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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
PRIVATE FUEL STORAGE L.L.C.	)	Docket No. 72-22
	)	
(Private Fuel Storage Facility)	)	ASLBP No. 97-732-02-ISFSI

APPLICANT'S PREFACE OF THE TESTIMONY OF JAMES L. COLE, JR., WAYNE O. JEFFERSON, JR. AND RONALD E. FLY CONTENTION UTAH K/CONFEDERATED TRIBES B

I. WITNESSES

A. James L. Cole, Jr.

James L. Cole, Jr. is Senior Director, Safety of the Air Transport Association and an associate with Burdeshaw Associates, Ltd., a consulting firm in the Washington, D.C. area that provides services to clients in the areas of aviation, transportation, military operations, and government affairs. In 1994 he retired from the United States Air Force with the rank of Brigadier General. Gen. Cole has extensive experience in and knowledge of aircraft operations and aviation safety. From 1991 to 1994, he served as Chief of Safety of the United States Air Force and directed the entire USAF safety program. In addition, he served as squadron commander of a C-141 heavy jet transport squadron. He was Instructor and Flight Examiner (Check Pilot) qualified and flew airdrop, special operations low level, and night vision goggle missions, including clandestine approaches to airfields and blackout landings. He has 6,500 total flying hours in seven different types of aircraft, with 3,000 flying hours in heavy jet aircraft.

B. Wayne O. Jefferson, Jr.

Wayne O. Jefferson, Jr. is an associate with Burdeshaw Associates, Ltd. He is also an associate with Parsons Associates, where he provides risk management training for General Electric Corp. In 1989 he retired from the United States Air Force with the rank of Major General. Gen. Jefferson has extensive experience in and knowledge of U.S. Air Force aircraft operations and weapons testing and training operations. He served in the Air Force for over 30 years, including service with the Strategic Air Command as a B-52 wing commander. He has 4,450 flying hours in 9 different aircraft types. He has been formally trained by the Air Force at the Air Force Safety Center to serve as an Accident Board President. Since he retired from the Air Force Gen. Jefferson has been a consultant in management, management training, and quantitative

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probabilistic analysis. His education includes a master's degree in operations research and a master's in business administration.

C. Ronald E. Fly

Ronald E. Fly is also an associate with Burdeshaw Associates. In 1998 he retired from the United States Air Force with the rank of Colonel. Col. Fly has extensive experience in and knowledge of U.S. Air Force aircraft operations. He served in the Air Force for 24 years as an F-16 pilot, instructor, squadron commander, operations group commander and a wing commander. He has approximately 1,200 flying hours in the F-16 as a pilot and instructor. From 1997 to 1998 he served as Commander of the 388th Fighter Wing at Hill Air Force Base, Utah, during which time he flew F-16s on the UTTR (including Skull Valley). He was also Commander of the UTTR beginning Oct. 1, 1997 when the range was transferred to the 388th FW. In addition to his flight operations and training operations experience, Col. Fly also has experience in strategic planning, operational analysis, international affairs, space operations, and logistical support. Furthermore, he is specifically knowledgeable about the operations of military and civilian aircraft that fly in and around Skull Valley, Utah, including the military aircraft that fly from Hill Air Force Base and on or around the UTTR and Dugway Proving Ground.

II. TESTIMONY

A. Scope

Gen. Cole, Gen. Jefferson, and Col. Fly will testify to the cumulative aircraft crash impact hazard to the PFSF posed by the following aviation activities in and around Skull Valley: (a) F-16 aircraft transiting Skull Valley, (b) fighter aircraft conducting air-to-air combat training on the UTTR, (c) F-16s returning to Hill AFB on the Moser Recovery, (d) military aircraft flying to and from Michael AAF in the direction of IR-420, and (e) jettisoned military ordnance.

B. F-16s Transiting Skull Valley

Gen. Cole, Gen. Jefferson, and Col. Fly will testify that the impact hazard posed to the PFSF by potential crashes of F-16 aircraft transiting Skull Valley from Hill Air Force Base (AFB) en route to the Utah Test and Training Range is 3.11 E-7 per year. They will testify to the analytical method and the data they used to assess the probability that an F-16 transiting Skull Valley would crash and impact the PFSF. They will rebut the challenges to their approach raised by the State of Utah regarding the number of F-16 flights projected to transit Skull Valley during the lifetime of the PFSF, the F-16 crash rate, the distribution of F-16 flights within Skull Valley, the probability that an in-flight emergency would leave a pilot in control of his aircraft, the ability of a pilot to avoid the PFSF in the event of an in-flight emergency leaving him in control of his aircraft, and the statistical inferences they drew from their analysis of F-16 accident data.

C. Aircraft Conducting Air-to-Air Combat Training on the UTTR

Based on their assessment of the training operations on the UTTR and Air Force F-16 accident reports concerning accidents during combat training, Gen. Cole, Gen. Jefferson, and Col. Fly will testify that aircraft conducting air-to-air combat training on the UTTR will be too far from the PFSF site to pose a significant hazard to it.

D. F-16s Returning to Hill AFB on the Moser Recovery

Based on their assessment of the small number of aircraft annually using the Moser Recovery, Gen. Cole, Gen. Jefferson, and Col. Fly will testify that aircraft using the Moser Recovery pose a small hazard to the PFSF.

E. Aircraft Flying to and From Michael AAF in the Direction of IR-420

Based on their assessment of the small number of cargo aircraft flying to and from Michael AAF in the direction of IR-420, aside from the F-16s flying to Michael AAF that are accounted for in their Skull Valley F-16 calculations, Gen. Cole, Gen. Jefferson, and Col. Fly will testify that aircraft using IR-420 pose a small hazard to the PFSF.

F. Potential Impacts of Jettisoned Military Ordnance

Based on their assessment of the small fraction of F-16s carrying ordnance while transiting Skull Valley, Gen. Cole, Gen. Jefferson, and Col. Fly will testify that the potential for such aircraft to jettison ordnance in response to an in-flight emergency poses a small hazard to the PFSF.

G. Conservatism in the PFS Assessment

In addition to their quantitative assessment of the probability that a crashing aircraft or jettisoned military ordnance would impact the PFSF, Gen. Cole, Gen. Jefferson, and Col. Fly will testify to the significant factors that are somewhat more difficult to quantify but which show that their assessment is conservative and thus that true impact hazard to the PFSF is significantly less than what they calculated. Thus, they will show that the cumulative hazard to the PFSF is well below the standard approved by the Commission of 1 E-6 per year.

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APPLICANT'S OUTLINE OF KEY DETERMINATIONS ON AIRCRAFT CRASH HAZARDS CONTENTION UTAH K/CONFEDERATED TRIBES B

I. ISSUES

A. This contention concerns the cumulative hazard to the Private Fuel Storage Facility (PFSF) posed by aviation activity in the vicinity of Skull Valley, Utah.

1. The types of aviation activity in and around Skull Valley relevant to determining the cumulative hazard to the PFSF in this proceeding are limited to: (1) F-16 fighter aircraft transiting Skull Valley from Hill Air Force Base (AFB) to the Utah Test and Training Range (UTTR), (2) military aircraft conducting training exercises on the UTTR, (3) F-16s returning to Hill AFB on the Moser Recovery Route, (4) military aircraft flying to and from Michael Army Airfield (AAF) in the direction of military airway IR-420, (5) civilian aircraft flying on federal airways J-56 and V-257, (6) general aviation, and (7) potential impacts of military ordnance jettisoned by F-16s transiting Skull Valley. Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-01-19, 53 NRC 416, 432, 434 (2001).

2. Of the above, after summary disposition, only the hazards posed by the following activities remain at issue: (a) F-16 aircraft transiting Skull Valley, (b) fighter aircraft conducting air-to-air combat training on the UTTR, (c) F-16s returning to Hill AFB on the Moser Recovery, (d) military aircraft flying to and from Michael AAF in the direction of IR-420, and (e) jettisoned military ordnance. Id. at 455-56.

B. The annual aircraft crash impact hazard posed by F-16s transiting Skull Valley en route from Hill AFB to the UTTR is 3.11 E-7.

1. The annual probability, P, that an F-16 aircraft transiting Skull Valley will crash and impact the PFSF can be estimated using the equation $P = N \times C \times A / w \times R$,

2. *N* is the projected annual number of F-16 flights through Skull Valley and is equal to 5,870, based on an average of the number of flights transiting Skull Valley in fiscal years 1999 and 2000 and the number of F-16s now based at Hill AFB. This number is reasonable and conservative in that aircraft number and sorties are likely to decrease in the future as a result of aircraft modernization.

3. *C* is the crash rate per mile of flight for the F-16 and is equal to 2.736 E-8.

    a. This is a 10-year average crash rate for the F-16, based on Air Force statistics regarding F-16 crashes and flight hours and a Department of Energy assessment of F-16 flight mileage. A 10 year rate is appropriate to use to avoid statistical aberrations that could result from yearly fluctuations in crash rates.

    b. Crash rates for the F-16 have been stable over time because it is a mature aircraft.

    c. Crash rates for any new aircraft that might replace the F-16 will be lower because of the advancement of technology.

4. *A* is the effective area of the PFSF from the perspective of a crashing aircraft and is equal to 0.1337 sq. mi., assuming a fully loaded facility of 4,000 casks.

5. *W* is the effective width of Skull Valley when modeled as an airway and is equal to 10 miles.

    a. Ten miles is the useable width of the Sevier B Military Operating Area (MOA) (which includes Skull Valley in the vicinity of the PFSF) at the latitude of the PFS site, which is located between restricted airspace two miles to the west of the site (where F-16s transiting Skull Valley do not fly) and the ridge of the Stansbury Mountains approximately 8 miles east of the site.

    b. This effective width is conservative because, due to the shape of the Sevier B MOA, F-16s tend to fly on the eastern side of the valley, away from the PFS site on the western side of the valley, thereby reducing the risk to the PFSF.

    c. The State of Utah's claim that the pilots will change their current routine to deliberately fly at or over the PFSF is wrong and does not account for the configuration of the MOA and the presence of restricted airspace to the west of the PFSF.

6. *R* is the factor by which the impact hazard to the PFSF is reduced by the potential for pilots to guide their crashing aircraft away from the facility before ejecting and is equal to 0.145.

    a. Based on PFS's expert assessment of the Air Force aircraft accident reports for 121 out of the 139 F-16s that were destroyed in accidents from FY89 to FY98, the probability that a pilot would remain in control of his or her aircraft after an in-flight emergency is equal to at least 90 percent, in that most accidents are caused by engine failures that leave the pilot in control of the aircraft.

b. Based on PFS's expert assessment of the pilot actions necessary to avoid the PFSF in the event of a crash and 10 years of Air Force F-16 accident report data, the probability that a pilot with the time and opportunity would be able to avoid the PFSF is at least 95 percent.

C. The annual crash impact hazard posed by fighter aircraft conducting air-to-air combat training on the UTTR is less than 1 E-8 because those aircraft fly too far from the PFSF to pose a significant hazard.

D. The annual crash impact hazard posed by F-16 aircraft using the Moser Recovery to return from the UTTR to Hill AFB is 2.0 E-8, considering that fewer than 290 aircraft per year use the Moser Recovery.

E. The annual crash impact hazard posed by aircraft travelling to and from Michael AAF in the direction of military airway IR-420 is 3.0 E-9, considering that IR-420 is used by fewer than 400 cargo aircraft per year, aside from the F-16s from Hill AFB, which PFS already accounts for in its estimate of the hazard posed by F-16s transiting Skull Valley.

F. The annual hazard posed by impact of military ordnance potentially jettisoned from a crashing F-16 flying over the PFSF is 3.2 E-8, considering that only approximately two percent of the F-16s transiting Skull Valley carry jettisonable ordnance.

G. Cumulative aircraft crash and jettisoned military ordnance impact hazard to the PFSF

1. The cumulative hazard posed by: (a) F-16 aircraft transiting Skull Valley, (b) fighter aircraft conducting air-to-air combat training on the UTTR, (c) F-16s returning to Hill AFB on the Moser Recovery, (d) military aircraft flying to and from Michael AAF in the direction of IR-420, and (e) jettisoned military ordnance, is less than 3.76 E-7 per year.

2. As established by the Board in ruling on PFS's motion for summary disposition, the cumulative hazard posed by other aviation activities in the vicinity of Skull Valley (i.e., (a) aircraft conducting training exercises on the UTTR other than fighter aircraft conducting air-to-air combat training, (b) civilian aircraft on federal airways J-56 and V-257, and (c) general aviation) is less than 4.1 E-8 per year. LBP-01-19, 53 NRC at 446, 450-51, 451-52.

3. The cumulative hazard to the PFSF posed by aircraft crashes and jettisoned military ordnance is less than 4.17 E-7 per year.

II. CONCLUSIONS OF FACT AND LAW

A. The cumulative probability that an aircraft crash or jettisoned military ordnance would impact the PFSF is less than the Commission approved standard of 1 E-6 per year.

B. The PFSF need not be designed to withstand the effects of aircraft crashes or jettisoned military ordnance impacts. Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), CLI-01-22, 54 NRC __, slip op. at 23 (Nov. 14, 2001).

February 19, 2002

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TESTIMONY OF JAMES L. COLE, JR., WAYNE O. JEFFERSON, JR., AND RONALD E. FLY ON AIRCRAFT CRASH HAZARDS AT THE PFSF—CONTENTION UTAH K/CONFEDERATED TRIBES B

TABLE OF CONTENTS

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I. BACKGROUND--WITNESSES

A. James L. Cole, Jr.

Q1. Please state your full name.

A1. James L. Cole, Jr.

Q2. By whom are you employed and what is your position?

A2. I am Senior Director, Safety of the Air Transport Association and an associate with Burdeshaw Associates, Ltd., a consulting firm in the Washington, D.C. area that provides services to clients in the areas of aviation, transportation, military operations, and government affairs. In 1994 I retired from the United States Air Force with the rank of Brigadier General.

Q3. Please summarize your educational and professional qualifications.

A3. My professional and educational experience is summarized in the curriculum vitae attached to this testimony. I have extensive experience in and knowledge of aircraft operations and aviation safety. As a pilot, I routinely reviewed accident reports germane to my aircraft type. From 1991 to 1994, I served as Chief of Safety of the United States Air Force and directed the entire USAF safety program. I was responsible for accident prevention and investigation in all aspects of ground and air operations. I was also commander of the 89th Airlift Wing, where I directed and operated VIP air transportation for the President of the United States and other senior government officials and foreign dignitaries. During my tour as commander, the 89th Airlift Wing won the Air Mobility Command Flight Safety Achievement Award. In addition, I served as pilot flight commander, chief pilot, assistant operations officer, operations officer, and squadron commander of a C-141 heavy jet transport squadron. I was Instructor and Flight Examiner (Check Pilot) qualified and flew airdrop, special operations low level, and night vision goggle missions, including clandestine approaches to airfields and blackout landings. My experience also includes service in senior positions on the Air Staff and Joint Staff in the Pentagon and on the faculty of the U.S. Air Force Academy. I have 6,500 total flying hours in seven different types of aircraft, with 3,000 flying hours in heavy jet aircraft.

Q4. What is your experience with assessing aircraft crash and related hazards generally?

A4. As noted above for more than three years as USAF Chief of Safety, I was responsible for accident prevention and investigation in all aspects of ground and air operations. I personally reviewed and approved every Air Force Accident Safety Investigation report for all types of aircraft. My direct involvement in aircraft crash and related hazards began early in my Air Force career. In 1967, as an Instructor pilot in the 1st Special Operations Wing, I served as Squadron Assistant Flying Safety Officer. As such I reviewed all USAF squadron type aircraft mishap reports and briefed them to squadron pilots. The following year I developed and taught an Instructor Pilot's cockpit risk management course designed to decrease training related accidents. During the subsequent years, I reviewed every USAF mishap report of the specific aircraft I was flying at that particular time. As noted above, as Chief of Safety of the U.S. Air Force, I had direct authority and accountability for accident prevention and investigations for 500,000 personnel and 9,000 aircraft in all aspects of ground and air operations. I was directly responsible for all flight, ground, and weapons safety as well as nuclear surety for all USAF nuclear weapons. We achieved the "Safest Year in USAF History."

Q5. What have you done regarding the assessment of the aircraft crash and related hazards at the Private Fuel Storage Facility (PFSF)?

A5. I was jointly responsible for Private Fuel Storage, L.L.C.'s (PFS's) assessment of the risk to the PFSF posed by aircraft crashes and ordnance impacts,[1] with respect to, generally speaking, overall aviation safety, data and information concerning military and civilian air traffic in the region of the PFSF and aircraft accident rates, and all aspects of civilian aviation. I also reviewed in depth the Air Force's mishap reports for the F-16 for the ten year period from FY 1989 through FY 1998.

Q6. Are you familiar with the Private Fuel Storage Facility (PFSF) and the activities that will take place there?

A6. Yes

Q7. What is the basis of your familiarity with the PFSF?

A7. I have been assisting with the assessment of the aircraft crash hazards to the PFSF since late 1998. I have extensively reviewed the documentation of the aviation activities that take place in the vicinity of the PFSF, including operations in Skull Valley and on the Utah Test and Training Range (UTTR). I have obtained information from the Air Force and the Army concerning the number and types of military aircraft that operate in the vicinity of the PFSF and the nature of the operations they conduct. I have also reviewed descriptions of the PFSF relevant to the aircraft crash hazard, spoken to PFS project personnel, and visited the site of the proposed facility. I have also been briefed by the 388th Fighter Wing leadership at Hill AFB, in person and by phone, on flight operations on the UTTR.

Q8. What is the purpose of your testimony?

A8. The purpose of my testimony is to respond to the allegations in Contention Utah K/Confederated Tribes B ("Utah K"). I will do so by describing our assessment of the probability that a military aircraft would crash at the PFSF or that ordnance jettisoned from a military aircraft would impact the PFSF and respond to alleged deficiencies in our assessment. The primary focus of my effort was overall aviation safety, general Air Force issues, and, in some respects, F-16 operations, although the probability assessment as a whole was a collaborative endeavor.

[1] "Private Fuel Storage, Aircraft Crash Impact Hazard at the Private Fuel Storage Facility," Revision 4 (August 10, 2000) ("Aircraft Report"); Revised Addendum to Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (July 20, 2001) ("Revised Addendum").

B. Wayne O. Jefferson, Jr.

Q9. Please state your full name.

A9. Wayne O. Jefferson, Jr.

Q10. By whom are you employed and what is your position?

A10. I am an associate with Burdeshaw Associates, Ltd, which, as stated, provides services to clients in the areas of aviation, transportation, military operations, and government affairs. I am also an associate with Parsons Associates, where I provide risk management training for General Electric Corp. In 1989 I retired from the United States Air Force with the rank of Major General.

Q11. Please summarize your educational and professional qualifications.

A11. My professional and educational experience is summarized in the curriculum vitae attached to this testimony. I have extensive experience in and knowledge of U.S. Air Force aircraft operations and weapons testing and training operations. I served in the Air Force for over 30 years, including service with the Strategic Air Command as a B-52 wing commander. I have 4,450 flying hours in 9 different aircraft types. My experience also includes service in senior positions on the Air Staff and Joint Staff in the Pentagon and on the faculty of the U.S. Air Force Academy. Since I retired from the Air Force I have been a consultant in management, management training, and quantitative probabilistic analysis. My education includes a master's degree in operations research and a master's in business administration.

Q12. What is your experience with assessing aircraft crash and related hazards generally?

A12. I have been formally trained by the Air Force at the Air Force Safety Center to serve as an Accident Board President, including management of the investigating team, preservation of the crash site, working with local law enforcement authorities, interviewing participants and witnesses, etc. As a pilot, I routinely reviewed accident reports germane to my aircraft type. As the Assistant Deputy for Operations of the Strategic Air Command, I reviewed accident reports for briefing to the commander and for follow-up corrective actions. I have also been formally trained by the Air Force at Sandia Base, NM, to be a Nuclear Incident/Accident

On-Scene Commander, including management of the responding team, security of nuclear assets, public relations, nuclear safety, security of the incident/accident area, etc.

