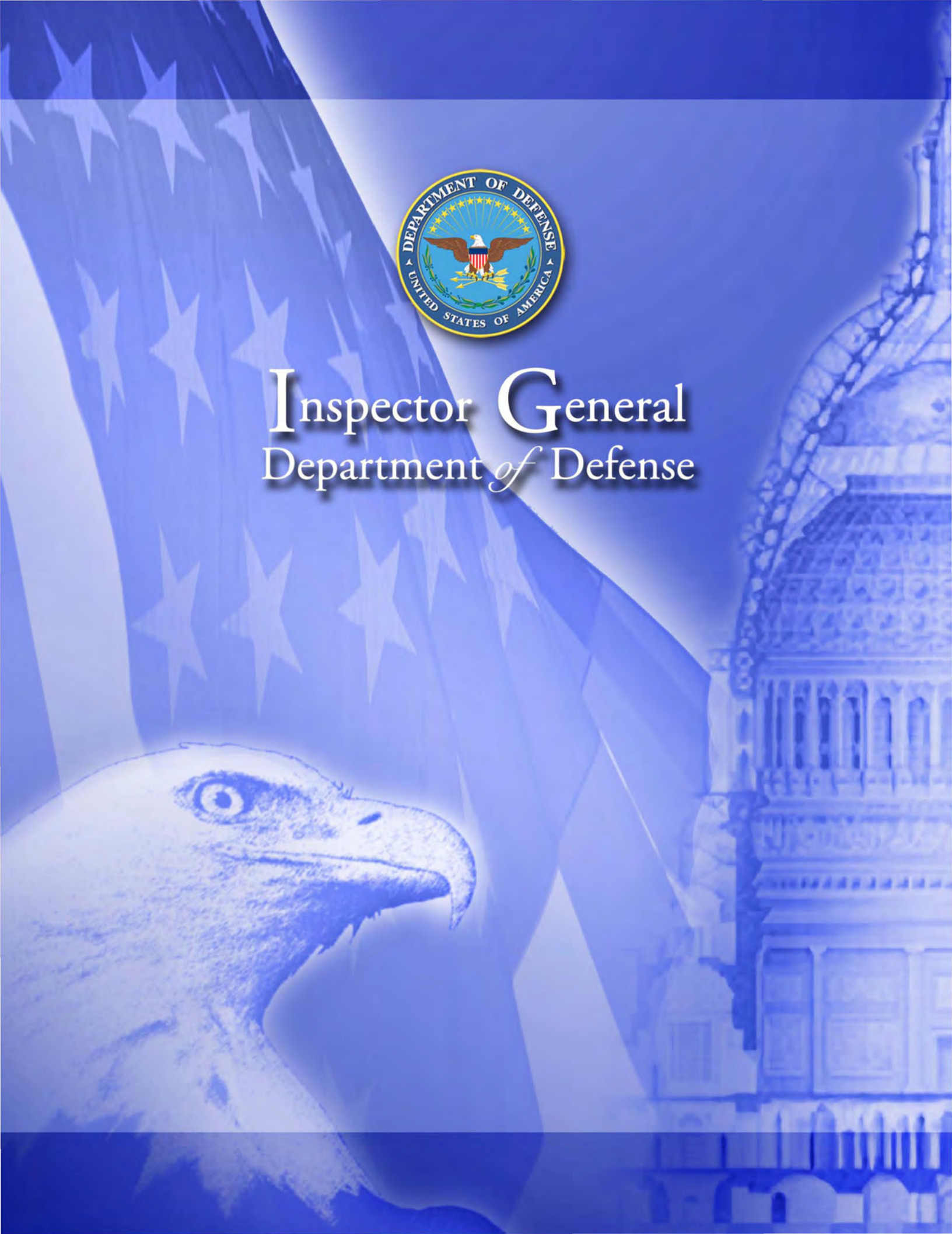
63	19	J 60-66	N	The reference states there was insignificant contamination of CO2, however, it is unclear how this translates to the OBOGS not being at fault. The TAB does support the claim secondary contamination from jet fuel was not a cause.	C	Agree that the information stated in "On Board Oxygen Generation System" paragraph does not accurately translate the information provided in Tab J page 60-66. However, the "Contamination Analysis" report at Tab J 60-65 states there was secondary contamination from JP-8. JP-8 was on the plane and spread throughout the crash site after it impacted the ground. The levels of CO2 were fund to be insignificant and no other evidence of contamination was provided. Therefore one can make the logical assertion that no evidence of OBOGS contamination was found. (Simplest Answer) Overall this section of the AIB report could have been more clearly written.
64	19	J 137 -146 & C 13	Y	The two references together support the claim that the materials were contaminated during exposure to the environment.		
65	19	CC 13	N	The reference on its own does not support the claim and should include actual data supporting what is described in TAB CC 13.	C	Concur, the memorandum cited in CC-13 does not clearly support the assertion in the "Gas Chromatograph Analysis". However, it can be inferred from the memo that all of the available life support equipment was tested and that contamination was not an issue.
66	20	F 14	Y	Supports the paragraph.		
67	20	F 3	Y	Supports the paragraph.		
68	20	F 3	Y	Supports the paragraph.		