Q13. What have you done regarding the assessment of the aircraft crash and related hazards at the Private Fuel Storage Facility (PFSF)?

A13. I was jointly responsible for PFS's assessment of the risk to the PFSF posed by aircraft crashes and ordnance impacts, with respect to, generally speaking, the quantitative calculations and modeling PFS performed concerning the probability that a crashing aircraft would impact the PFSF. I also reviewed in depth the Air Force's mishap reports for the F-16 for the ten year period from FY 1989 through FY 1998. On all relevant aspects of the assessment I provided my judgment regarding pilot actions and responses to emergencies.

Q14. Are you familiar with the Private Fuel Storage Facility (PFSF) and the activities that will take place there?

A14. Yes.

Q15. What is the basis of your familiarity with the PFSF?

A15. I have been assisting with the assessment of the aircraft crash hazards to the PFSF since mid-1999. I have extensively reviewed the documentation of the aviation activities that take place in the vicinity of the PFSF, including operations in Skull Valley and on the Utah Test and Training Range (UTTR). I have also reviewed descriptions of the PFSF relevant to the aircraft crash hazard and I have spoken to PFS project personnel.

Q16. What is the purpose of your testimony?

A16. The purpose of my testimony is to respond to Contention Utah K by providing our assessment of the probability that a military aircraft would crash at the PFSF or that ordnance jettisoned from a military aircraft would impact the PFSF. The primary focus of my effort in responding to the State's Contention was the modeling and calculations used to determine the various probabilities and risk factors associated with the assessment, although the review of the relevant accidents and the probability assessment as a whole were collaborative endeavors.

C. <u>Ronald E. Fly</u>

Q17. Please state your full name.

A17. Ronald E. Fly

Q18. By whom are you employed and what is your position?

A18. I am self-employed and a partner in a small business based in Tampa. I am also an associate with Burdeshaw Associates. In 1998 I retired from the United States Air Force with the rank of Colonel.

Q19. Please summarize your educational and professional qualifications.

A19. My professional and educational experience is summarized in the curriculum vitae attached to this testimony. I have extensive experience in and knowledge of U.S. Air Force aircraft operations and training operations. I served in the Air Force for 24 years as an F-16 pilot, instructor, squadron commander, operations group commander and a wing commander. I have approximately 1,200 flying hours in the F-16 as a pilot and instructor. From 1997 to 1998 I served as Commander of the 388th Fighter Wing at Hill Air Force Base, Utah, during which time I flew F-16s on the UTTR (including Sevier B MOA and Skull Valley). I was also Commander of the UTTR beginning Oct. 1, 1997 when the range was transferred to the 388th FW from Air Force Material Command. As a pilot, I routinely reviewed accident reports germane to my aircraft type. In addition to my flight operations and training operations experience, I also have experience in strategic planning, operational analysis, international affairs, space operations, and logistical support. Furthermore, I am specifically knowledgeable about the operations of military and civilian aircraft that fly in and around Skull Valley, Utah, including the military aircraft that fly from Hill Air Force Base and on or around the UTTR and Dugway Proving Ground ("Dugway").

Q20. What is your experience with assessing aircraft crash and related hazards generally?

A20. I reviewed and was briefed upon aircraft accidents, trends and safety issues. In addition, I served as the pilot member for an F-16 accident investigation.

Q21. What have you done regarding the assessment of the aircraft crash and related hazards at the Private Fuel Storage Facility (PFSF)?

A21. I was jointly responsible for PFS's assessment of the risk to the PFSF posed by aircraft crashes and ordnance impacts. My main area was military aircraft operations on and around the UTTR and F-16 emergency procedures. I reviewed in depth the Air Force's mishap reports for the F-16 for the ten year period from FY 1989 through FY 1998. On all relevant aspects of the assessment I also provided my judgment regarding pilot actions and responses to emergencies.

Q22. Are you familiar with the Private Fuel Storage Facility (PFSF) and the activities that will take place there?

A22. Yes.

Q23. What is the basis of your familiarity with the PFSF?

A23. I have been assisting with the assessment of the aircraft crash hazards to the PFSF since late-1999. I am familiar with and have extensively reviewed the documentation of the aviation activities that take place in the vicinity of the PFSF, including operations in Skull Valley and on the Utah Test and Training Range (UTTR). I have also reviewed descriptions of the PFSF relevant to the aircraft crash hazard and I have spoken to PFS project personnel. When I was commander of the 388th FW I flew F-16s through Skull Valley where the PFSF site is located.

Q24. What is the purpose of your testimony?

A24. The purpose of my testimony is to respond to Contention Utah K by assessing the probability that a military aircraft would crash at the PFSF or that ordnance jettisoned from a military aircraft would impact the PFSF. The primary focus of my effort was F-16 operations, F-16 emergency procedures and flight operations in and around the UTTR, although the probability assessment as a whole was a collaborative endeavor.

II. OVERVIEW

Q25. Please describe in greater detail the issues to which the three of you are testifying.

A25. In the bases for Contention Utah K, as admitted by the Licensing Board, the State asserts in part that Applicant PFS inadequately considered the hazard to the PFSF of credible accidents involving materials or activities at or emanating from Hill Air Force Base, the UTTR, and Dugway (i.e., Michael Army Airfield). We understand that the sole issue remaining to be decided with respect to this contention is the probability that a military aircraft crash or jettisoned military ordnance would impact the PFSF. We have reviewed the information and data concerning the potential hazard to the PFSF from military aircraft crashes and jettisoned military ordnance have concluded, as we set forth below, that they pose no credible or significant hazard to the PFSF.

Q26. Where is your assessment documented?

A26. Our assessment is set forth in a formal report, identified as PFS Exhibit N, entitled, "Private Fuel Storage, Aircraft Crash Impact Hazard at the Private Fuel Storage Facility," Revision 4 (August 10, 2000) ("Aircraft Report") and the Addendum to the Aircraft Report[2] ("Revised Addendum") (identified as PFS Exhibit O). The Revised Addendum also contains PFS responses to Requests for Additional Information from the NRC Staff regarding aircraft crash hazards that we prepared.[3] Our analysis and the conclusions from the report are summarized in Part III below.

Q27. In short, what did you determine regarding the aircraft crash hazard to the PFSF?

A27. We found that the cumulative hazard to the PFSF posed by aircraft crashes and impacts of military ordnance is a probability of an accident of less than 4.17 E-7 per year.

Q28. How did you determine that probability?

A28. We generally followed the procedures of Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE STD 3014-96, and the Standard Review Plan for Nuclear Power Plants, NUREG-0800. We calculated crash impact probabilities for each of the aviation activities conducted in the vicinity of the PFSF site. The calculations were based on: the number of aircraft flights, aircraft crash rates, the effective area of the PFSF from the perspective of a crashing aircraft, the space over which the flights are distributed, the distance between the flights and the

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[2] Revised Addendum to Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (July 20, 2001).

[3] Request for Additional Information on Aircraft Hazards—Partial Response (Mar. 30, 2001) ("March 30 Response"), contained in Revised Addendum Tab FF; Request for Additional Information on Aircraft Hazards—Clarification (May 15, 2001) ("May 15 Clarification"), contained in Revised Addendum Tab GG; Request for Additional Information on Aircraft Hazards—Remaining Response and Clarification (May 31, 2001) ("May 31 Response"), contained in Revised Addendum Tab HH.

PFSF, and, for military aircraft, the likelihood that a pilot of an aircraft experiencing an in-flight emergency would be able to direct the aircraft away from the PFSF before the pilot ejected and the aircraft impacted the ground. We then added the hazards posed by the individual activities conducted in the vicinity of the PFSF site as follows:

Table 1 Calculated Aircraft Crash Impact Probabilities

Aircraft	**Annual Probability**
F-16s Transiting Skull Valley	3.11×10^{-7}
Aircraft on the UTTR	$< 1 \times 10^{-8}$
Aircraft Using the Moser Recovery	2.00×10^{-8}
Aircraft on Airway IR-420	3.0×10^{-9}
Aircraft on Airway J-56[4]	1.9×10^{-8}
Aircraft on Airway V-257[4]	1.2×10^{-8}
General Aviation Aircraft[4]	$< 1 \times 10^{-8}$
Cumulative Crash Probability	$<3.85 \times 10^{-7}$
Jettisoned Military Ordnance	3.2×10^{-8}
Cumulative Hazard	$<4.17 \times 10^{-7}$

In order to assess the probabilities above, we solicited and received information from the Air Force, Hill AFB and Michael Army Air Field including accident reports for the 10 years FY 89 to FY 98, F-16 crash rates and Class A and Class B Mishap rates[5], operational procedures relevant to the airspace near the proposed storage site, and actual sortie (flight) counts for the areas over and around the site. We also requested and received information concerning weather and bird hazards in the area as well as ordnance carried on the F-16s on sorties near the proposed storage site. From PFS we received data on the size, construction, and design of the storage site, rate of receipt of spent fuel shipments, lighting of the site, and local area weather.

[4] These issues were dismissed from the proceeding but we present the calculated hazard here for the purpose of determining the cumulative hazard to the PFSF. Memorandum and Order (Granting in Part and Denying in Part Summary Disposition Motion Regarding Contention Utah K/Confederated Tribes B; Referring Ruling on Aircraft Crash Hazard Regulatory Standard to the Commission (May 31, 2001)).

[5] A Class A mishap is one in which there is a fatality, the aircraft is destroyed, or the accident results in \$1 million or more in damage. A Class B mishap is one in which the total cost of property damage, injury, and illness is between \$200,000 and \$1 million.

Subsequent to the preparation of the Report, we received data for the years FY 99 and FY 00 concerning aircraft accident statistics and accident reports, plus updated information on sorties flown, ordnance carried, operational procedures and the number of aircraft assigned to Hill AFB in those years.

Q29. What in particular did you do to assess the nature of the accidents that could possibly occur at the PFSF?

A29. As part of our assessment, we reviewed all of the available Air Force F-16[6] Class A Mishap Aircraft Accident Investigation Reports from the period fiscal year 1989 through fiscal year 1998. Those reports are prepared under Air Force Instruction 51-503 after each aircraft mishap to determine the cause of the accident for the purposes of preserving all available evidence and providing a complete factual summary for use in claims, litigation, disciplinary actions, adverse administrative proceedings, and other purposes in accordance with AFI 51-503. The reports follow a set format which sets forth the details of the circumstances surrounding the accident, including: a summary of the history of the flight, the flight mission, preflight activities and planning, the actual flight activity, crash impact information, the functioning of the emergency escape mechanism, rescue activity, maintenance and mechanical factors, supervisory factors, pilot qualifications and performance, navigational aids and facilities, weather, and pertinent directives and publications. Each report may conclude with a statement of opinion by the investigating officer as to the cause of the accident. The flight activity section in particular gives the relevant information as to pilot actions after the emergency begins. Efforts to avoid populated areas and built up structures on the ground may be discussed here. By obtaining these reports, we have been able to evaluate the causes of and the pilot and aircraft responses in F-16 accidents relevant to Skull Valley and the UTTR. In total, we reviewed 126 Class A accident reports, covering mishaps in which 121 F-16s were destroyed.

Q30. Please summarize the Skull Valley F-16 flights and the potential hazard they pose to the PFSF.

A30. F-16 fighter aircraft fly north to south down Skull Valley, en route from Hill AFB to the UTTR South Area. The F-16s use the eastern side of Skull Valley as their

[6] Almost all of the military aircraft flights through Skull Valley and the great majority of the flights on the UTTR relevant to the PFSF are conducted by F-16s.

predominant route of travel and typically pass approximately five miles to the east of the PFSF site. In FY 99 and FY 00, an average of approximately 5,000 F-16 flights transited Skull Valley per year.

As shown above and in our Aircraft Report, the annual probability of an F-16 crashing into the PFSF while transiting Skull Valley is 3.11×10^{7}. Typical maneuvering in Skull Valley is in the administrative and routine categories of flight, both of which are low risk. Aircraft Report at 11-13, Tabs E and F. Furthermore, by far the most likely cause of an accident in Skull Valley would be an engine failure, which would leave the pilot in control of the aircraft and potentially able to avoid the PFSF before ejecting from the aircraft.

Q31. Please summarize the aircraft operations conducted in the restricted airspace areas of the UTTR and the hazard they would pose to the PFSF.

A31. Aircraft in the restricted areas of the UTTR conduct a variety of activities, including air-to-air combat training, air-to-ground attack training, air-refueling training, and transportation to and from Michael Army Airfield (which is located beneath UTTR airspace). Because of the distance between the locations on the UTTR where the activities are conducted and the PFSF site, those activities would pose only a negligible hazard to the PFSF. The State of Utah's expert has agreed that aircraft on the UTTR do not, as a practical matter, pose a threat to the PFSF.[7]

Q32. Please summarize the aircraft operations using the Moser Recovery and the hazard they would pose to the PFSF.

A32. Some aircraft returning to Hill AFB from the UTTR South Area may use the Moser recovery route, which runs from the southwest to the northeast, approximately two miles from the PFSF site. The Moser route is only used during marginal weather conditions or at night under specific wind conditions which require the use of Runway 32 at Hill AFB. The hazard posed by the use of the Moser route is small both because the route is seldom used and because of the low risk nature of the F-16s' flight along the recovery route.

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[7] Declaration of Lt. Col. Hugh L. Horstman, Air Force (Retired) in Support of the State of Utah's Response to PFS's Motion for Summary Disposition of Contention Utah K and Confederated Tribes B (Jan. 30, 2001) ("Horstman Decl."). Deposition of Lt. Col. Hugh Horstman (Dec. 11, 2000) at 218 ("Horstman 1st Dep."), Revised Addendum Tab BB.

Q33. Please summarize the aircraft operations using airway IR-420 and the hazard they would pose to the PFSF.

A33. Aircraft flying to and from Michael Army Airfield on Dugway Proving Ground may fly in the direction of IR-420, which runs to the northeast from a point about seven and a half miles northeast of the PFSF site. The hazard posed by such flights is very small because, aside from the F-16s flying through Skull Valley, which are accounted for above, approximately 400 or fewer aircraft fly this route each year. Moreover, those that do are mostly transport aircraft that exhibit very low crash rates.

Q34. Please summarize the potential hazard posed to the PFSF by jettisoned military ordnance.

A34. Approximately two percent of the F-16s transiting Skull Valley carry jettisonable ordnance. In the event of an incident leading to a crash in which the pilot would have time to respond before ejecting from the aircraft (e.g., an engine failure), one of the pilot's first actions would be to jettison any ordnance carried by the aircraft. The probability that jettisoned ordnance would hit the PFSF is very small due to the small number of aircraft carrying ordnance, the rarity of aircraft jettisoning ordnance, and the small probability that ordnance jettisoned somewhere along the route would hit the PFSF.

III. AIRCRAFT CRASH IMPACT HAZARD ASSESSMENT

A. Aviation Activity in the Vicinity of the PFSF in Skull Valley

Q35. Please state where the PFSF is located and describe the airspace in its vicinity.

A35. The PFSF site is located in Skull Valley, Utah, approximately 50 miles southwest of Salt Lake City. The Cedar Mountains, on the west side of the Valley, are approximately 10 miles to the west of the proposed PFSF site, and the Stansbury Mountains, on the east side of the Valley, are approximately 10 miles to the east. The PFSF site is under the Sevier B and Sevier D Military Operating Areas. A Military Operating Area (MOA) is airspace designated by the FAA for military use, although civilian aircraft may transit MOAs. Approximately 2 miles west and south of the PFSF site is restricted airspace that is part of the UTTR. No aircraft, military or civilian, may enter restricted airspace without specific clearance.

The UTTR airspace is shown on the map identified as PFS Exhibit P. It is divided into a North Area, located on the western shore of the Great Salt Lake, north of Interstate 80, and a South Area, located to the west of the Stansbury Mountains, south of Interstate 80. The area covered by the airspace of the UTTR South Area is roughly 148 miles long (at its longest point) by 102 miles wide (at its widest point). The PFSF site is located over 18 statute miles east of the eastern land boundary of the UTTR South Area. The site lies within the Sevier B MOA, two miles to the east of the edge of UTTR restricted airspace. The altitude of the PFS site is approximately 4,500 ft. above mean sea level (MSL). As shown on PFS Exhibit P, the area covered by the airspace of the Sevier B MOA is roughly 145 miles long and, in the vicinity of the PFSF site, is approximately 12 miles wide. The airspace of the Sevier B MOA extends to an altitude of 9,500 ft. MSL. The airspace of the Sevier D MOA lies immediately above the Sevier B MOA and extends to an altitude of 18,000 ft. MSL.

Q36. Please describe the military air operations that take place in the vicinity of the PFSF.

A36. Military air operations in the vicinity of Skull Valley consist of the following:

- U.S. Air Force F-16 fighter aircraft transiting Skull Valley en route from Hill AFB to the UTTR South Area.
- F-16s from Hill AFB and other military aircraft of various types conducting training exercises on the UTTR.
- F-16s from Hill AFB occasionally returning from the UTTR South Area to Hill AFB via the Moser Recovery Route, which runs to the northeast, 2-3 miles north of the PFSF site.
- Military aircraft, comprising mostly transport aircraft, flying , to and from Michael Army Airfield, located on the Dugway Proving Ground , about 17 miles southwest of the PFSF.
- A small fraction of the F-16 flights transiting Skull Valley carry jettisonable military ordnance. [8]

Q37. Have you assessed the hazard posed by each category of operations?

A37. Yes. We have grouped the aircraft flying in and around Skull Valley that could potentially pose a hazard to the PFSF in the event of an accident as above. We have calculated the annual crash impact probabilities for the PFSF for each group

[8] Aircraft Report at 1.

of aircraft and the probability that ordnance jettisoned from a military aircraft (separate from the aircraft itself) would impact the PFSF. The annual crash impact probability that we have calculated for all aircraft (military and civilian) and jettisoned ordnance combined is less than 4.17 E-7/year. Each of the military operations is addressed separately below.

B. F-16 Aircraft Transiting Skull Valley

1. PFS Assessment

Q38. Please describe the F-16 traffic that transits Skull Valley.

A38. F-16 fighter aircraft fly north to south down Skull Valley en route from Hill AFB to the UTTR South Area. The F-16s use the eastern side of Skull Valley as their predominant route of travel and typically pass approximately five miles to the east of the PFSF site. The U.S. Air Force has stated that the F-16s typically fly in the Sevier B MOA between 3,000 and 4,000 ft. above ground level (AGL), with a minimum altitude of 1,000 ft AGL at approximately 350 to 400 knots[9] indicated airspeed (KIAS). While there may be a recent trend toward flying at higher altitudes in the Sevier D MOA, that would not significantly affect our assessment. Flying at higher altitudes would give pilots more time to respond in the event of a mishap, such as an engine failure, and would make it easier for them to avoid hitting a site on the ground like the PFSF. In Fiscal Year 1998, 3,871 flights passed through Skull Valley. Aircraft Report at 5-6. In FY 99 and FY 00, an average of approximately 5,000 F-16 flights transited Skull Valley per year. Revised Addendum at 4-5.[10] As discussed below, we project that, because of the subsequent addition of 12 F-16s to the wing at Hill AFB, approximately 5,870 flights per year will transit Skull Valley during the life of the PFSF. This number will likely prove conservative in that, as discussed below, the continuing modernization and increased technological capability of newer military aircraft will likely result in fewer aircraft and a reduction in annual sorties over the life of the PFSF.

Q39. What hazard would the F-16 traffic pose to the PFSF?

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[9] One knot is one nautical mile per hour.

[10] As discussed in the Revised Addendum, the number of flights is derived from the MOA usage reports provided by the Air Force.

A39. It is highly unlikely that a crashing F-16 would impact the PFSF. F-16s use the airspace above Skull Valley primarily as a transition corridor to the UTTR. Typically F-16s will start a descent after turning south from over the Great Salt Lake and descend below 5,000 ft. above ground level (AGL) before entering the Sevier B MOA. They will also spread out in a tactical formation which may be 1-2 nautical miles across. Formations vary depending on the number of aircraft in the flight, meteorological conditions, mission objectives, etc. In addition, the F-16s may accelerate to above 400 KIAS and perform two 90° G-awareness turns. These and other typical maneuvers that F-16s may undertake while transiting Skull Valley are part of the administrative and routine categories of flight, or normal phase of flight, which are low risk (compared to aggressive combat training maneuvers in restricted areas, which is higher risk). Aircraft Report at 11-13. Furthermore, based on our analysis of the accident reports, by far the most likely cause of an accident in Skull Valley would be an engine failure. In 100% of the accidents of this type, the pilot retained control of the aircraft. Air Force pilots are trained and instructed to avoid ground facilities in the event of a mishap in which the pilot retains control of the direction of the aircraft. Thus, the pilot of an F-16 that had suffered an engine failure would be able to take steps, if necessary, to avoid a facility on the ground, such as the PFSF, before ejecting. Given this, we calculated the probability that an F-16 transiting Skull Valley would crash and impact the PFSF as described further below.

Q40. How did you calculate the probability that an F-16 transiting Skull Valley would crash and impact the PFSF?

A40. We calculated the probability that an F-16 transiting Skull Valley would crash and impact the PFSF using the following equation based on NUREG-0800:

$P = C \times N \times A / w \times R$, where

P = probability per year of an aircraft crashing into the PFSF

C = in-flight crash rate per statute mile

N = number of flights per year along the airway

A = effective area of the PFSF in square miles

w = width of airway in statute miles

R = a factor that accounts for the reduction in crash hazard resulting from the pilot's ability to avoid impacting the PFSF site (described in the Aircraft Report)

Aircraft Report at 6-8.

Q41. How did you determine *C*, the crash rate per mile?

A41. The crash rate for the F-16 flight was calculated from Air Force data to be 2.736 E-8 per mile. Aircraft Report at 8-13. This represents an average of the crash rate for the F-16 in normal flight operations over the 10-year period from FY 89 to FY98, i.e., flight not involving takeoff or landing or aggressive maneuvering on a training range. This was the most recent data at the time we prepared our initial report. We used a 10-year average to minimize the effect of statistical fluctuations from year to year. [11]

Q42. What did you determine *N*, the number of flights per year to be?

A42. The number of flights through the valley was taken to be 5,870 per year. This is an average of the number of flights transiting Skull Valley in FY 99 and FY 00 adjusted upward to reflect the greater number of F-16s that were stationed at Hill AFB beginning in FY 01. Revised Addendum at 7.

Q43. What did you determine *A*, the effective area of the PFSF to be?

A43. Given the flight characteristics and dimensions of the F-16, the region within the PFSF where the storage casks are located (including the Canister Transfer Building, where canisters are moved from transportation casks to storage casks) has an effective area of 0.1337 sq. mi., assuming a facility at full capacity with 4,000 spent fuel storage casks on site. Aircraft Report at 13-16.

Q44. What did you determine *w*, the width of the airway for Skull Valley to be?

A44. The airspace in the vicinity of the PFSF was treated as an airway with a width of 10 statute miles. Aircraft Report at 16. This was based on our assessment of the width of the useable airspace in the Sevier B MOA through which the F-16s could fly at the latitude of the PFSF, even though the route preferred by the F-16s is along the east side of the valley, about five miles east of the PFSF site. For F-16s flying above the Sevier B MOA (i.e., above 9,000 ft. MSL/4,400 ft. AGL), the width of the useable airspace would be more than 10 miles, and therefore using an

[11] A 10-year average using data for the most recent 10 years would be very close to the average we used. See Question and Answer 61 below.

airway width of 10 miles is conservative for these aircraft on this basis as well. Further, the Hill AFB staff have informed the NRC Staff that pilots flying through Skull Valley tend to maintain buffer zones of about two miles both from the Stansbury Mountains in the east and from the restricted airspace immediately to the west of the MOA.[12] Thus, the traffic through Skull Valley tends to flow through the eastern part of the valley rather than over the PFS site.

Q45. How did you determine *R*, the factor accounting for the reduction in crash impact probability arising from the pilot's potential ability to avoid hitting the PFSF site in the event of a crash?

A45. We determined, from an extensive review of Air Force F-16 accident investigation reports over a 10-year period, that over 90 percent of the F-16 crashes that would result from accident-initiating events that could occur in Skull Valley would leave the pilot in control of the aircraft after the event. Aircraft Report at 16-18, Tab H. An engine failure is the most likely such accident–initiating event.

Furthermore, we determined that the pilot would be able to direct the aircraft away from the PFSF at least 95 percent of the time in which such an event cause a crash in Skull Valley. This is because of the training Air Force pilots receive in responding to such in-flight events, the flight characteristics of the F-16, the absence of other built up areas in Skull Valley, and the small effort required for the pilot to avoid the PFSF site in the event of a crash caused by an accident-initiating event leaving him in control of the aircraft. Aircraft Report at 18-23. Review of the F-16 accident reports showed a number of instances in which pilots maneuvered their aircraft to avoid sites on the ground after an accident-initiating event. Significantly, the accident reports showed no cases, in which the pilot had the opportunity to avoid a facility or populated area on the ground but failed to do so. Therefore, based on this data, the assumption that pilots would fail to avoid the PFSF 5 percent of the time is a conservative upper bound in that the data would support assigning a percentage of near zero. Aircraft Report at 23, Tab H at 28 n.22.

Accordingly, conservatively, 85.5 percent (90% x 95%) of the crashing F-16s would be able to avoid the PFSF. Hence the calculated crash impact hazard to the

[12] September 18, 2001 NRC Staff "Summary of Aircraft Hazard Meeting with Hill Air Force Base Staff on September 7, 2001" (NRC/Hill AFB September 7, 2001 Meeting Summary).

PFSF would be reduced by this fraction. Thus, the factor R in the equation above is equal to 100% - 85.5%, or 14.5%. See Aircraft Report at 23-25.[13]

Q46. What crash impact probability did you calculate for the F-16s transiting Skull Valley?

A46. Based on the above, we calculated the annual crash impact probability for F-16s transiting Skull Valley (assuming a fully loaded PFSF) to be 3.11 E-7, based on the 5,870 F-16 flights per year projected for the future. Revised Addendum at 16; see Aircraft Report at 24-25.

Q47. What was the basis for your projection of 5,870 flights for future years?

A47. As stated above, that number was based on an average of the annual number of F-16 sorties through Skull Valley for FY 99 and FY 00, increased proportionately for additional aircraft stationed at Hill AFB beginning in FY 01. As set forth below, we believe that this number is a reasonable, conservative projection of future traffic density when the PFSF will be operating.

Q48. Did the annual number of F-16 sorties through Skull Valley change since the original Aircraft Report was prepared using FY 98 data?

A48. Yes. We originally obtained data from Hill AFB on the number of F-16s transiting Skull Valley en route to the south part of the UTTR for Fiscal Year 1998 showing that 3,871 F-16s transited the valley. Subsequently we obtained data for Fiscal Years 1999 and 2000. For Fiscal Year 1999, 4,250 F-16s transited Skull Valley and for Fiscal Year 2000, 5,757 F-16s transited Skull Valley. We believe that taking into account this new data, an appropriate and reasonable historical number of F-16 sorties to assume transiting Skull Valley on an annual basis is an average of the FY 99 and FY 00 numbers, or approximately 5,000. Revised Addendum at 2-7.

Q49. Why is the average of FY 99 and FY 00 appropriate?

A49. The change in the number of F-16 flights through Skull Valley from FY 98 to FY 99 and FY 00 reflects certain changes in Air Force operations plus normal fluctuations in the number of sorties flown annually as well. The Air Force began a new policy for overseas and other deployments of Air Force units away from their

[13] In the Aircraft Report, the factor R is expressed as the sum of the factors R_1 and R_2. See Aircraft Report at 7-8.

home bases through adoption of the Air Expeditionary Force (AEF) concept, initially implemented in October 1999 (FY 00). Under the AEF concept, portions of various Air Force wings are assigned to an AEF on a regular basis for overseas or other deployment as needed. Under the AEF concept, units are on call for deployment for 90 days over a 15-month period. The purpose is to make more equal and regular the on-going deployment of Air Force units from their home bases of operations. This provides a more stable and predictable operating and training cycle and reduces the amount of time spent away from the home base of operations.

There were major Air Force deployments of aircraft overseas in FY 98 to both Bosnia and the Persian Gulf and in FY 99 to Kosovo. These deployments tapered off towards the end of FY 99, and FY 00 saw the beginning of the regular AEF deployments. The 388th Fighter Wing had part of one squadron (out of three) deployed in October, November and half of December 1999 (FY 00).

Further, during FY 00, the 388th Fighter Wing significantly increased its sortie count from its available aircraft, and achieved the highest sortie rate per aircraft of any F-16 wing.[14] Since the 388th Fighter Wing was doing what it could to maximize its sortie rate in FY 00, it has little leeway to increase the rate even more and we would therefore not expect further increases. Past history has shown, moreover, that fluctuations in sortie rates do occur as a result of various operating constraints and training needs as well as changes in operating priorities or emphasis. Thus, we would not expect the number of sorties to continue indefinitely at the maximum or near-maximum rate achieved per aircraft by the 388th Fighter Wing in FY 00.

Also, during FY 00, United States military forces were not involved in a major international crisis. The number of UTTR sorties in future years in which there were such a crisis, would therefore be expected to be lower than those in FY 00. Even if the 388th Fighter Wing or 419th Reserve Fighter Wing were not deployed overseas for such a crisis, some of their aircraft might be temporarily deployed to other locations and units in the United States to replace aircraft that were sent

[14] Hilltop Times, September 7, 2000 (Col. John Weida, 388th FW Commander) and Hilltop Times, October 19, 2000 (Col. John Weida, 388th FW Commander), which can be found at http://www.hilltoptimes.com/archives.

overseas. Based on past history and the current war on terrorism, it is reasonable to expect periodic unscheduled future deployments and an associated lower sortie count at Hill. In addition, a long term trend in Air Force force structure is to replace aging aircraft with fewer, more capable and more reliable aircraft.

Based on the above considerations, we believe that an appropriate and reasonable number of F-16 sorties to assume on an annual basis transiting Skull Valley for the number of F-16s based at Hill AFB those years, is an average of the FY 99 and FY 00 numbers, or approximately 5,000 (before adjusting for the 12 additional aircraft discussed below). It is important to keep in mind that the planned operational life of the PFSF is 40 years.[15] As discussed further below, we believe that this average is a reasonable, conservative approximation of the future traffic density when the PFSF will be operating, particularly 20 or more years in the future when the Facility would be approximately at full capacity.

Q50. Did anything else change since FY 98 that would change the number of F-16 sorties through Skull Valley during the life of the PFSF?

A50. Yes. The number of F-16 aircraft assigned to the 388th Fighter Wing at Hill AFB has increased in FY 01 from that authorized for the Wing during each of the previous three fiscal years (FY 98, FY 99, and FY 00). For those 3 years, the number of F-16 aircraft assigned to the 388th FW at Hill AFB was stable at 54.[16] However, an additional 12 F-16 aircraft were officially assigned to the Wing in the third quarter (April) of FY 01, at which time the Wing would have received additional personnel and funding to support them. We were initially advised that, as before, the 419th Fighter Wing (Reserve) had 15 authorized F-16s at Hill AFB.[17]

Therefore, we calculated that the 12 additional aircraft assigned to the 388th FW had increased the total number of authorized F-16 aircraft at the base from 69 (54 + 15) to 81 (66 + 15), for an increase of 17.4%.[18] If we assume the same Skull

[15] The license term is 20 years, extendible for an additional 20 years.

[16] May 23, 2001 FOIA Response from Hill AFB, Mary Maynard, FOIA Manager, Hill AFB.

[17] Telephone conversation between Brig. Gen. James Cole, Jr., USAF (Ret.) and Capt. Bernadette Dozier, USAF, 388th Fighter Wing, Public Affairs, December 29, 2000.

[18] See Addendum to Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Jan. 19, 2001) ("January 2001 Addendum"); May 31 Response.

Valley sortie rates per F-16 as determined above, the 12 additional F-16s would also increase the number of F-16 sorties through Skull Valley, (*N* in the equation set forth in Answer 40) by 17.4%. Thus, our estimated historical sortie count of 5,000 per year, based on FY 99 and FY 00 sortie counts, would increase to an estimated count for the future of 5,870 sorties per year. This in turn yields an annual crash impact probability for F-16s transiting Skull Valley (assuming a fully loaded 4,000 cask facility) of 3.11 E-7. We later learned that the 419th FW possessed somewhat more aircraft in FY98 to FY01 (an average of just over 17).[19] Thus, our assumption regarding the effect of the assignment of the 12 additional F-16s to Hill on the total annual F-16 sortie count is somewhat conservative (a larger baseline number would reduce the proportional effect of assigning additional aircraft to the base—resulting in a 16.8 % increase rather than 17.4%).

Q51. Why is it reasonable to assume that the number of F-16 sorties transiting Skull Valley would increase in proportion to the number of F-16s based at Hill AFB?

A51. Changes in the number of F-16 aircraft at Hill AFB will result in an approximately proportional change in the number of sorties flown through Skull Valley and on the UTTR. As the number of F-16 aircraft assigned to the 388th FW increases, the number of pilots, maintenance personnel, flying hours and support funding will also increase proportionally. These are determining factors in the number of sorties flown and a change in them will result in a corresponding change in sorties flown. See March 30 Response, Question 1(c). Since the squadrons at Hill AFB all have similar training requirements, they tend to fly similar schedules in terms of airspace usage and mission types (simulated air-to-air combat, medium altitude surface attack, low altitude navigation and bombing, etc.). As a result, with the addition of F-16 aircraft to Hill AFB, flights through Skull Valley and the other portions of the UTTR will increase. Similarly, with the departure of aircraft from Hill AFB, flights through Skull Valley and the UTTR would decrease. State of Utah witness Lt. Col. Hugh Horstman, USAF (Ret.) agrees that an increase in the number of F-16s at Hill AFB would produce a proportionate increase in the number of training sorties. Horstman Decl. ¶ 24.

[19] June 11, 2001 FOIA Response from Hill AFB, Mary Maynard, FOIA Manager, Hill AFB; see Revised Addendum at 5, note 18.

Q52. What would happen if you took the FY 00 Skull Valley sortie count as a baseline (and adjusted it for the additional F-16s based at Hill AFB) instead of the average of the FY 99 and FY 00 counts?

A52. As a sensitivity analysis excursion, we have examined the use of the FY 00 count of 5,757 F-16 sorties in Skull Valley as the norm and adjusted it upward by 17.4% (to account for the additional F-16s based at Hill AFB) to 6,759 sorties as the new steady state rate. While we do not believe this rate is likely to be the steady state rate over the life of the PFSF, using it increases the Skull Valley F-16 impact probability from 3.11 E-7 to 3.58 E-7.

Q53. In future years over the life of the PFSF, would you expect the Skull Valley F-16 sortie rate to increase beyond the FY 00 rate (adjusted for the 12 additional F-16s at Hill)?

A53. No. As explained in greater detail in the Revised Addendum, pages 7-13, future traffic density of military aircraft operating in the vicinity of the PFSF will be determined, for the most part, by the future structure of the U.S. Air Force and tempo of U.S. Air Force operations. The long term trend in the USAF has been for fewer, more modern aircraft to replace older, less capable ones. We expect this general trend to continue as the existing USAF aircraft inventory is replaced with more modern, capable and reliable aircraft over the life span of the proposed PFSF.

It is our belief that the USAF will continue to operate fighter aircraft from Hill AFB for the foreseeable future, even as current day aircraft are replaced by newer ones such as the F-35 Joint Strike Fighter (JSF) or the F-22. The training and testing opportunities available on the UTTR represent excellent capabilities that are difficult to replicate elsewhere.[20] However, it is reasonable to assume that the significant USAF wide reduction in total fighter aircraft will affect Hill AFB, just as previous force structure reductions have resulted in fewer aircraft at Hill AFB.[21] The Joint Strike Fighter, a stealth-type aircraft currently in research and

[20] Despite the excellent capabilities of the UTTR, the Air Force, would not place too large a percentage of the future fighters at Hill AFB. Although the weather is normally excellent for fighter operations at Hill AFB and on the UTTR, the runway at Hill AFB is periodically closed during the winter due to snow and ice. After particularly heavy storms, it may take a few days to clear the accumulated ice and snow from the parking aprons, taxiways and runways. In times of crisis, it would be unacceptable to have a significant portion of the fighter force trapped at any one location by inclement weather.

[21] The 388th FW previously had 4 assigned F-16 squadrons. The 16th Fighter Squadron was deactivated several years ago as part of an Air Force reduction in force structure.

development, is the planned replacement for the F-16. The total planned USAF buy over the life of the airplane is 1,763 aircraft.[22] This is only 78% of the 2,230 F-16s ordered by the USAF.[23]

Furthermore, given that the PFSF will not reach full capacity until 20 years into its operational life,[24] the USAF should be well into delivery of the Joint Strike Fighter before the PFSF is at full capacity. The calculated aircraft crash probability for the PFSF using the average of the FY 99 and FY 00 sortie count for Skull Valley is based upon the Facility being at full capacity and does not assume any Air Force downsizing or modernization. Thus, the USAF long-term modernization program that is expected to result in a significant downsizing and a likely reduction in total annual sorties will in all likelihood result in our base case probability being conservative.

2. State Challenges

Q54. In what respect did the State of Utah challenge PFS's assessment of the probability that an F-16 transiting Skull Valley would crash and impact the PFSF?

A54. In responses to PFS discovery requests, in depositions, and in response to PFS's motion for summary disposition of December 30, 2000, the State of Utah challenged PFS's assessment in the following respects:[25]

a. The State asserts that additional F-16 aircraft will be stationed at Hill AFB and hence the number of sorties flown over Skull Valley and on the UTTR will be higher than what PFS assumed in its original Aircraft Report.

[22] JSF Public Affairs office July 11, 2001.

[23] If the JSF were to replace the F-16s at Hill AFB at a rate proportionate to the respective aircraft buys, the total fighter aircraft assigned to the base would drop from 81 to 63. This would be the functional equivalent of deactivating an 18-fighter squadron, such as the 421st Fighter Squadron of the 388th FW.

[24] Aircraft Report Section III.A.8.

[25] State of Utah's Supplemental Response to Applicant's First Set of Discovery Requests for Contention Utah K (Dec. 5, 2000) ("State Disc. Resp."); see also Memorandum from Matt Lamb and Marvin Resnikoff to Hugh Horstman (Dec. 5, 2000) ("Lamb/Resnikoff Memo"); State of Utah's Response to Applicant's Motion for Summary Disposition on Contention Utah K/Confederated Tribes Contention B (Jan. 30, 2001) ("State Mot. Resp."); Horstman Decl.; Declaration of Dr. Marvin Resnikoff Regarding Material Facts in Dispute with Respect to Contention K (Jan. 30, 2001) ("Resnikoff Decl.").

b. The State claims that PFS's use of an average of FY 99 and FY 00 sortie counts for F-16s transiting Skull Valley was incorrect; PFS should have used the higher FY 00 number.

c. The State claims that PFS used a crash rate that was too low for Skull Valley and UTTR military flight operations, in that 1) the F-16 will begin to experience a higher crash rate in the future as it gets older, due to an asserted "bathtub effect" in aircraft crash rates and 2) the F-16 will be replaced by a new aircraft sometime in the next 40 years and new aircraft typically have high crash rates.

d. The State claims that PFS assumes an incorrect random distribution of flights across a 10-mile width of Skull Valley, in that 1) if the PFSF is built, F-16 pilots will aim at the facility in order to calibrate their instruments before entering the restricted areas on the UTTR and 2) the effective width of Skull Valley from the perspective of transiting F-16s is six miles rather than 10.

e. The State asserts that PFS overestimates a pilot's ability to avoid the PFSF in the event of a mishap leaving the pilot in control of the aircraft, in that 1) PFS does not account for variations in pilot experience and 2) bad weather may obscure the PFSF from the view of the pilot and hence impede his ability to guide his aircraft away from the site before ejecting.

f. The State claims that PFS has incorrectly assessed and categorized the F-16 accidents described in the accident reports and thus has overestimated the probability that an in-flight emergency would leave a pilot in control of the aircraft with the ability to avoid the PFSF.

g. The State claims that it is inappropriate for PFS to draw statistical inferences for the future from its F-16 accident data.