69	20	R 83-85	Y	Supports the paragraph.		
70	20	F 5	Y	Supports the paragraph.		
71	20	R 45 - 46	Y	Supports the paragraph.		
72	20	G 3 & 10-12	Y	Supports the paragraph.		
73	21	T 3	Y	Supports the paragraph.		
74	21	V 8.5 - 8.6	Y	Supports the paragraph. Only one reference to his supervisor; should have more to reference peers as well to fully support.		
75	21	G 10	N	Reference material lists 16 November as last flight before the mishap, and not 15 November as stated on p21 of the AIB report.	C	Agree the extract lists a date of 16 Nov. However, this is a ZULU day/time issue related to the Aviation Management System and the differential between local and zulu day/time. (Note the 16 Nov Flight was input on the 15th)
76	21	G 56-57	Y	Supports the paragraph.		
77	21	G 3 & 30-31	Y	Supports the paragraph.		
78	21	G 28	N	Reference material list 16 November as last flight before the mishap, and not 15 November as stated on p21 of the AIB report.	C	Agree the extract lists a date of 16 Nov. However, this is a ZULU day/time issue related to the Aviation Management System and the differential between local and zulu day/time. (Note the 16 Nov Flight was input on the 15th)
79	21	G 56-57	Y	Supports the paragraph.		
80	22	X 3	Y	Supports the paragraph.		
81	22	X 3	Y	Supports the paragraph.		`
82	22	X 3	Y	Supports the paragraph.		
83	22	X 3	N	The reference does not support the statement of toxicology testing on additional flight crew members or maintenance personnel.	Y	Concur
84	22	BB 4	N	Only references the front page of AFI 11-202 Vol 3 and does not direct the reader to the section pertaining to crew rest.	Y	Concur. This is not in keeping with direction provided in AFI 51-503
85	22	R 139-154	N	The reference reviews sleeping habits of the mishap pilot, but does not specifically address crew rest.	Y	Concur - CC-12 in addition to R-139-154 would have made a better reference.
86	23	V 8.5	Y	Supports the paragraph.		
87	23	R 53	N	The referenced tab does not support the paragraph and does not discuss the mission briefing.	Y	Concur. However other sections of testimony suppor this assertion
88	23	BB 5	Y	Supports the paragraph.		
89	23	BB 5	N	Does not provide detailed information on Channelized Attention, which isn't listed until BB-12.	Y	Concur - Recommend that the AIB reference AFI 91-204 Attch 5
90	23	J 76	N	The reference states that the EOS was "most likely" not activated, which does not mean it wasn't activated. This is misinterpretation of the data.	C	Agree - The board should have used the same verbaige as from the J-76 and/or added additional information to support the assertion that the wedge block was not removed from the EOS, thereby it was not activated.
91	24	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
92	24	CC-3	Y	Supports the paragraph, however, claim of "less than 1g" in the AIB should have a more precise number to be fully supported.		
93	24	BB-5	N	Does not provide the definition of breakdown of visual scan, which isn't listed until BB-11.	Y	Concur - Recommend that the AIB reference AFI 91-204 Attch 5
94	24	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
95	24	BB-5	N	Does not provide the definition of spatial disorientation, which isn't listed until BB-13.	Y	Concur - Recommend that the AIB reference AFI 91-204 Attch 5

Item #	Report Page	Ref TAB	Support (Y/N)	Comments	Concur (Y/N/C)	F-22 LSS TF Response
96	24	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
97	25	BB 5	N	Does not describe training issues.	Y	Concur (at least not on BB-5)
98	25	BB 5	N	Does not discuss personal equipment.	Y	Concur (at least not on BB-5)
99	25	H 53-58	N	The reference does not support whether or not the pilot was wearing cold weather gear. It only states what is considered cold weather gear.	Y	Concur - Additionally, Tab H ends at H-56 with an "Intentionally Left Blank" page. Other tabs could be used to support this assertion.
100	25	CC 5	Y	Supports the paragraph		
101	25	BB 5	N	Does not discuss controls and switches	Y	Concur - Recommend that the AIB reference AFI 91-204 Attch 5
102	26	BB 17	N	This is not accurately quoted and does not reference the denent.	Y	Concur
103	26	U 4	Y	Supports the paragraph.		
104	27	CC 5	Y	Supports the paragraph.		
105	28	BB 5	N	Does not describe Inadvertent Operations and isn't listed until BB-11.	Y	concur
106	28	EE	N	TAB EE cannot be verified because it is an animation and was not included in the AIB package. Other evidence can be used to support this statement. Why an animation was used to support this statement is unclear.	N	Agree that Tab EE cites an animation that is not physically in Tab EE and that it is not readily available to the public. However the animation described in Tab EE is a synthesis of data (including CSMU) from various parts of the report, which would drive multiple Tab references. The animation best captures this synthesized data and presents it in a succinct and useful manner.
C	28		N	The entire section on noncontributing factors is undocumented.	Y	concur
109	**Total Items**		**63**	# of references not supported	**14**	Non concur
			106	Total # of references (Does not include A, B, & C)	**44**	Concur
					5	Concur with Comment



Inspector General
Department of Defense