Q55. How do you respond to the State's challenges?

A55. We respond to each of the State's claims in order below.

a. Additional F-16 Aircraft and Sorties

Q56. Please elaborate on the State's first claim regarding additional F-16 aircraft at Hill AFB and F-16 sorties through Skull Valley?

A56. The State claimed that PFS needed to include in its projections of future sorties the effect of 12 additional F-16 fighter aircraft, not accounted for in the original Aircraft Report (PFS Exhibit N), that were based at Hill AFB after 2000. State Disc. Resp. at 4; Lamb/Resnikoff Memo at 1. These 12 additional aircraft were assigned to Hill during FY 01.

Q57. Has the effect of basing additional F-16s at Hill AFB after FY 00 been accounted for in your calculation of the potential aircraft hazard for the PFSF?

A57. Yes it has. Our assessment in the Aircraft Report was based on FY 98 data, but, as discussed above (see Answers 47-53), we subsequently updated our assessment to account for new FY 99 and FY 00 sortie data as well as the additional aircraft that will be stationed at Hill AFB after FY 00. Specifically, we assumed in our calculations in the Revised Addendum, PFS Exhibit O, that the total F-16 sorties transiting Skull Valley (adjusted to reflect FY 99 and FY 00 operational levels) would increase proportionally in tandem with the increased number of F-16s at the base. Therefore, this concern raised by the State has been fully addressed.

b. The Use of An Average of FY 99 and FY 00 Sortie Counts

Q58. In what respect does the State claim that PFS's use of an average of the FY 99 and FY 00 sortie counts for F-16s transiting Skull Valley as the baseline for its assessment was incorrect?

A58. The State claims that PFS's use of an average of FY 99 and FY 00 sortie counts for F-16s transiting Skull Valley was incorrect and that PFS should have used the higher FY 00 number. Horstman Decl. ¶ 25; Resnikoff Decl. ¶ 25. The State claims that one purpose of the AEF concept recently introduced by the Air Force is to deploy units away from their home bases (e.g., Hill AFB and the UTTR) less often and therefore the higher number of sorties for FY 00 is not due to normal fluctuations but can be expected to continue into the future. Moreover, the State claims that there is no assurance that the FY 00 sortie count will not be exceeded sometime during the "40 plus years" of the PFSF. Horstman Decl. ¶ 25.

Q59. Is the State correct that PFS should have used the higher, FY 00 sortie count as a baseline?

A59. No. For the reasons explained in Answers 49 and 53 above, we believe that the average of FY 99 and FY 00 sorties is a reasonable and conservative historical basis on which to evaluate future potential aircraft hazard at the PFSF. The FY 00 rate is unlikely to be consistently maintained into the future because 1) the United States was not involved in any major international crises requiring significant overseas deployments in FY 00 which, as we see with the years before FY 00 and with the war against terrorism, was atypical and is not likely to be repeated for some period of time, 2) during FY 00 Hill AFB was achieving a very high sortie rate for its F-16s, which is usually not sustainable in the long run, and 3) the continuing trend towards more modern aircraft will result in the future procurement of fewer, more capable fighter aircraft, and an overall reduction in the numbers of aircraft. This latter point is particularly relevant for, as explained in Answer 53 above, by the time the PFSF would reach its maximum capacity (on which our potential hazard calculation is based) the Air Force should be well along in its procurement of the next generation of fighter aircraft. Thus, by the time the facility would reach full capacity, the number of sorties is likely to be less than that used in our calculation, and any accident rates associated with the introduction of new types of aircraft, discussed below, will have stabilized at lower levels.

Therefore, we have fully reviewed the State's claims and continue to believe that use of the average number of sorties for FY 99 and FY 00 increased to account for the additional F-16s based at Hill AFB is a reasonable, conservative projection of future traffic density when the PFSF will be operational.

c. Skull Valley and UTTR Crash Rates

(1) F-16 Crash Rates and the "Bathtub Effect"

Q60. What is the State's claim regarding F-16 crash rates and the "bathtub effect?"

A60. The State asserts that a "bathtub effect" is exhibited by aircraft accident statistics that show that in the life cycle of an aircraft model (e.g., F-16), high accident rates are seen as the aircraft is introduced. Horstman 1st Dep. at 75-77; Horstman Decl. ¶¶ 31-32. The State alleges that as pilot and maintenance experience are gained and problems are fixed, the accident rate decreases for most of the life of the aircraft model. The accident rate then assertedly increases as the aircraft reaches the end of its life cycle because of mechanical fatigue and aging. This argument is allegedly buttressed by the observation that the F-16 accident rate for FY-99 increased. Horstman Decl. ¶¶ 28-30; State Mot. Resp., supra note 17, at 10-12. Purportedly, according to the State, the FY 99 increase in accident rates was the consequence of the bathtub effect and presages future increased accident rates generally for the F-16.

Q61. Do you agree that the higher FY 99 accident rate is the consequence of the bathtub effect and portends increased accident rates in the future for the F-16?

A61. No. As shown below, the higher rate for FY 99 simply reflects inherent variability in year to year accident rates and is not evidence of the alleged bathtub effect as claimed by the State. Although the annual accident rate for the F-16 did increase to 5.11 Class A mishaps per 100,000 hours in FY 99, it decreased sharply to 2.62 Class A mishaps per 100,000 hours in FY 00. This is hardly an upward trend. Shown below is a table of the number of Class A mishaps, the Class A annual mishap rate, and rolling 10-year average of Class A mishap rates for the F-16 from FY 98 through FY 2001.[26]

Rates per 100,000 Hours

Fiscal Year	Class A Mishaps	Annual Rate	10 Yr Rate
FY 98	14	3.89	3.54
FY 99	18	5.11	3.67
FY 00	9	2.62	3.62
FY 01	13	3.85	3.53

It is clear that taking the one-year FY-99 numbers as a trend, as done by the State, is seriously misleading and using a 10 year average rate, as done in the Aircraft Report, avoids the inherent variability in year to year accident rates.

[26] http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/F16mds.html; http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/sep_eom_stats01.txt.

Q62. Have you evaluated whether the accident rate of the F-16 is exhibiting a bathtub effect as claimed by the State?

A62. Yes, we have evaluated the destroyed accident statistics both for the F-16 generally as well as for the oldest F-16 model in service, the F-16A, specifically relied upon by the State. We have also evaluated the accident statistics for recently phased out Air Force aircraft. As explained in the Aircraft Report (p. 11), the best way to understand aircraft accident statistics is to take a multi-year average in order to avoid statistical aberrations that might occur over shorter intervals of time. The shorter the average, the more variability there is and the more likely one is to mistake a short-term aberration for a trend. Although we used the ten year crash rate average in our Aircraft Report, our evaluation of the State's bathtub claim looks at the five and ten year rolling averages over the life of the aircraft. As can be seen in PFS Exhibits Q to V, the five-year and ten-year rolling averages progressively dampen single year fluctuations.

Further, our evaluations of the State's claim are based on destroyed aircraft in order to focus on those accidents that could potentially impact the PFSF. As explained in the Aircraft Report (p.10), Class B mishaps rarely involve a crash and Class A mishaps may not involve a crash. Therefore, it is appropriate to focus the evaluation on destroyed aircraft. The results of our evaluation are described below and are shown on the graphs identified as PFS Exhibits Q to V.

Q63. Does your evaluation of the five or ten year rolling averages for the F-16 destroyed aircraft accident rate show any evidence of a bathtub effect?

A63. No. Both the five-year and ten-year rolling averages show a steadily decreasing or generally level accident rate over the life of the F-16, even with the FY 99 figures. A graph of those averages based on F-16 data through FY 00 (the last year of currently available data on destroyed aircraft) is shown on PFS Exhibit Q. Thus, the F-16 accident data shows no bathtub effect.

Q64. What happened with respect to the F-16A, whose crash rates the State claims are particularly relevant to the model of F-16 currently flown at Hill AFB and on the UTTR?

A64. Looking specifically at flying hour and accident statistics for the F-16A model, the first model of the F-16 introduced to the Air Force and therefore the oldest of the F-16s, it is apparent that most of them have been retired. (Hill AFB currently has only F-16C and F-16D models.) As may be seen on the charts identified as

PFS Exhibit R, flying hours for the F-16A model were at a peak of about 170,000 hours per year in the FY 1984 to FY 1988 time frame, then have steadily decreased to level at about 20,000 hours in FY 00. This indicates about a 90% decrease in the inventory of F-16A aircraft as they are being phased out. The number of destroyed aircraft in the last five years has been zero, one, or two each year since 1995. Despite this, the five-year and ten-year average accident rates have stayed flat. Thus, contrary to the State's claim, see Horstman Decl. ¶¶ 29-30, the F-16A is not exhibiting a bathtub effect in accident rates. Therefore, there is no reason to expect accident rates for the newer F-16 models to increase in the future.

Q65. Have you reviewed the data for any other fighter aircraft that is in the process of being phased out of the inventory.

A65. Yes. We have reviewed the statistics for the F-15A, which was the first model of the F-15. Like that for the F-16A, the rolling five and 10 year averages of destroyed aircraft for the F-15A show no bathtub effect. The F-15A is the oldest of the F-15s (the other principal jet fighter for the Air Force, introduced a few years before the F-16) and like the F-16A, is being phased out of the inventory. As shown in the chart identified as PFS Exhibit S, the F-15A flew in the neighborhood of 65,000 to 75,000 hours per year between 1980 and 1992, but it has now dropped to about 20,000 hours per year for the last 5 years, indicating about a 70% drop in the inventory of F-15A aircraft. Despite this, the number of destroyed aircraft has been 0 or 1 each year since 1987, and the accident rates show a commensurate decrease from the mid-life years. In the later years, the 5 year rate shows a gradual increase, even in years when there were no accidents, because of anomalies in the rates due to the small numbers involved, as explained below. The 10 year rate continues its general decrease or leveling off from the mid-life rates.

Q66. Have other Air Force aircraft that were phased out of inventory recently exhibited a rise in accident rates due to the claimed bathtub effect?

A66. No. A study of aircraft accident rates on other fighter aircraft that have been, or are being, phased out of the inventory within the last 20 years does not show a rise at the end of their lives. There are some anomalies in rates towards the very ends of the life cycles of some aircraft, where a single accident causes a large spike in the rate. This is because the number of flying hours has decreased drastically from the norm due to the sharply decreased number of aircraft remaining in the inventory. Thus a large rate change results from a single accident. This does not mean that aircraft are falling out of the sky everywhere. It only means that there are only a few aircraft of that model still flying. The risk to a facility on the ground from that aircraft is actually decreasing since the total number of aircraft flying, the number of sorties, the number of flight hours, and the number of accidents are all decreasing.

The aircraft that have been phased out of the active inventory most recently are the F-106 (FY 97); F-111 (FY 98); and the F-4 (FY 99).[27] All of these aircraft exhibit the trends of decreasing or level accident rates relative to the mid-life rates except when flying hours are very low. The F-106 (identified as PFS Exhibit T) is a good example of the effect of an accident when there are only a few aircraft flying and flying hours are low. The F-106 began phase-out in 1984 and most were gone by 1988. Rates (but not accidents) for that aircraft skyrocketed in its last years after 1990, but it was flying less than 100 hours in each of those years. In several cases for the F-106, e.g., in FY 1992 and FY 1995, the rolling average rates rose <u>even when there were no accidents</u>, because of the fewer number of hours being added to the denominator of the moving average equation to replace larger numbers from earlier years. The graphs identified as PFS Exhibits T, U and V show the number of flight hours and the rolling five-year and ten-year average crash rates for the F-106, the F-111, and the F-4, respectively.

Q67. Based on your evaluation, do you expect the accident rates for F-16s to increase sometime in the future due to the alleged bathtub effect?

A67. No. First of all, we showed above that neither the F-16 accident data nor that for other recently phased out aircraft exhibit a bathtub effect. Further, aircraft accident rates are decreasing generally for the total Air Force aircraft inventory because of better maintenance, parts control, improved inspections, built-in tests and fault reporting, better pilot training and other improvements. Air Force commanders are focused on safety and will routinely reallocate resources to reduce and manage risk. According to the Air Force Chief of Safety, the Air Force expe-

[27] Although the F-4 had still flown a small number of hours in FY 99 (4,306) it had been essentially phased out by that date.

rienced its lowest accident rate ever in FY 00.[28] The broad trend is illustrated by Figure 2 in the Aircraft Report (behind p. 9), which shows that accident rates for Air Force single engine fighter aircraft have decreased greatly over the past 50 years. There is no reason to believe that this trend will not continue into the future.

Parts do fail eventually, but the aviation community, including commercial airline and general aviation operators as well as the Air Force, routinely inspect their aircraft for signs of wear and replace parts with new ones well before expected failure points. Inspections are performed before and after each flight and major inspections are performed on the basis of hours flown on the airframe or engine. Aircraft may not fly without successfully completing these inspections. Thus, the alleged bathtub effect does not apply to aircraft safety statistics. It could be a description of the fact that, as an aircraft ages, it need more resources (parts, inspections, maintenance hours, etc.) to safely fly. The Air Force, however, provides these resources specifically to safely maintain flying operations while continuing to reduce its accident rates.

Q68. In the end, which accident rate is most appropriate for you to use in your assessment?

A68. For all of the above reasons, the ten-year average conservatively represents what one should expect the rates to be in the future. Therefore, we have fully evaluated the State's challenges and do not believe that they warrant any change in the F-16 accident rates used in our assessment.

(2) Replacement of the F-16

Q69. Why else does the State contend that PFS used the wrong accident rate in assessing the hazard from potential F-16 crashes?

A69. The State also asserts that the introduction of a new fighter aircraft is always accompanied by a high accident rate as the aircraft comes into the inventory and is only decreased toward the middle of the service life of the aircraft. Horstman Decl. ¶¶ 31-32; see State Mot. Resp. at 11. Thus, the State claims that the replacement for the F-16 (e.g., the F-22 or the F-35 Joint Strike Fighter) will be a

[28] Secretary of the Air Force, Public Affairs, News Release (Oct. 3, 2000).

greater hazard to the PFSF than the F-16 if it is assigned to Hill AFB as a replacement for the F-16.

Q70. Is the State's contention correct?

A70. No. The State has overlooked several interrelated points. First, the previously observed high levels in aircraft introductory accident rates involved numerically relatively few accidents accompanied by relatively few flight hours. These rates were also transitory, lasting only a few years before stabilizing at a lower rate. If a new aircraft were stationed at Hill AFB as its first base and experienced an increased rate for a year or two while the inventory was being built up, the actual risk to the PFSF would be lower due to the fact that the fewer introductory aircraft would fly fewer sorties through Skull Valley near the PFSF. During this early time period, the PFSF would not be filled, resulting in an even lower effective area and consequent risk.

Second, relatively higher fighter accident rates during introduction and initial service were the case in the past, even with the F-16, which was first delivered to the active inventory in 1978. However, it should be emphasized that introductory aircraft accident rates have been generally declining over time. As demonstrated by Figure 2 in the Aircraft Report, behind page 9, initial accident rates (first spikes) for single engine fighters have decreased significantly since the F-86 was introduced in 1950. Based on the trend evidenced in Figure 2, new aircraft using the latest technology would be expected to have lower initial accident rates. A further reduction in introductory accident rates can be expected due to increased skill in designing aircraft with computer modeling, as well as the large scale use of high fidelity simulator training for pilots, enabling them to know the characteristics of an aircraft before flying it. Further, aircraft control systems and instrumentation have also improved markedly over the recent years with advances in electronics and computer power.

Therefore, there is every reason to expect that the newest computer designed aircraft, the F-22 and the F-35 Joint Strike Fighter, will be safer than the F-16 during their introduction and throughout their total life cycles, continuing the trend in fighter aircraft. Moreover, the F-22 is a twin-engine aircraft. As such, because engine failure is a significant cause of aircraft accidents, the F-22 accident rate will likely be lower than that of the F-16 on that basis alone. Indeed, a comparison of F-16 (single engine) and F-15 (twin engine) accident rates shows that over the last 10 years, the F-15 rate has been only 50.3 percent of the F-16 rate. See also Horstman 1st Dep. at 85. Therefore, new fighter replacements for the F-16, if assigned to Hill AFB, will not pose a greater hazard to the PFSF.

Q71. Would the F-16s at Hill AFB necessarily be replaced by the first F-22s or the first Joint Strike Fighter aircraft during the lifetime of the PFSF?

A71. No. First, the F-22 is specifically intended to be an air superiority fighter that will replace the F-15 and there are no F-15s stationed at Hill AFB.[29] F-22 training will be accomplished at Tyndall AFB, Florida and that base will receive the first two F-22 squadrons. Present plans are for Langley AFB, Virginia to receive the first operational F-22s. This is consistent with the current basing of the F-15.

Second, the F-35 Joint Strike Fighter will replace the F-16 in the Air Force inventory, but, as discussed in Answer 53 above, the Air Force is planning to buy fewer of them than the number of F-16s it bought.[30] The F-35 is a "joint" fighter, meaning that it will be flown jointly by the Air Force, the Marines and the Navy, as well as several foreign countries. Each variant of the aircraft will be tailored for the military service flying it, but there will be a great deal of commonality (70 – 90%) between the models. The first operational F-35s will go to the Marines, with an initial operational capability (IOC) in 2010. The Air Force will receive them next, achieving IOC in 2011, and the Navy is next, reaching its IOC in 2012. Since the Marines will be flying their F-35s first, the Air Force (and the manufacturer) will be able to learn from problems they encounter and consequently decrease the probability of future problems. The Air Force has not yet decided where to base the F-35s when they do get them. It is quite likely that the first Air Force F-35s will go to Luke AFB as the training base. F-16 training is conducted there now.

Thus, the first flights of the F-35 would probably not be at Hill AFB. Therefore it is unfounded speculation that the F-35 will exhibit higher crash rates than the F-16 and that its early flights, when its accident rates might be higher than its own lifetime average, would necessarily take place at Hill AFB. Hence, the potential

[29] Horstman 1st Dep. at 84.

[30] JSF Public Affairs office July 11, 2001.

introduction of new Air Force aircraft during the life of the PFSF does not invalidate our hazard analysis and warrants no change in the analysis.

d. Distribution of F-16 Flights in Skull Valley

(1) Use of the PFSF as a Navigational "Turning Point" or for Sensor Alignment

Q72. What claim has the State raised regarding PFS's assumption in its calculation of an even distribution of F-16 flights in Skull Valley?

A72. The State claims that pilots would use the PFSF as a navigational turning point or for sensor update and alignment as a matter of convenience. Presently, pilots successfully conduct their flight through Skull Valley, and their training mission overall, without relying on the PFSF as any sort of reference. Nevertheless, the State claims that, if the PFSF were built, it would satisfy a long lasting need for a good "turning point" in Skull Valley for F-16 pilots to update, refine, and cross-check their navigational and target systems. Horstman Decl. ¶¶ 20-23. The State claims that in doing so F-16s will be pointed at the PFSF for some period of time during their transit through the valley thereby increasing the risk to the facility. State Mot. Resp. at 13. Thus, the State essentially asserts that if the facility is built, the predominant flight paths and activities which currently take place in Skull Valley will fundamentally change and therefore the PFS analysis will no longer accurately reflect the potential risk posed by military aviation to the PFSF.

Q73. Please describe what is meant by a navigational "turning point" and "sensor alignment."

A73. Navigational turning points or steer points are the latitude and longitude coordinates of the steering points for the intended route of flight. They are programmed into the aircraft's Inertial Navigational System (INS).[31] The intended route of flight is normally programmed as a sequential series of steer points in the INS. Additional points of interest, for example, emergency airfields may be programmed into the INS as well. The flight generally proceeds in a straight line between the steer points.

[31] March 30 Response at 8. The INS is a self-contained navigation unit that is aligned to known coordinates after the start of the aircraft engine and before taxi. Once aligned, the three internal gyroscopes sense acceleration, which the navigation computer uses to update the aircraft's present position, direction, speed, and altitude.

Sensor alignment generally refers to updating, aligning or cross-checking the aircraft's various navigational and target systems, such as the INS.[32] While navigational turning points are often used for sensor alignment, sensors can be aligned by other means as well. For example, certain sensors are often aligned or updated while on the ground before take-off, and for those aircraft that have the capability to receive and use the Global Positioning System (GPS) navigation signals, such as those for the 388th FW, the INS may be automatically updated continually during flight by the GPS.

Q74. Do you agree with the State's claim that, if the PFSF is built, the predominant F-16 flight path through Skull Valley will fundamentally change such that the PFS analysis will no longer accurately reflect the potential risk posed by military aviation?

A74. No. The State's claim is flawed in several key respects. First, the State ignores the significant conservatism in our current analysis. Although the Air Force has stated that the "predominant" route used by F-16 pilots favors the eastern portion of Skull Valley, Aircraft Report at 5, our analysis assumed an even distribution of F-16 flights over Skull Valley, id. at 6.[33] Therefore, our analysis overstates the risk associated with current F-16 operations. Second, we believe that the State overstates the likelihood that pilots will significantly alter their current flight pattern through Skull Valley should the facility be built. The State assumes, without providing any empirical data or analysis, that pilots will radically change their long established pattern of flight through Skull Valley if the PFS facility were built. We believe that the same considerations which currently make the eastern side of the valley the preferred route (e.g., the fundamental configuration of the MOA) will remain unchanged. Third, the State overstates the risk implications of the pilots changing their flight paths even assuming they used the PFSF as a navigational turning point or for sensor alignment. In short, we believe that any adverse risk implications resulting from the building of the PFSF would be minimal compared to the inherent conservatism in our analysis and would not affect its validity. Each factor is discussed below.

Q75. Why is your assumption of an even distribution of F-16 flights across Skull Valley conservative?

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[32] The INS normally has a small drift error that translates into an error in the present position over time. The positioned error is corrected by the INS update. March 30 Response at 7 n.5.

[33] We assumed that each flight was distributed randomly from east to west within the valley.

A75. Our analysis conservatively assumes that there will be more F-16 overflights of the facility than there actually would be. This is evident when considering the proposed location for the PFS site (on the western side of the MOA), its proximity to restricted airspace both to the west and to the south, and the available routes of flight that will reasonably keep the pilots within the lateral confines of the MOA. See Aircraft Report at Tab A and PFS Exhibit O. In fact, the Hill AFB staff has informed the NRC Staff that F-16s transiting Skull Valley maintain about a two-mile buffer zone on the western edge of the MOA next to the restricted airspace.[34] Since the PFSF would be located approximately two miles from the restricted airspace, the practical effect of such a buffer zone is that the PFSF would be located effectively at the western edge of the area where the F-16s transiting the MOA fly, and not in the center as implied by the State. Moreover, the geometry of the MOA (17 miles wide in the northern portion of the Valley converging to the east to only 7 miles wide in the southern portion) induces a natural funneling effect on flights proceeding south through the narrow "neck" of the MOA east of Dugway Village. Aircraft Report, Tab A;[35] see also PFS Exhibit P. This geometry makes the eastern side of Skull Valley (roughly five miles away from the proposed site) the preferred, "predominant" route of flight. Id. at 5-6.

Q76. Why do you believe that the PFSF, if built, would not cause pilots to significantly change their flight pattern through Skull Valley so as to fly at or over the facility?

A76. Our belief is based on several factors. First, pilots routinely perform a number of administrative tasks while transiting Skull Valley. These include: operations checks, where pilots will check the operating status of the airplane, fuel quantity and distribution, and oxygen system operation; G-awareness maneuvers where the pilot accelerates and then performs two 90° turns to check the proper operation of the anti-G suit and his ability to withstand G-forces; and a "fence" check where the pilot positions certain cockpit switches as though he were preparing to cross into hostile territory. There is no prescribed order in which these tasks must be done and pilots have different habit patterns regarding when and how they ac-

[34] NRC/Hill AFB September 7, 2001 Meeting Summary. The State's expert witness acknowledges that "as a practical matter, pilots will not essentially fly within one mile of restricted airspace to the west" of the PFSF. Horstman Decl. ¶ 23.

[35] The lines drawn on the map in Tab A relate to the UTTR crash hazard calculation and have no bearing on the discussion here.

complish them. However, they are typically done early in the flight to minimize the impact on the tactical maneuvering portion of the mission. It is reasonable to assume that pilots will continue to do these routine tasks while transiting Skull Valley whether or not the PFS facility is built rather than change their routine to use the PFSF as a steer point or for sensor updates.

Second, the State infers that pilots will use the proposed PFS site as the primary navigation reference in Skull Valley. Horstman Decl. ¶¶ 22-23. However, the State fails to give adequate consideration to the prominent mountain ranges on both sides of Skull Valley that currently provide excellent visual references for maintaining positional awareness and that obviate the need for a specific navigational turn point while performing the other tasks pilots routinely accomplish during this phase of flight. If a pilot did use the PFSF as a visual reference rather than a navigational turn point, he would not necessarily fly directly over the site. In addition, there are other cultural features, such as ranches that can be used for turn points (and sensor alignment) if desired. Many of these are located east of the proposed PFS site which will allow pilots to fly more directly and conveniently toward the narrow "neck" of the MOA at the southern end of Skull Valley.

Third, the State's argument is based in part upon the claimed lack of significant sensor signal returns from cultural (i.e., man-made) objects in Skull Valley upon which to align the aircraft sensors, as well as to use for navigation as previously discussed.[36] The State, however, acknowledges that there are no requirements to update the sensors or to update them on any particular point, Horstman 1st Dep. at 159, and that pilots update their sensors at different times, id. at 123, 160. Moreover, as explained further below even if a pilot used the PFSF to align and update the aircraft's sensors, he would not necessarily fly directly at or over the site.

We understand that the proposed site will be a prominent feature in Skull Valley and that some pilots may use the PFSF as a reference point for navigation, sensor alignment, or both. However, the State overestimates the impact of building the proposed facility on pilot activities while transiting Skull Valley and it fails to

[36] Cultural objects tend to have different infrared characteristics than the natural environment surrounding them. Focusing the targeting pod on the F-16 requires infrared contrast in its field of view. Cultural objects are also more easily seen by pilots.

give sufficient weight to the close proximity of restricted airspace just west and south of the proposed site and the associated buffer zone on the west side of the MOA, as well as to the funneling configuration of the MOA airspace. Therefore, we do not agree that the PFSF will result in a significant change to the flight distribution pattern described in the Aircraft Report.

Q77. Please specify the various reasons why you believe that F-16 pilots transiting Skull Valley would be unlikely to use the PFSF as a navigational turning point as claimed by the State?

A77. First, because of the prominent mountain ranges on both sides of Skull Valley that provide excellent visual references for maintaining positional awareness, there is no need for a navigational turning point or steer point in Skull Valley.

Second, as noted previously, the current practice is for F-16s to fly toward the eastern side of the MOA for airspace considerations and to practice terrain masking. The PFS site is located toward the western side of the MOA, within two miles of the restricted airspace, and away from the narrow "neck" at the southern portion of Skull Valley. Pilots must still contend with the airspace limitations regardless of whether or not the PFS facility is built.

Third, pilots will still be required to do those routine functions and checks discussed above. Skull Valley will remain a good location to complete these checks. The addition of a navigation turn point at the PFSF site on the western side of the MOA would add an unnecessary complication to performing these tasks and would be of little benefit for navigation purposes.

Fourth, if the PFSF were used as a turning point in navigating the valley, a pilot could not transit the MOA without a second turning point because of the restricted airspace to the south of the PFSF site. Thus, a second turning point in the region of the narrow neck of the MOA near Dugway Village, about 10 miles away, would be necessary, and would add yet another unnecessary complication.

Fifth, there are other points more favorably aligned with the narrow "neck" of the MOA that can be used as a navigational steer point if desired. For example, the intersection of the PFS access road with Skull Valley Road, approximately two miles to the east of the facility, will be an additional such point that can be used although it will lack the vertical build up of the PFS facilities.

Sixth, although turn points are normally visually identifiable, a pilot may also select a turn point that is simply a programmed steer point on the INS with no visually distinctive characteristics. For example, a pilot could, if desired, select a turn point in the middle of the narrow "neck" portion of the MOA, southeast of Dugway village, to have an INS steer point that could be used to ensure that the flight stayed within the narrow corridor.

Q78. Please specify the various reasons why you believe that the potential use of the PFSF for sensor alignment would be unlikely to cause pilots to deliberately fly at or over the proposed PFSF as claimed by the State?

A78. First, as discussed above and as acknowledged by the State, there is no requirement to update sensors in Skull Valley or at any other particular point in time, and pilots both can and do update sensors at different points in time. For example, some sensors (such as the navigation pod discussed below) may be aligned on the ground prior to takeoff. Further, the F-16 aircraft flown by the 388th FW has an automatic INS update capability tied to the GPS network that allows the INS system to be updated continually during flight.[37]

Second, the same airspace considerations that make it unlikely for pilots to use the PFSF as a navigational steering point, specified in the previous answer, would similarly make it unlikely for plots to fly directly at or over the PFSF in order to align and update their sensors. As further noted in the context of that discussion, there are other cultural features, such as road intersections and ranches, that are more favorably aligned with the narrow "neck" of the MOA southeast of the PFSF that could be used for sensor alignment in Skull Valley, if desired.

Third, even assuming the PFSF were used for sensor alignment, it is not necessary for the aircraft to be pointed directly at the facility in order to update the present position of the INS computer. There are several ways to update the INS with the sensors: by means of the pilot's Heads Up Display (HUD), by means of the onboard radar, by using the GPS capability, or by directly overflying the point. As noted, the F-16 aircraft flown by the 388th FW (which comprise more than 75% of

[37] The 419th FW aircraft currently do not have this capability.

the F-16s stationed at Hill) has an automatic INS update capability tied to the GPS which alleviates the need for updating the INS using other methods.[38]

To update the INS using a ground reference with the pilot's HUD, as a practical matter most pilots will usually have the object aligned fairly close with the nose of the airplane, but the point really only needs to be within the HUD field of view (within 15° either side of the aircraft nose and not more than approximately 10° below the horizon). If the PFSF were in place and the pilot wanted to use the PFSF as an update reference point without getting too close to the site itself, there would still be freedom for him to navigate towards the neck of the valley as is currently done while using the PFSF, offset to the right, to update his INS system using the HUD.

To update using the radar, a ground target at a minimum angle of at least 15° away from the nose of the aircraft provides a much more precise radar picture for the pilot and therefore a much more precise update of the INS computer. It would therefore be advantageous to not fly directly at or over the PFSF while using the radar for an update.

As stated, the INS could also be updated by flying directly over the point (overfly update). We believe that it would be unlikely that a pilot would use the PFSF to update the INS in this manner given the proximity of the PFSF to the restricted airspace, directly to the west and to the south of the site, and the buffer zone observed by pilots on the western edge of the MOA.

Fourth, it is similarly unnecessary to be pointed at or directly overfly the PFSF in order to update other navigational and targeting systems. In addition to the INS, the Low Altitude Navigation and Targeting Infrared Night (LANTIRN) system is the other system that a pilot could possibly align using the PFSF. The 388th FW aircraft are equipped with the LANTIRN system.

The LANTIRN system consists of a navigation pod and a targeting pod which are attached to the aircraft's fuselage. The navigation pod is used at night to assist with navigation. Its alignment occasionally needs to be adjusted, but the pilot can

[38] In the normal mode of operation, the 388th FW aircraft automatically update the INS present position using the GPS.

easily correct it with a one-time adjustment either on the ground or in the air. Thus it does not need to be aligned using the PFSF.

The targeting pod is used to designate specific targets for laser guided bombs.[39] The targeting pod is automatically positioned (or aimed) to look at the selected INS steer point; the pilot does not have any capability to adjust this automatic positioning function. The pilot can, however, take manual control of the targeting pod sensor and position it as desired or command it to track an object. Additionally, pilots can manually adjust the targeting pod focus if desired. If the pilot elects to focus the targeting pod, he will normally attempt to do this at approximately 6-8 miles from the selected point of interest. This is the range at which he would be finalizing his target tracking solution if this was a bombing pass. Focusing the targeting pod, however, is normally a once per mission event, and may be accomplished on the ground or in the air, if required. See March 30 Response at 8-9. Further, the aircraft does not need to be pointed directly at the point of interest to focus the pod. Thus, even if a pilot did use the PFSF to focus the pod, the pilot would not necessarily fly directly at or over the site.

Q79. Assuming hypothetically that the pilots did use the PFSF as a navigational reference and for sensor alignment, how does the State overstate the risk implications of the pilots changing their flight paths?

A79. First, as discussed above, the State has focused its claim on a single point – that the site will be plainly visible – and speculates solely from this fact that a significant change will occur in F-16 flight patterns without providing any supporting analysis that addresses the airspace limitations and other factors which impact and influence the current operations and flight distribution pattern in Skull Valley.

Second, as described above, a pilot could use the PFSF for sensor alignment and as visual navigational reference point without flying directly at or over the PFSF.

Third, even if a pilot chooses to fly directly at the PFSF as a navigation point and to update his sensors, he may turn anywhere from 10 miles short of the navigation

[39] The targeting pod is normally used at medium altitude (i.e., at 15,000 to 25,000 ft. AGL). The USAF has discontinued training their pilots for full low altitude LANTIRN employment (i.e., night low level at 500 ft. AGL, automatic terrain following radar, loft bombing using the targeting pod). The targeting pod is of little value in the low altitude bombing events that all F-16 pilots are qualified to perform. These missions can be successfully completed if the targeting pod is never used.

point on which he updates his sensors to where he is directly above the navigation point. Horstman 1st Dep. at 229-230. Therefore, even if the PFSF were used as a turning point and pilots flew at the site, it would not necessarily require pilots to fly directly over the site. Moreover, even if one pilot in a formation were to fly over the site, the other would clearly not.[40] Thus, it would not lead to the increase in risk claimed by the State.

Fourth, the State is in essence acknowledging that the proposed PFS facility will be well known to all pilots since they will use it regularly as a primary visual reference point. If this were the case, pilots would be able to see or at least would be aware of the location of the PFSF and would be able to avoid it in the event of an emergency. This makes the conservative allowances built into our original crash impact probability calculations regarding a pilot's ability to see and avoid the PFSF in the event of a mishap unnecessary, which makes the actual crash impact probabilities lower than those calculated. As discussed elsewhere, we assumed that 5 percent of the time a pilot would fail to avoid the PFSF in the event of a mishap that left him in control of the aircraft, even though our review of F-16 mishap reports over the last 10 years revealed no case where a pilot failed to avoid a site on the ground when he had the time and opportunity to see and avoid it.

Thus, the State incorrectly attributes a higher risk to the PFSF site by asserting a change would occur in the distribution of the flights within Skull Valley. The State's assertion is based solely on the visibility of the site to the pilot. The State fails to take into account other important considerations that influence flight through the MOA and affect the risk equation. The conservative assumptions used in our calculations adequately allow for any redistribution of F-16 flight operations should they occur as a result of the building of the proposed PFS facility and the State's challenges do not warrant any change to our analysis.

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[40] Flights normally fly with 6,000 ft.-12,000 ft. lateral separation between the aircraft. Therefore, at most only 50% maximum of the aircraft would point directly at the site if it were used. Since it is not necessary to point directly at or overfly the site, it is possible that none of the aircraft would point directly at the site.

(2) The Effective Width of Skull Valley

Q80. What is the State's claim regarding the effective width of Skull Valley and the distribution of flights within it from the perspective of assessing the aircraft crash risk to the PFSF?

A80. The State claims that the effective width of Skull Valley should be six miles rather than the 10 used by PFS. Horstman Decl. ¶ 23.[41] The State claims that pilots will not fly within one mile of restricted airspace to the west of the PFSF (i.e., they will fly no more than one mile to the west of the PFS site) and that pilots would be prevented from flying more than four or five miles to the east of the PFSF by the presence of the Stansbury Mountains on the east side of Skull Valley. Id. The State claims further that the natural path of the F-16s through Skull Valley is more toward the center of the valley, over or near the proposed PFS site. Id. ¶ 10.

Q81. How did you conclude that the width of the MOA near the PFSF was 10 miles and what was your assumption as to the distribution of flights within that width?

A81. The Sevier B MOA in Skull Valley is 12 statute miles wide at the latitude of the PFSF. Aircraft Report at 6. At this latitude, the PFSF sits in the Valley at a point 2 miles to the east of the western boundary of the MOA, at an altitude of 4,500 ft. MSL. The top of the Sevier B MOA is established at 9,500 ft. above sea level (MSL). Air Force Instructions pertinent to the UTTR establish a floor at 1,000 ft. AGL below which aircraft may not fly through Skull Valley north of English Village. Rising terrain on the east side of the MOA intersects the top of the MOA 10 miles to the east of the PFSF at 9,500 ft. MSL (5,000 ft. above the PFSF) at the MOA's eastern limit (see Aircraft Report, Figure 1). Because of the rising terrain, flight is not practical at all altitudes from 1,000 ft. to 5,000 ft. above the PFSF for the entire width of the MOA. While an F-16 could in fact fly in the Sevier B MOA airspace at a point over 9 miles east of the PFSF, implying a usable width of the airway of over 11 miles, we chose to assume a more conservative 10 mile value for the usable width.

[41] In its crash impact probability calculations, the State assumes that the valley should be taken to be five miles wide on the basis that pilots will deliberately fly in the direction of the PFSF to use it as a turn point. See Resnikoff Decl. ¶ 29.

We have consistently been informed by Air Force and 388th FW officials[42] that the predominant route of flight through Skull Valley is approximately 5 miles east of the proposed PFSF. As a conservatism to account for variations among individual flight paths and to be consistent with the NUREG 0800 methodology we chose to model the flights as being evenly distributed across the 10 mile width.

Q82. Are there other factors which make flying on the eastern side of the Sevier B MOA, away from the PFSF, the preferred route of flight?

A82. Yes. The two primary factors are the configuration of the MOA and the restricted airspace on the western edge of the MOA. Tab A of the Aircraft Report depicts the Sevier B MOA in Skull Valley. From a point approximately 11 miles northeast of the PFSF, the northern border of the MOA slants in an east-southeasterly direction across the valley to the ridge of the Stansbury Mountains. From the northern border, the eastern edge goes southward in a straight line along the ridge of the Stansbury Mountains, while the western edge slants from the MOA's northwestern tip in the Cedar Mountains to the southeast across the valley, closing on the eastern edge until it reaches a point 10 statue miles south of the PFSF, east of Skull Valley Road and near English Village on Dugway Proving Ground. At the northernmost end of the MOA, approximately 10 miles to the north of the PFSF, the MOA is 17.0 miles wide. Ten miles to the south of the PFSF the MOA narrows to its narrowest width, 7.1 miles wide. The terrain within the MOA here at this narrowest width is basically flat and the entire width of the MOA at this latitude is usable airspace. Hence within a north-south distance of 20 statute miles, the MOA has narrowed to the east by almost 10 statute miles. This configuration serves to naturally funnel F-16 traffic in Skull Valley toward the eastern side of the valley. The Restricted Areas on the western edge of the MOA, discussed above, further serve to make the eastern side of the valley the preferred route of choice.

Q83. What other information shows that the F-16 flights would tend to pass away from the PFSF rather than close to it?

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[42] Nov. 20, 1998 meeting and teleconference with Air Force Deputy Chief of Safety, Col. Bergman, along with Lt. Col. Dan Phillips (who flew F-16s at Hill for 3 years and then worked for Col. Bergman) and Lt. Col. Thompson, 388th FW Chief of Safety included by teleconference); December 15, 1998 meeting with 388th FW Vice Wing Commander (Col. Oholendt) and wing staff at Hill AFB; May 25, 1999 meeting with Air Force Chief of Safety (Col. Bergman); July 29' 1999 teleconference with 388th FW Vice Wing Commander (Col. Oholendt).

A83. The Hill AFB staff has recently advised the NRC Staff that pilots maintain approximately two-mile buffer zones between their route of flight through Skull Valley and the Restricted Areas on the western edge of the MOA and the Stansbury mountains to the east.[43] The PFS site is located two miles east of the western edge of the MOA, i.e., right at the edge of where the F-16s fly. Thus, given the fact that the F-16s tend to fly in formation, typically separated by an east to west distance of 6,000 to 12,000 feet, the easternmost aircraft would rarely, if ever, fly over the site. Therefore, our assumption allows for more overflights of the site than would actually occur and thus its hazard calculation is conservative.

Hill AFB officials have also recently indicated that there is a trend to fly more transits in the Sevier D MOA, which lies above Sevier B at altitudes from 9,500 to 18,000 ft.[44] If F-16s do fly above the Sevier B MOA, in the Sevier D MOA airspace, they are not constrained by the Stansbury Mountain terrain and hence have the full width of the MOA available from 2 miles east of the Restricted Area to the eastern edge, a distance of 10 miles, as usable airspace. The Hill AFB staff corroborated that the width for sorties in Skull Valley is less restrictive at that altitude.[45] In fact, if the pilots were operating under visual flight rules (VFR) above Sevier B, they could fly to the east of the Stansbury mountains (i.e., to the east of the MOA into uncontrolled airspace) if needed or desired, using an even wider airway width. To the extent that F-16s fly further to the east at higher altitudes, it reduces the risk to the PFSF.

Q84. What is your conclusion regarding the State's challenge to your use of a 10 mile width for calculating the hazard for the PFSF?

A84. Our conclusion is that our analytical method was, and remains, conservative. Even assuming the width of the Valley actually used by the F-16 pilots might be somewhat less than 10 miles, most of the flights are distributed toward the eastern part of the valley away from the PFSF because of the narrowing of the MOA airspace toward the southeast and the buffer zone observed by the pilots on the edges of the MOA. Therefore, the number of overflights will in fact be significantly lower than what we assumed. Further, as F-16s fly higher in the airspace, the

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[43] NRC/Hill AFB September 7, 2001 Meeting Summary.

[44] Id.

[45] Id.

useable width to the east increases consequently decreasing the risk to the PFSF. Thus, the hazard will be lower than what we calculated and no change to our analysis is warranted.

e. Avoidance of the PFSF in the Event of a Mishap

(1) Pilot Experience

Q85. Please describe the State's claim that PFS did not properly account for pilot experience in determining the ability of a pilot to avoid the PFSF in the event of an in-flight mishap leading to a crash?

A85. During his December 11, 2000 deposition, State witness Lt. Col. Horstman asserted that PFS did not account for variations in pilot experience in determining that an F-16 pilot would be able to guide his aircraft away from the PFSF in 95 percent of the mishaps in which the pilot was left in control of the aircraft. Horstman 1st Dep. at 173; see also Horstman Decl. ¶ 63. Lt. Col. Horstman agreed that all pilots in such circumstances would intend to avoid the PFSF. Horstman 1st Dep. at 172-73. He stated, however, that the probability that a pilot would succeed would be higher for more experienced pilots and that only 60 percent of the Air Force's F-16 pilots are "experienced" in terms of the number of flying hours they have in the aircraft. Id. at 173-77. Lt. Col. Horstman then asserted his belief that PFS's assumption that pilots would be able to avoid the PFSF 95 percent of the time was too high because of the potential for inexperienced pilots to be involved in mishaps, but he did not know what the actual percentage should be. Id. at 175-77, 181, 185.

Q86. Is the State correct that PFS failed to account for pilot inexperience in its assumption that an F-16 pilot would be able to guide his aircraft away from the PFSF in 95 percent of the mishaps which the pilot was left in control of the aircraft ?

A86. No. At the outset, in assessing Lt. Col. Horstman's assertion, it is important to note that during Lt. Col. Horstman's deposition and the December 12, 2000 deposition of Col. Fly,[46] the word "experienced" was used in two different contexts as it relates to pilots. The first context is commonly understood and is directly relevant to a pilot's skill and ability to avoid the PFSF; the second context stems from an Air Force management tool used to maintain a balance between more junior

[46] Deposition of Col. Ronald Fly (Dec. 12, 2000) ("Fly Dep.").

and senior pilots in its fighter wings. Col. Horstman's reference to 60 percent of F-16 pilots being "experienced" is concerned with the latter context, not the former. See Horstman 1st Dep. at 173-74.

The commonly understood usage of the term "experienced" refers to a person having the "practical knowledge, skill, or practice derived from direct observation of or participation in events or in a particular activity[47]". In this context, a typical pilot who completes pilot training, initial F-16 training, and is then assigned to an operational fighter wing, would be considered "experienced" in terms of practical knowledge, skill or practice derived from direct participation in a particular activity – flying an F-16. Obviously, a pilot who has been flying the F-16 for ten years is more experienced than one who has been flying it for two years. However, the purpose of basic pilot training (approximately a year in duration), F-16 initial training (approximately 7-8 months in duration), and the mission ready training after arriving at the operational wing (a few months in duration) is to provide a sufficient level of experience to proficiently operate the F-16 under routine and emergency conditions at home station and to successfully conduct combat sorties when deployed for military operations.

The other usage of the term "experienced" is a management tool used by the Air Force related to specific pilot flying time, i.e., seniority. It is a quantitative definition used to distinguish those pilots with more flying hours in the F-16 from those pilots with fewer flying hours. There is no qualitative assessment of an individual pilot associated with this quantitative categorization. A typical pilot who completes pilot training, initial F-16 training and is then assigned to an operational fighter wing, is considered "experienced" only after he has 500 hours of flying time in the F-16.[48] This classification is automatic when the pilot completes the requisite number of hours. There is no prescribed level of performance or any specific evaluation of skills associated with a pilot moving into the "experienced" category. It is worth noting that many pilots who flew combat missions in the Persian Gulf War, Bosnia, Kosovo, and Afghanistan were not categorized

[47] Merriam-Webster Collegiate Dictionary, electronic on-line version definition 2.a of "experience." at http://www.m-v.com/cgi-bin/dictionary.

[48] Pilots with different backgrounds who have transitioned into the F-16 after flying some other USAF aircraft do not require 500 hours in the F-16. If they have flown another fighter, they may be "experienced" with as few as 100 hours in the F-16.

as "experienced" for pilot career field management purposes. The success of those combat operations clearly shows that those pilots are highly capable, well trained aviators capable of handling the most difficult situations under the stress of combat. They have amply demonstrated that Air Force pilots in operational units are all "experienced."

Rather, the Air Force uses the "experienced" category primarily as a management tool. The general guidelines are to have a 60/40 split between "experienced" pilots and more junior "non-experienced" pilots in an operational fighter wing. This ensures there is adequate intake of new pilots into the force structure to maintain a viable fighter force over time as the senior pilots either fill non-combat positions, such as undergraduate pilot training instructors, non-flying headquarters staff positions, etc. and allow for normal attrition through retirement, routine separation from the Air Force, and transition to civilian life.

Q87. Did you see anything in the aircraft accident reports that indicated that a pilot failed to avoid a site on the ground in the event of an emergency because of inexperience?

A87. No. During our review of the 126 F-16 accident reports, there was nothing to indicate, in those cases in which a pilot took actions following an engine failure or other emergency in which he was able to control the airplane, that pilots with less experience would be more likely to fail to turn to avoid an inhabited area. As explained above and stated in the report (Aircraft Report, Tab H at 28 n.22), in all of those cases where inhabited areas were indicated as a consideration, pilots did in fact turn to avoid them. This is in accordance with the standard training provided to new pilots. Aircraft Report at 19-19a.

Further, there are three factors that mitigate any concerns raised by the State regarding pilot experience. First, those accidents that were assessed as accidents which could have happened in Skull Valley were randomly distributed across the pilot population. As stated in the original report, mechanical engine failures constituted the vast majority of these accidents. These engine failures would be independent of pilot experience.[49] Therefore, in assessing the ten years of accident reports, there was a reasonable distribution of these events over the spectrum of

[49] The State's witness claimed that this was incorrect. Horstman Decl. ¶ 63. However, we based our assessment of the likelihood of an engine failure on the aircraft accident reports, which included all of the F-16 pilots who were involved in accidents. Thus, any effect of pilot experience is captured in our analysis.

pilot experience. As a result, the Aircraft Report implicitly considers pilot experience in its analysis. Second, the report used a lower bound limit of 90% for the fraction of Skull Valley type accidents that would leave the pilot in a position from which he could maintain control of the aircraft after the initiating event for the emergency, as opposed to the 97% that is supported by consideration of the data in the F-16 mishap reports (see Aircraft Report, Tab H at 13-20). Use of the lower bound 90% fraction increases the calculated probability that an F-16 experiencing a mishap in Skull Valley would not be able to avoid the PFSF above what we believe the true value is. Third, in determining the fraction of pilots with control of their aircraft after a mishap who would fail to avoid the PFSF, we used a 5% allowance factor as a conservatism even though the analysis did not indicate such a conservatism was warranted. As discussed above, the F-16 mishap data support an assumption that in 100% of the cases in which a pilot remained in control of his aircraft after a mishap he would be able to avoid a site on the ground like the PFSF (i.e., according to the data, our allowance factor for the failure to avoid the PFSF could be set at zero).

Therefore, adequate allowance was made for pilot experience in our assessment. No change in our assumption that pilots would be able to avoid the PFSF in 95 percent of the mishaps that left the pilot in control of the aircraft is warranted.

(2) Weather Effects

Q88. Please describe the State's claim that PFS did not properly account for weather effects in determining the ability of a pilot to avoid the PFSF in the event of an in-flight mishap leading to a crash.

A88. The State asserts that cloud cover in Skull Valley will increase the risk of an F-16 impacting the proposed PFS site. See Horstman Decl. ¶¶ 64-74. The State claims that Skull Valley has at least 5/10 (five-tenths) cloud cover at or below 12,000 ft. AGL or lower 46.3 percent of the time in a given year and that, as a result, F-16 pilots would be unable to see and avoid the PFSF in the event of an engine failure or other emergency 46.3 percent of the time. Horstman Decl. ¶ 71; Resnikoff Decl. ¶ 34.

Q89. Do you agree with the State's claim?

A89. No. We disagree with the State's claim in two key respects. First, as discussed in the testimony of meteorologist Steven Vigeant, the State of Utah incorrectly interprets its cloud data and therefore incorrectly assesses the effect of cloud cover on the probability of an F-16 impacting the proposed PFS site. The State's claims are incorrect regarding 1) the fraction of the time a cloud ceiling would exist in Skull Valley and 2) the altitude at which the ceiling would exist. Second, the State incorrectly assumes that if there were a cloud ceiling in Skull Valley at the time a pilot experienced an in-flight emergency leading to a crash the pilot would inevitably be unable to guide his aircraft away from the PFS site.

Q90. Please describe the cloud cover data relied upon by the State and the respects in which the State incorrectly interprets its data?

A90. As described in the testimony of meteorologist Steven Vigeant, the State relies on the International Station Meteorological Climate Summary for Dugway Proving Ground ("Climate Summary"). The Climate Summary indicates the annual average fraction of the time there is greater than 50 percent cloud coverage, but it does not state the altitude at which the cloud cover exists nor does it state whether the cloud cover constitutes a ceiling. Significantly, the State does not account for the fact that its cloud cover data include instances in which the sky is covered in whole or in part by transparent or thin clouds (as opposed to opaque clouds) that do not contribute to a cloud "ceiling" and would not obscure a pilot's view of the ground.

The Climate Summary provided by the State, therefore, does not provide any useful data on the altitude of the various cloud layers nor of a pilot's ability to operate under visual flight rules (VFR), see the ground, or maintain general positional awareness using outside references. To have a better appreciation of the potential impact on flight operations in Skull Valley, it is necessary to have more detailed information concerning the actual weather and how it could affect the pilots' actions. Specifically, cloud ceiling data which indicate the altitudes at which opaque clouds would be located is needed to properly evaluate the effects of weather on a pilot's actions. As we will discussed further below, such data from the Air Weather Service for Michael Army Airfield shows that the limited occurrence of cloud cover in the Skull Valley area would allow pilots to visually locate the PFSF nearly all of the time. Thus, the Climate Summary data relied upon by the State does not mean that the PFSF would be invisible to F-16 pilots transiting Skull Valley 46% of the time.

Q91. Even assuming that a ceiling existed in Skull Valley at 12,000 ft. AGL or below at the time an F-16 pilot transiting the valley experienced an in-flight emergency, would the ceiling necessarily prevent him from seeing or avoiding the PFSF as claimed by the State based on its interpretation of the Climate Summary data?

A91. No. For example, there could be a solid deck of clouds at 12,000 ft. AGL with no clouds below that. Under those conditions it would be possible for the pilot to operate VFR under the cloud deck without any restrictions[50] and be able to maintain the required clearances of 500 ft. below, 1,000 ft. above, and 2,000 ft. horizontal from clouds. If the cloud deck were at 12,000 ft. AGL, this would allow VFR flight through all of the Sevier B airspace and approximately 6,000 ft. above it, up to approximately 16,000 ft. MSL. Under these circumstances, normally a pilot would simply fly under the cloud deck at 12,000 AGL and could do this easily in Skull Valley. Thus he would be able to see the ground.

If the pilot elected to operate VFR over the solid deck of clouds, he would not be able to see the ground, or any other features since the 12,000 AGL cloud deck would be above the Stansbury Mountains. In this situation, the pilot would use his Inertial Navigation System (INS) and other navigational aids such as the Tactical Air Navigation (TACAN) System,[51] the Horizontal Situational Indicator (HSI)[52] and, for those planes so equipped, the Global Positioning System (GPS) for navigation and positional awareness. Typically, this is done by reference to the navigation steer points along the preplanned route of flight. As part of his premission planning, the pilot will compute the distance and heading from one navigation steer point to the next. The pilot uses these onboard systems to maintain the desired ground track between points and maintain his positional awareness without having to see the ground. Further, in context of Skull Valley, due to the funneling effect of the MOA in the southern part of the valley, it would be reasonable for pilots to select a ground track that pointed them toward the center of the "neck" where the MOA narrows, just east of English Village and Dugway Proving Ground. This ground track and the buffer zone the pilots normally

[50] To remain under VFR in Skull Valley, the pilot must have 3 miles horizontal in-flight visibility below 10,000 ft. MSL (5 miles visibility is required above 10,000 ft. MSL).

[51] The TACAN provides the bearing and distance to a particular ground station that is selected at a given time. March 30 Response at 27-28.

[52] The HSI displays the bearing and distance to the selected navigation steering point and can be used to fly an exact course to that point. May 15 Clarification, Response to Question 4.

maintain would keep them away from the western boundary of the MOA next to UTTR restricted airspace, which slants toward the southeast in the southern portion of Skull Valley. This ground track would also tend to keep pilots away from the proposed PFS location as well. Thus, a pilot would be less likely to be near the PFSF in the event of an emergency and he would retain ability to avoid the site if he were near it.

In a second example, again assuming a ceiling of 12,000 ft. AGL based on the Climate Summary data as interpreted by the State, the total cloud coverage could be reported as 6/10, with a 1/10 layer at 3,000 AGL, a 2/10 layer at 5,000 AGL, 2/10 layer at 7,000 AGL, and a 1/10 layer at 12,000 ft. AGL. The sum of these is cloud coverage of 6/10 with a ceiling at 12,000 ft. AGL. When looking at the distribution of the coverage, however, it is apparent that F-16s could most likely fly VFR at any altitude up to 12,000 ft. AGL, the maximum altitude for cloud coverage assertedly contained in the Climate Survey. If pilots chose to fly at 3,000 ft.AGL, 5,000 ft. AGL, 7,000 ft. AGL, or 12,000 ft. AGL they might have to adjust portions of their route of flight depending on where the actual clouds were, but they could operate at any of those altitudes. If the pilots elected to fly above the highest layer of clouds, it is reasonable to assume that they could maintain their positional awareness with ground references such as mountain ranges, major roads, cultural features, etc., as well as with the INS and related navigational aids. While there will be specific points or features that might not be visible because of the cumulative cloud coverage, the pilot would still have awareness of the general location of those points and features as well as the location of the PFSF.

In a third example, the area could be 8/10 covered by low altitude clouds at 1,000 ft. AGL. This would preclude VFR operations below 1,000 ft.[53] In addition, it would preclude direct identification of most ground features in the relatively flat plain areas in and around Skull Valley. However, pilots could easily operate VFR over the clouds. In Skull Valley they would be able to maintain positional awareness using the portions of the Stansbury and Cedar Mountains that rise above the clouds and that portion of the ground which is still visible. In addition, their INS

[53] Air Force instructions prohibit flying below 1,000 ft. AGL in Skull Valley north of English Village on Dugway Proving Ground in any event.

would assist them with navigation as well. Thus, the pilots would retain ability to avoid the PFSF in the event of an accident.

There are innumerable variations to this theme, but they can conclusively show that in many, if not most, possible circumstances where there is cloud coverage a pilot flying through Skull Valley would still be able to see the PFSF or surrounding landmarks and his ability to avoid the site in case of an in-flight emergency would not be compromised by the clouds. Even in those cases in which he could not see the site, the pilot would be aware of its relative location because of the positional awareness he would maintain while flying through the valley. Thus, in most cases he would still be able to avoid the site in the event of an in-flight emergency.

Q92. Please describe your assessment of the weather in Skull Valley and what effects the weather would have on the ability of a pilot to avoid the PFSF in the event of an in-flight emergency in which the pilot retained control of the aircraft and had time to avoid the facility.

A92. A more detailed investigation of the cloud cover in Skull Valley shows that our original, conservative analysis adequately allows for the effects of cloud cover and that no further adjustments to the probability of an F-16 impacting the proposed PFS site are required. See March 30 Response, Question 9. PFS has obtained detailed ceiling and visibility weather information from the Air Weather Service (AWS) for Michael Army Airfield. This data, set forth at pages 29-32 of the March 30 Response, is described in the testimony of Steven Vigeant. The weather data for Michael AAF is a reasonable approximation for the weather in Skull Valley and the southern UTTR. As shown in the AWS data for Michael AAF (see March 30 Response at 29-32), F-16s transiting the Sevier B MOA (which according to the MOA usage reports include the great majority of the flights transiting Skull Valley) would encounter no ceiling and seven or more miles visibility 91.5 percent of the time. The airspace above Skull Valley up to the Positive Controlled Airspace at 18,000 ft. MSL, corresponding to the airspace for both the Sevier B MOA and the Sevier D MOA, would have no ceiling and seven or more miles visibility 74 percent of the time.[54] Thus, pilots transiting

[54] Sevier B is the predominant route of flight through Skull Valley. If a pilot were to elect to fly VFR above Sevier B he must remain below 18,000 ft. MSL, within the Sevier D MOA, to avoid the FAA's Positive Control Airspace (PCA).

Skull Valley would be able to visually locate the PFSF or its surrounding environment nearly all of the time. Moreover, as discussed above, even the presence of a ceiling would not necessarily preclude a pilot from seeing a site on the ground. Therefore, it is highly unlikely that cloud cover would prevent a pilot from avoiding the PFSF in the event an accident were to occur while transiting Skull Valley.

Figure 9-1[55] in the March 30 RAI response (Revised Addendum Tab FF) is a pictorial depiction of the vertical segregation of the airspace over Skull Valley and the corresponding historical ceiling and visibility based on the AWS data for Michael AAF. It shows that the Sevier B MOA has no ceiling and 7 or more miles visibility 91.5% of the time. For the airspace up to the Positive Controlled Airspace, encompassing both the Sevier B and Sevier D airspace, no ceiling conditions and visibility greater than 7 miles are observed 74% of the time. Figure 9-1 also shows that overall 70.5% of the time there is no ceiling and visibility is 7 miles or greater.

Figures 9-2 through 9-5 are examples of representative cloud coverage conditions that could occur under conditions of "no ceiling" and 7 miles or greater visibility. As shown in some of the examples, "no ceiling" does not necessarily mean "no clouds." As explained in the testimony of meteorologist Steven Vigeant, with respect to this data a ceiling is defined as a cumulative coverage of greater than half of the sky by opaque clouds. When there is no ceiling present, conditions are highly favorable for VFR operations. Figures 9-6 through 9-8 similarly depict illustrative examples of representative cloud coverage of "no ceiling" at 14,000 ft. AGL or below and 7 or more miles of visibility.

Figures 9-9 through 9-12 show examples of representative cloud coverage conditions corresponding to the ceiling and visibility conditions that predominate in the Sevier B MOA, which are no ceiling below 5,000 ft. AGL and 7 miles visibility. As can be seen from the AWS data, this is the prevailing ceiling and visibility condition 91.5% of the time. In essence, pilots should be able to maintain VFR in the Sevier B MOA the vast majority of the time.

[55] Note that the horizontal distance between the Stansbury and Cedar mountains is not to scale. The distance between the mountain ranges varies from approximately 18nm in the north to about 7nm in the southern neck of Skull Valley.

As discussed above, if there is a cloud layer or layers that preclude pilots from operating at specific altitudes, then they may operate VFR above or below those cloud layers as long as they meet the VFR weather requirements. Thus the presence of a ceiling does not necessarily prohibit VFR operations. As can be seen from the historical weather data, pilots have the option to fly through Skull Valley VFR in the Sevier B MOA approximately 91% or more of the time.

In addition to weather rarely prohibiting VFR operations in Skull Valley, in the event the weather did preclude VFR operations in Skull Valley, it is reasonable to assume that similar weather conditions would be present in the adjoining UTTR airspace. Therefore, one would anticipate the fighter squadrons would reduce their flying activities accordingly. Since most of the tactical training requires VFR conditions, there would be little training accomplished if there was extensive vertical and horizontal cloud cover on the range. Missions would be cancelled rather than uselessly flown.

In summary, the more detailed USAF Air Weather Service data demonstrates that the weather in Skull Valley clearly supports VFR flight operations. Indeed, the Air Force describes the UTTR as having "excellent" weather and visibility.[56] Further, the weather data shows that when cloud coverage is a factor, pilots will normally be able to conduct their training below the clouds rather than above them. The State's interpretation of the 46.3% cloud coverage greater than 5/10 is clearly not an accurate representation of the occurrence of ceilings or the amount of time a pilot will be able to maintain positional awareness using visual references. In addition, it does not account for pilots' general positional awareness using navigation systems when operating above an undercast, even if it obscures the ground. Also, it does not allow for probable ground tracks pilots would select to keep them from violating restricted airspace when operating over an undercast or the fact that those ground tracks would tend to keep pilots away from the proposed PFS site. Finally, it does not account for the cancellation of flight operations in Skull Valley due to poor weather.

[56] See PFS Exhibit W (" The climate at UTTR is generally arid . . . . Visibility and weather are excellent; 96 percent of hourly observations show ceilings of 3,000 feet or higher, and visibility of 3 miles or greater. Storms tend to be short in duration, with visibility exceeding ten miles during more than 95 percent of the year. Flight testing may normally be carried out 350 days of each year.")

Q93. What did your review of the F-16 accident reports show with respect to the effects of weather on the ability of a pilot to avoid an area on the ground in the event of an in-flight emergency that left him in control of the aircraft?

A93. All 126 F-16 Class A Flight mishaps were re-examined and the impact and effect of weather and cloud conditions at the time of each mishap were specifically assessed. Focus was placed on determining if the weather and cloud conditions influenced the pilot's behavior and performance in a way that would have prevented avoiding a structure like the PFSF. We identified a number of mishaps where the weather and cloud conditions could have affected the actions taken by the pilot during the emergency and which might have impeded the ability to avoid a structure like the PFSF in a setting similar to Skull Valley.

In two accidents in which pilots experienced engine failures above or in weather that prevented them from seeing the ground, the pilots specifically asked for vectors from ground controllers to avoid inhabited areas. In another case, the pilot descended below the clouds to clear the area before ejecting. In one other accident occurring below a low overcast, the pilot elected to reduce his zoom and stay below the clouds. This enabled him to keep sight of the ground and avoid hitting ground structures.

Notably, in only one instance with the pilot in control of the aircraft did the pilot eject above an undercast without taking action with respect to facilities on the ground, the scenario envisioned by the State that would cause a pilot to be unable to avoid the PFSF. This occurred in Europe where the pilot had been operating above an undercast at low altitude[57] and zoomed higher after experiencing engine problems, but could not see the ground. Had the accident occurred in Skull Valley, with this cloud deck, the pilot would have seen the surrounding mountains and still might have been able to avoid the PFSF.

Q94. What conclusion do you draw from the accident reports with respect to the effects of weather?

A94. We conclude that it is unlikely that weather would significantly reduce the likelihood that a pilot would be able to guide his aircraft away from the PFSF in the

[57] Assuming the pilot had a minimum of 1000 ft. above clouds for VFR flight, the top of the cloud deck could have been no higher than 3,000 ft. AGL.

event of an in-flight emergency that would leave him in control of the aircraft. In addition to our evaluation of the accident reports, which reflect that pilots can and do take steps to avoid facilities and populated areas on the ground under overcast weather conditions, this conclusion is further based upon the generally excellent weather in and around the UTTR for VFR flight and the positional awareness that pilots are able to maintain both by easily recognizable reference points in Skull Valley and use of the INS and other navigational aids.

In addition to evaluating the effect of weather on a pilot's ability to avoid a facility during an in-flight emergency that left him in control of the aircraft, our evaluation included accidents where weather was a factor in causing the accident. Thus, our evaluation of the accident reports appropriately incorporates the effects of weather into our assessment.[58]

Q95. In the end, what adjustments need to be made to your assessment to account for the effects of weather in Skull Valley?

A95. Based upon the detailed data provided, the subsequent analysis, and the conservatisms built into the analysis, the Aircraft Report adequately considers the impact of weather on the probability of an F-16 impacting the proposed PFS site. No adjustments to the analysis are required because of weather.

f. Likelihood that an In-Flight Emergency Would Leave the Pilot in Control of the Aircraft

Q96. In what respect does the State claim that PFS's analysis was incorrect regarding the probability that an in-flight emergency would leave a pilot in control of the aircraft with the ability to avoid the PFSF?

A96. The State claims that PFS has incorrectly analyzed F-16 engine failures that occurred during special operations (i.e., operations involving high-stress maneuvering on a training range), in that engine failures are not randomly distributed as PFS assumed. Resnikoff Decl. ¶ 85. Thus, the State claims that "the percentage of accidents deemed to be caused by engine failure is artificially raised for 'Normal Inflight' conditions." Id.

[58] As discussed above, the UTTR has "excellent" visibility and weather for in flight training and we did not see anything in our review of the accident reports to suggest that the weather in Skull Valley would result in accident rates higher than the rates exhibited by the F-16s in the Air Force as a whole.

The State also claims that PFS has incorrectly assessed and categorized the F-16 accidents described in the accident reports and thus has overestimated the probability that an in-flight emergency would leave a pilot in control with the ability to avoid the PFSF. See Horstman Decl. ¶¶ 34-59; Resnikoff Decl. ¶¶ 76-78.

Q97. How do you respond to the State's claims?

A97. We respond to the State's claims regarding each F-16 accident and its claim regarding the nature of F-16 engine failures below.

Q98. How did you assess the probability that an in-flight emergency would leave a pilot in control of the aircraft with the ability to avoid the PFSF?

A98. To assess this probability, we first jointly identified the evaluation parameters needed for performing the analysis and established precise definitions of these parameters, as set forth below. These evaluation parameters were chosen to enable various statistical evaluations of the data to be performed.) We then independently evaluated each accident report, using the parameters as defined below, to assess and determine: (1) the phase of flight in which the accident occurred (following the definitions of the DOE ACRAM study); (2) the cause of the accident, in particular whether the accident was caused by an engine failure, or some other cause; (3) whether the pilot remained in control of the plane long enough after emergency conditions began to be able to maneuver the aircraft to avoid a facility on the ground, such as the PFSF; (4) whether or not the accident occurred under flight conditions (airspeed, altitude, weather, maneuvering, etc.) that would be encountered near the PFSF in the Sevier B MOA by a transiting F-16; and (5) whether or not the accident could have otherwise reasonably happened in Skull Valley – i.e., whether the accident was caused by an event that could have occurred in Skull Valley (a "Skull Valley-Type Event").

After our independent evaluations, we undertook a joint review involving detailed discussions of each accident, which allowed us to consider and to incorporate into the analysis our respective expertise (e.g., Col. Fly's extensive F-16 flight experience, including flights through Skull Valley) and professional judgements. Although our independent reviews yielded nearly identical results, this combined review was undertaken to ensure consistency of the evaluation approach and analysis, and to jointly resolve the few minor discrepancies found. Thus, the final results of the review represents our combined professional judgements for each of the defined evaluation parameters, for each of the accidents assessed in the analysis.

The evaluation parameters provided the basis for determining the percentage of relevant F-16 crashes in which the pilot retained control of the aircraft and could avoid a specific site or area on the ground. The results of the analysis of the accident reports are set forth in Tab H of the Aircraft Report.

Q99. How do you define the evaluation parameters?

A99. The following evaluation parameters[59] were used in our analysis :

ACRAM Phase of Flight. The categories within this parameter are based upon the categories defined in DOE's Aircraft Crash Risk Analysis Methodology (ACRAM) Standard[60] and are a description of the aircraft phase of flight at the time of the accident. The categories are Takeoff & Landing (takeoff roll, abort/discontinue, initial climb portions of flight, & landing pattern, final approach, flare and rollout), Normal Inflight (climb to cruise, normal point-to-point flight, and cruise descent), and Special Operations (military maneuvering training such as "dog fighting", bombing practice, and low level navigation below 500 ft. AGL). Accidents were categorized in these three groups to provide a basis for determining those accidents of primary interest for Skull Valley transits, which are done in the Normal Inflight phase of flight.

Engine Failure. The "yes or no" categorization for this parameter is a function of whether the accident was caused by mechanical failure of the engine. Note: the State agrees with all the engine failure categorizations in our analysis. Therefore, we do not discuss the engine failure category further here.

Able to Avoid. The "yes or no" categorization for this parameter is our professional assessment of whether or not the pilot could have avoided the proposed PFSF if the accident had occurred in Skull Valley in the vicinity of the PFSF. It is based upon the specific circumstances under which the accident occurred, whether the pilot maintained control of the aircraft after the initiating event, etc.

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[59] Refer to the Aircraft Report, Tab H, para 1.B, pp. 9-13 for a detailed description of the categories.

[60] Kimura et al., "Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard" (August 1, 1996).

In some cases, the accident report specifically mentions actions taken by the pilot to maneuver the airplane to avoid or minimize potential damage to people or structures. Accidents are described as either 'Able to Avoid' or 'Not Able to Avoid'.

Sevier B MOA (Military Operating Area) Flight Conditions. The "yes or no" categorization for this parameter is our judgment as to whether the accident could have occurred in Sevier B MOA. This category is limited to those accidents which occurred in Normal Flight within the prescribed altitudes, airspeeds, weather, etc., under which the aircraft transit through the Sevier B MOA. According to the Air Force MOA Usage Reports, and corresponding information that we received from Hill AFB at the time of our analysis, the large preponderance of F-16s that fly over Skull Valley do so in the Sevier B MOA. Therefore, this category was used to assess the risk associated with the highest volume military traffic in the area. Accidents are labeled either "Sevier B MOA flight conditions" or "not Sevier B MOA flight conditions."

Skull Valley Type Event. The "yes or no" categorization for this parameter is our judgment as to whether the events leading to the accident could have occurred in Skull Valley. This broader category includes all accidents that could have reasonably happened in Skull Valley near the proposed PFSF even if they happened under circumstances not typically associated with flight through Skull Valley (altitude, airspeed, etc.). This broad category (which encompasses all the accidents in the Sevier B MOA Flight conditions category described above) was used for the first and most inclusive analysis in the Aircraft Report, Tab H. Accidents are labeled either "Skull Valley type event" or "not a Skull Valley type event."

Q100. In what specific respect did the State challenge what you did?

A100. The State challenged our categorization of individual accidents and it challenged our treatment of engine failures in our categorization process.

Q101. At the outset, how do you respond to the State's claim regarding the nature of F-16 engine failures?

A101. The State claimed that the percentage of accidents PFS attributed to engine failure in "Normal Inflight conditions" was artificially raised because engine failures are more frequent when an airplane is undergoing high stress maneuvers. Resnikoff

Decl. ¶ 85 (citing Horstman Decl. ¶ 38). The State also claimed that PFS's analysis was non-conservative because the category Skull Valley-type events improperly assumes engine failures have a random distribution. Resnikoff Decl. ¶ 85.

First, contrary to the State's claim (see Resnikoff Decl. ¶ 85), our assessment of the percentage of accidents caused by engine failure during "Normal Inflight" conditions was completely unaffected by any "Special Operations" engine failures. The "Normal Inflight" data, on which we based our evaluation for the Normal Inflight category, did not include any Special Operation accidents.

Second, our analysis of the Skull Valley type event category is not affected by a higher engine failure rate in Special Operations. Special Operations accidents which followed an event (e.g. engine failure) which could reasonably have occurred in Skull Valley are by definition included in our assessment of accidents in the "Skull Valley-type events" category. The following calculations show that when calculating a pilot's ability to avoid a site on the ground in the event of an accident, a higher F-16 engine failure rate in Special Operations than in Normal flight does not bias the result. According to the ACRAM study, F-16s flew approximately 8.3 E8 miles in Normal flight and 9.3 E8 miles in Special Operations between 1979 and 1993.[61] In the 10 years of accident reports we analyzed, we found 16 engine failures in Normal flight and 26 in Special Operations. Aircraft Report, Tab H, p. 12. Using the same ratio of miles flown between special operations and normal flight (1.12/1) with our FY89 to FY98 data, it may be seen that the relative engine failure rate per mile of flight between Special Operations and Normal flight is 1.45:1. This value may be used to normalize the failures in Special Operations to the failures in Normal flight to remove any bias based on relative engine failure rates from our calculation of a pilot's ability to avoid a site on the ground in the event of an accident.

The accidents that we classified as "Skull Valley-type events," (where the State claims that we have failed to account for the higher engine failure rate in Special Operations) included 25 engine failures in Special Operations, 15 engine failures in Normal flight, and 15 engine failures in Takeoff and Landing. See Aircraft

[61] Kimura et al., Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard at 4-13.

Report, Tab H, Table 2.[62] Our assessment showed that in every case of engine failure a pilot would have been able to avoid a site on the ground. The Skull Valley-type events also included 4 accidents not attributed to engine failure in which a pilot could have avoided a site on the ground and 2 accidents not attributed to engine failure in which he could not have avoided a site on the ground. Id. Thus, in our calculation, in 59 out of 61 Skull Valley-type events, or 97%, a pilot could have avoided a site on the ground. Tab H at 17. If our data is normalized to account for the engine failure rate in Special Operations, the number of Special Operations accidents that were Skull Valley-type events (25) would be divided by 1.45 (the ratio of engine failure rates per mile of flight in Special Operations to the rate per mile of flight in Normal flight) to yield 17.2 normalized Normal Inflight accidents. If the 25 Special Operations accidents in our original calculation were replaced by the 17.2 normalized accidents, then a pilot would be able to avoid a site on the ground in 51.2 out of 53.2 Skull Valley-type events, or 96.2% (compared to the 97% unadjusted rate from above). Therefore, in calculating the probability that a pilot could avoid a specific site on the ground for Skull Valley Type events, there is no significant difference in the impact of relative engine failure rates between Special Operations and Normal flight.

Q102. What did the State dispute with respect to your categorization of the individual accident report?

A102. The State's expert witness took issue with the categorizations of 12 specific accidents identified in PFS Exhibit X. Horstman 2nd Dep. at 133-35.[63] He further stated that the State had no issue with PFS's analysis of any of the remaining accidents. Id. at 131-32; 135. Each of the 12 accidents is addressed in chronological order below.

Q103. Please provide your assessment of the State's contentions concerning the May 25, 1990 accident.

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[62] We determined that one engine failure in Special Operations and one engine failure in Normal flight were not Skull Valley-type events.

[63] PFS Exhibit X is Table 1 to Tab H to the Aircraft Report which sets forth the results of our evaluation for each accident as marked up by the State's witness to show his disagreements with our categorization of the accidents. PFS Exhibit Y consists of the pages of the deposition transcript where the State's witness summarizes his area of disagreement with our categorization of the accident reports.

A103. Accident Synopsis.[64] This accident occurred during the day shortly after the start point for a planned 300 ft. AGL low level navigation run at 480 knots.[65] Descending toward the low level route start point, the lead and accident aircraft, radio call sign Otto 23, gave a visual signal for the flight to turn on course for the first leg of the low level run. During the turn, Otto 23, passed in front of and below Otto 24, his wingman. Otto 23 was in a shallow descent at the time. Otto 24 continued his turn, rolled out on heading, and looked over his right shoulder to reacquire Otto 23.[66] "Otto 23 completed his turn to a heading of 300 degrees and immediately impacted the ground."[67] At the time of the accident, all the aircraft systems were operating normally; weather was not a factor. This accident appears to have been controlled flight into the ground caused by pilot distraction and failure to properly monitor aircraft flight parameters. The report stated that the pilot was conscious at the time of the impact with his hands and feet on the controls.

We categorized this accident as one occurring in: 1) Normal Flight, 2) not Able to Avoid a specific ground site, and, conservatively, applicable to both 3) Sevier B MOA conditions and 4) the broader Skull Valley type events category, although we noted the accident was actually unlikely to occur in Skull Valley. Aircraft Report Tab H at 18. In fact, the accident occurred in a descending turn from approximately 1,000 ft. AGL down to the planned altitude of 300 ft. AGL. Since the Air Force considers low-level flight below 500 ft AGL to be a "demanding mission" that requires specialized training, the accident appropriately could be classified as special operations and not applicable to Skull Valley. Nevertheless, we conservatively included the accident in all three of our categories for analytical purposes.

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[64] See May 25, 1990 Aircraft Accident Investigation Report.

[65] In the summary of this accident on page 18 of Tab H to the Aircraft Report, the reference to "500 ft. AGL" in the first sentence of the summary should be "300 ft. AGL."

[66] During this type of turn it is common for one of the aircraft to lose sight of the other for approximately half of the turn due to steep bank angles in the turn. At any given time, however, at least one of the aircraft can see the other. The aircraft typically start and complete this type of turn from a line abreast position with 6,000 ft.-12,000 ft. lateral separation between the aircraft.

[67] May 25, 1990 Aircraft Accident Investigation Report at 3.

The State's expert witness had the following objection to the original categorization and analysis of the accident "I disagree with the PFS's assessment that the May 25, 1990 accident assessment is unlikely to occur in Skull Valley because pilots usually transit Skull Valley at 3,000 to 4,000 feet AGL."[68] This is an inaccurate statement of our rationale. Just prior to commenting that this was an unlikely event to occur in Skull Valley, we stated that (1) a descending turn to low level flight in the region near the PFSF would be inconsistent with normal flight entry procedures for Skull Valley[69] and (2) "pilots do not descend below 1,000 ft. within Skull Valley".[70] Because pilots do not fly below 1,000 ft. AGL in the portion of Skull Valley where the PFSF would be located, an accident involving a descending turn below 1,000 ft., such as happened in this accident, would not be expected to occur in Skull Valley.

However, during the July 2001 deposition, the State expert witness agreed with our classification of the accident with respect to all four of the categorizations used for the analysis (Normal ACRAM phase of flight, not Able to Avoid a specific ground site, Sevier B MOA conditions, Skull Valley type event).[71] Therefore, the only areas of disagreement are whether the aircraft flight path and maneuvering being performed by the pilot represents a typical entry and flight for Skull Valley and whether we were therefore conservative in including the accident in our analysis as a lower bound. Our original description of Skull Valley entry procedures[72] is accurate and representative of typical F-16 flight paths and maneuvers when entering Skull Valley. Because the accident involved a descending turn to 300 ft. AGL which would not be part of the planned flight through Skull Valley in the region of the PFSF – we continue to believe that we were conservative to include the accident in our evaluation of events that could occur in Skull Valley.

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[68] Horstman Decl. ¶ 43.

[69] As we stated there, the descent to the low level flight pattern for Skull Valley (usually around 3,000 to 4,000 ft. AGL) would occur "well north of the point at which the Sevier B MOA begins," which itself is well north of the PFSF.

[70] Aircraft Report, Tab H at 18.

[71] Horstman 2nd Dep. at 75-76; see also PFS Exhibits X and Y.

[72] Aircraft Report, Tab H, p. 18.

Q104. What is your analysis of the State's contentions about the PFS analysis of the 19 Sep 90 accident?

A104. Accident Synopsis.[73] This was a night low-level accident that occurred as the pilot was preparing for a simulated bombing attack using the radar. The accident occurred over a heavily wooded area with no moon illumination or visible horizon. The aircraft impacted in a shallow descent with approximately 9 degrees of right bank. The aircraft systems were operating normally at the time of impact. Information in the report indicates the pilot was conscious and performing routine cockpit tasks at the time of impact, but unaware that the aircraft was in a shallow descent. This accident was controlled flight into the ground caused by the pilot failing to adequately monitor aircraft flight parameters.

We categorized this accident as 1) Special Operations flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA event and 4) not a Skull Valley type event.

The State disagreed with our categorizations in three areas, asserting that the pilot was not Able to Avoid a specific ground site and that the accident should be considered a Sevier B MOA and a Skull Valley type event.[74]

The State agreed with our assessment that this was a Special Operations flight.[75] Special Operations includes air-to-ground bombing and gunnery training and low-level night navigation.[76]

Our analysis concluded that loss of situational awareness due to lack of visual outside references was the key cause of this accident. (The State concurs that this accident was caused by the pilot losing situational awareness. Horstman Decl. ¶ 45.) As noted in the accident report, "[t]he aircraft impacted in an undeveloped, heavily-wooded, and swampy area."[77] The report further states "[t]he horizon

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[73] September 19, 1990 Aircraft Accident Investigation Report at 2-3.

[74] Horstman Decl. ¶ 45; PFS Exhibits X and Y.

[75] Horstman 2nd Dep. at 71.

[76] C. Y. Kimura, et al., Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard, Lawrence Livermore National Laboratory, UCRL-ID-124837 at 4-4 to 4-5 (August 1996); Aircraft Report at 11-12.

[77] September 19, 1990 Aircraft Accident Investigation Report at 3.

was not clearly discernable at the crash site"[78] and "[t]he moon illumination was zero".[79] Thus, outside visual references that are normally used, consciously and subconsciously, to help maintain aircraft attitude awareness and orientation were clearly absent.

In contrast, the PFSF within Skull Valley will be well lit and easily visible at night under normal visibility conditions in the Skull Valley area.[80] According to the PFS lighting consultant, the PFSF will be illuminated at a level equivalent to a highway or interchange in a major metropolitan area, i.e. at a level 20 to 50 times that of full moonlight.[81] Based on our extensive experience flying at night the PFSF will be clearly visible and stand out from the air at significant distances, particularly given the lack of other significant light sources in the area surrounding the proposed PFSF. This large, illuminated area will be an easily recognizable, external, visual reference that pilots can use to help maintain their aircraft pitch and roll orientation after passing the lights on Interstate 80 as they enter Skull Valley. The illumination of the site will also allow pilots to see and avoid it in the event of an accident.

Based upon information in the accident report, it appears that the pilot was in control of the aircraft but failed to recognize it was in a shallow descent and flew into the ground. The following sequence of events is based upon information in the report.

1. The lead and accident aircraft, radio callsign Nobby 91, departed the Initial Point (IP)[82] and turned approximately 80 degrees to the right toward the target. Airspeed for this leg of the flight was to be 540 knots.
2. Twenty seconds later, Nobby 91 made a radio call directing the flight to turn on their video cassette recorders, set the switch to record the radar scope, and place the armament switch in the "simulate" position.

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[78] Id. at 6.

[79] Id.

[80] The PFSF restricted area (RA) in which the storage pads and the CTB are located will encompass approximately 99 acres. The RA will be illuminated 24 hours a day. Light will be delivered by 130 foot high poles that will support four 1,000 watt high pressure sodium vapor lamps. The fixtures will be installed and oriented to illuminate the facility while minimizing off-site glare. PFS Environmental Report §§ 2.1.1 and 4.2.8.2 at pp. 2.1-2, 4.2-12 and 4.2-13.

[81] Memorandum from Todd Roup, Holophone, Inc., to Jeff Johns, Stone & Webster, Inc. (Jan. 7, 2002).

[82] The initial point is the last point on the route of flight prior to the target.

3. Shortly thereafter, ten to fifteen seconds, the fireball from Nobby 91's impact with the ground was sighted by Nobby 92, the wingman, who was approximately 8 miles behind in trail. The aircraft attitude at impact was a "shallow descent . . . and approximately nine degrees right bank" and with "an airspeed of greater than 480 knots."[83]

   Further, information in the report indicates the pilot was functioning normally but unaware of his shallow descent rate. "Life sciences equipment findings indicated that at the time of impact, the mishap pilot's head was in an erect posture and was looking slightly left and downward.[84] . . . The right hand was in contact with the control stick. The left hand was not in contact with the throttle control and the left arm was angled away from the body and extended toward the inboard aspect of the left instrument console. . . . All findings support that the pilot was accomplishing some action with his left arm, and was also apparently looking down in this same general area, when cockpit disintegration occurred."[85]

   Thus, all the information in the report indicates that the pilot had become preoccupied with internal cockpit tasks during the simulated bombing pass and, due in part to the lack of any outside visual cues, failed to notice the high-speed, shallow descent into the ground.

   The well lit PFSF will provide the sense of horizon and aircraft attitude references that were clearly absent in the heavily wooded area in which this accident occurred. We therefore believe that this pilot would have been able to avoid a specific (lighted) ground site. Since the pilot was clearly involved in the Special Operations flight phase, he would not be in either the Sevier B MOA environment or a Skull Valley type event since F-16s do not make simulated radar bomb passes against "targets" in Skull Valley. Hence, this accident had no effect on our calculation of a pilot's ability to avoid a site in Skull Valley in the event of an accident.

Q105. How do you respond to the State's contention concerning the 20 Feb 91 accident?

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[83] Id. at 3.

[84] Id.

[85] Id.

A105. Accident Synopsis.[86] This accident was caused a mechanical failure of the engine. The aircraft was at 18,000 ft. MSL (16,000 AGL) when the first engine anomalies occurred. The pilot turned toward the nearest suitable base[87] for landing. After the engine failed, the pilot tried, unsuccessfully, to restart the engine. He then continued his approach and ejected when it became clear he would not be able to glide to the runway. The aircraft impacted approximately 3,200 ft. short of the runway.

We categorized this accident as occurring in the 1) Landing phase of flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, but 4) part of the Skull Valley type event category.

The State agrees with us in all categorizations except for the ACRAM phase of flight,[88] which it contends should be "Normal".

As indicated in the Aircraft Report, Tab H, pg. 9, the ACRAM phase of flight category reflects the phase of flight the accident aircraft was flying when it was destroyed. As noted previously, the ACRAM study defined "landing" crashes as those that occurred within 10 miles of the end of the runway, when the aircraft is on approach to landing.[89] Thus, the original classification for ACRAM phase of flight as 'Landing' is correct and consistent with the ACRAM study. The place and circumstances at the time of the accident, not the time and place of the initial problem, are the determining factors. The aircraft was in the process of an attempted landing when it impacted the ground approximately 3,200 ft. from the runway. The pilot ejected shortly prior to that when it became apparent he would not be able to successfully glide to the runway. Although the initial engine problems were experienced at 18,000 ft. MSL (16,000 ft. AGL) in excess of 15NM from the field, this accident clearly falls within the ACRAM definition for landing.

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[86] See February 20, 1991 Aircraft Accident Investigation Report.

[87] Diyarbakir Air Base, Turkey. The report does not explicitly state how far the aircraft was from the base at the onset of the problem. However, after the pilot turns toward the base, the narrative indicates the pilot was then 15 miles away. Therefore, it is reasonable to assume the pilot was in excess of 15 miles at problem onset.

[88] Horstman Decl. ¶ 46; Horstman 2nd Dep. at 81-82; PFS Exhibits X and Y..

[89] DOE-STD-3014-96 at B-9; Kimura et al., Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard at 4-4.

From a statistical perspective, if it were to be reclassified as in the "Normal" phase of flight as the State has suggested, this would result in a higher calculated probability of the pilot being able to avoid a specific ground site in the "Normal" category. The statistical analysis for the other categories would be unaffected.

Furthermore, the report states that while en route to the emergency landing airfield, "Captain Strom could see the ground and determined it was safe to jettison his wing fuel tanks and ordnance to reduce the drag enhancing the glide potential."[90] Later on, the report states that after descending through the clouds, "[i]t was now readily apparent to Captain Strom that he could not glide to the runway so he concentrated on preparing for ejection. He checked his flight path and determined that there was nothing to harm, no inhabited areas or buildings."[91] This is one of the several accident reports which indicate the pilot did consider the surrounding environment prior to jettisoning external stores or ejecting.

Q106. Please comment on the State's contention concerning the 19 Mar 91 accident.

A106. Accident Synopsis.[92] Approximately 7 minutes after takeoff while climbing through 19,000 ft. to 20,000 ft. altitude the accident aircraft's Stores Management System (SMS) failed.[93] The pilot recycled the SMS power and reset the system. It functioned normally for approximately one minute at which time the SMS failed a second time. Very quickly thereafter, the pilot had his first indications of an oil/hydraulic malfunction. The pilot advised his flight lead that he had an emergency and turned back toward the departure base intending to land. A series of other electrical and hydraulic system problems ensued as those systems continued to degrade while the pilot flew toward the airfield. Approximately 4 to 5 minutes after the first indications of a problem, the aircraft started an uncommanded barrel roll type maneuver and the pilot ejected. Weather was not a factor.

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[90] February 20, 1991 Aircraft Accident Investigation Report at 3-4.

[91] Id. at 4.

[92] See March 19, 1991 Aircraft Accident Investigation Report.

[93] The Stores Management System is a panel in the cockpit used to tell the onboard computers what fuel tanks, ordnance, and other items are loaded onto the airplane.

We categorized this accident as occurring in 1) Normal flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, but 4) a Skull Valley type event.

The State agrees with the PFS analysis with exception of the "Able to Avoid" categorization.[94]

The State initially incorrectly stated that the pilot could not have avoided the proposed PFSF because of the altitude at which the pilot ejected and the forecast weather. The State contended, incorrectly, "[t]he pilot ejected at 9,800 feet above ground level. The pilot would not have been able to see the proposed PFS facility due to scattered clouds at 4,000 and 8,000 feet above the ground". Horstman Decl. ¶ 47. The accident report contradicts the State's assessment of the weather conditions at the time of the accident. The report provides the following forecast weather conditions "Forecast weather at 0400Z/0800L was scattered clouds at 4000 feet, 8000 feet, and 25,000 feet, visibility 9000 meters with haze...."[95] However, the next sentence in the accident report states, "[t]he supervisor of flying, Captain Craig, reported the weather as clear at the time of the accident." Id. at 8-9. Captain Craig's statement on actual weather conditions is supported by Spider 31, the pilot of the aircraft who was flying in a chase position (aft and clear) of the accident aircraft prior to and at the time of the pilot ejecting, "Spider 31 witnessed the aircraft fall like a leaf after ejection and flat plate into the ground." Id. at 4. Therefore, there is no basis for the State's contention that weather was or could have been a factor in obscuring the pilot's ability to see a facility on the ground.

Six months later, the State added the accident aircraft's loss of control prior to the pilot ejecting as an additional reason this accident should be classified as a "not Able to Avoid."[96] Although the State acknowledges the pilot turned toward an emergency field and maintained control of the aircraft for 4-5 minutes after initial indications of a problem, they do not agree the pilot could have avoided the pro-

[94] Horstman Decl. ¶ 47; Horstman 2nd Dep. at 87; PFS Exhibits X and Y.

[95] March 19, 1991 Aircraft Accident Investigation Report at 8.

[96] Horstman 2nd Dep. at 84-87. This contention was not included in the January 30, 2001 declaration.

posed PFSF. The State contention is based upon the pilot's inability to control the aircraft for an unspecified amount of time just prior to ejection.

Our assessment considered the fact that the pilot maintained control of the aircraft for 4-5 minutes after the initial indications of a problem relevant to the analysis. If the pilot were operating in or near Skull Valley, there would be ample time to turn and proceed toward Michael Army Airfield, the nearest emergency airfield to Skull Valley.[97] In the ensuing 4-5 minutes, the pilot would be well clear of the proposed PFSF.

Therefore, the original analysis that the pilot would be 'Able to Avoid' is correct and proper.

Q107. What is your analysis of the State's contentions regarding the 4 Apr 91 accident?

A107. Accident Synopsis.[98] This accident occurred while the flight was maneuvering in a fighting wing formation.[99] The flight was operating clear of clouds but between multiple cloud layers. The accident aircraft, radio call sign Rally 14, started a slow clearing turn away from his leader, Rally 13. Rally 14 then perceived movement by Rally 13 toward Rally 14. Rally 14 started a series of aggressive turns away from Rally 13 in response to this perceived motion by Rally 13. The resultant series of maneuvers, based in part upon the pilot's misinterpretation of the actual aircraft attitude, placed Rally 14 in an approximately 65° nose low attitude. The pilot's attempts to correct the situation were ineffective, in part due to his misunderstanding of the aircraft attitude and misapplication of corrective inputs. The pilot, believing that ground impact was imminent and that the aircraft was not responding to control inputs, ejected. This accident was caused by the pilot incorrectly assessing aircraft flight parameters and response to control inputs while maneuvering between cloud layers.

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[97] Refer to the Aircraft Report, Tab A for a map of the area. It is approximately 16 miles from the proposed PFSF to MAAF, roughly $2^{1/2}$ minutes at typical F-16 speeds flown in Skull Valley.

[98] See April 4, 1991 Aircraft Accident Investigation Report.

[99] Fighting wing is a formation designed for maneuverability, the wingman (Rally 14) flies approximately 30° to 60° aft of the leader's wingline and normally 500 ft.-1,500 ft. away. Tab H, p. 19, footnote 17.

We categorized this accident as occurring in 1) Normal flight, 2) not Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, but 4) a Skull Valley type event.

The State agrees with the PFS categorization of this accident with the exception of whether this occurred in Sevier B MOA flight conditions.[100]

According to the USAF MOA usage reports the majority of aircraft overflying Skull Valley do so by transiting through the Sevier B MOA.[101] Therefore, this category was established to mirror the Sevier B MOA flight conditions and parameters. As noted in the Aircraft Report[102], this category is defined as "...conditions which match the conditions of an F-16 transiting the Sevier B MOA near the PFSF would experience in terms of altitude (between 1000 to 5000 ft. AGL)...."

The Sevier B MOA extends to approximately 5,000 ft. AGL. This accident occurred between 7,000 ft. AGL and 8,000 ft. AGL. Thus, the accident occurred outside the criteria for the Sevier B MOA flight conditions and it should not be included in this category.

The Aircraft Report recognizes that there were F-16 accidents which occurred under circumstances that do not meet the strict definitional requirements for the Sevier B MOA but which could have occurred in proximity to the proposed PFSF. These accidents are included in the Skull Valley Type Events category[103] and their potential risk to the proposed site is evaluated in the report. F-16's are very unlikely to descend through multiple low altitude cloud layers to enter the low altitude environment while transiting Skull Valley. Nevertheless, although the report states that the 4 Apr 91 accident would be unlikely to occur in Skull Valley (footnote Tab H, page 19), it was conservatively included in the Skull Valley Type Events category and, since it occurred in the normal phase of flight, it was included in the ACRAM Normal category as well. Thus, the potential risk to the proposed PFSF is included in both categories in the Aircraft Report. Therefore,

[100] Horstman Decl. ¶ 44; PFS Exhibits X and Y.

[101] See note 54, supra.

[102] Aircraft Report, Tab H, p. 12.

[103] Aircraft Report, Tab H, p. 15

the State's disagreement would not affect the analyses under either of those categories.

Q108. What is your analysis of the State's contentions concerning the 8 Jun 91 accident?

A108. Accident Synopsis.[104] The F-16 flight, aircraft radio call signs Tex 21 and Tex 22, were proceeding from their working area toward Ellington AFB, Texas, to land. The first indications of Tex 22's pending engine failure occurred as the flight was passing through 4,000 ft. altitude MSL[105] while in their descent to 3,000 ft. into the landing pattern. Tex 22 attempted to maneuver for a straight-in, engine out landing pattern while the engine continued to deteriorate. Tex 22 ejected approximately 10 miles from the base.

We categorized this accident as 1) Landing phase of flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, but 4) a Skull Valley type event.

The State contends that the ACRAM phase of flight should be "Normal" and that the accident should be classified as "Unable to Avoid." It agrees with us on the other categorizations.[106]

As noted in Aircraft Report[107] and earlier in this testimony,[108] the ACRAM landing phase includes the area within approximately 10 miles of the runway when the pilot is maneuvering for a landing.

In this case, the flight had already departed the working area and was approaching Ellington AFB to land. At this time, there were no indications of any mechanical problems. They had decided to fly an Instrument Landing System (ILS) approach and were in a descent passing through approximately 4,000 ft. to 3,000 ft. when Tex 22 began experiencing problems. Tex 22 had slowed to 200 knots, an airspeed typically associated with the landing pattern and well below normal cruise

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104 See 8 June 1991 Aircraft Accident Investigation Report.

105 Ellington AFB is close to sea level, so far the purposes of this discussion MSL and AGL may be considered to be the same.

106 Horstman Decl. ¶ 48; PFS Exhibits X and Y.

107 Aircraft Report Tab H, p. 10.

108 See February 20, 1991 Aircraft Accident Investigation Report.

speeds. This type of maneuvering and the crash location are consistent with the ACRAM Landing phase of flight. As stated earlier, the ACRAM standard states that "[i]n military aviation, landing crashes are more widespread and extend up to 10 miles beyond the end of the runway."[109] Therefore, the original classification as "Landing" was correct.

The State further contends that the pilot could not have maneuvered to avoid the proposed PFSF because of the weather.[110] However, the accident report contains information which indicates that both pilots were able to see the ground and take action to avoid a site on the ground. First, the accident report states "Although 3,500 feet visibility with broken cloud formations was the official forecast, rain showers in the area precluded an overhead approach…."[111] The statement implies that it was the rain showers, which tend to be localized, which were the deciding factor and that the existing visibility was such that the pilots at least considered a visual approach. Second, during the descent to 3,000 ft., Tex 22 did a series of "S turns" to generate spacing behind Tex 21. Tex 22 subsequently stabilized at a distance of two miles in trail behind Tex 21. "S turns" for spacing are done clear of clouds. If pilots need separation while in the weather, it is done: 1) by one aircraft (the wingman) reducing power while maintaining the aircraft heading, 2) by turning to an Air Traffic Control radar directed heading (establishing divergent vectors between the aircraft), or 3) a combination of the two. Third, the report states that Tex 21, the lead aircraft two miles in front of Tex 22, "noticed and pointed out several possible impact areas for the aircraft and called this to [the pilot's] attention. At this time the external centerline fuel tank was jettisoned."[112] Finally, the report states that the pilot "was considering where to point the aircraft"[113] when he noticed that the engine had (temporarily) restarted. This clearly indicates that the ground could be seen at least some of the time and that these potential impact areas were within a reasonable distance of the aircraft flight path. While the report is silent as to the location of the possible impact areas (i.e., it does not state if they were on the extended flight path or off to the sides) and

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[109] DOE-STD-3014-96 at B-9.

[110] Horstman Decl. ¶ 48; Horstman 2nd Dep. at 94.

[111] June 8, 1991 Aircraft Accident Investigation Report at 2.

[112] Id. at 3.

[113] Id.

whether or not the pilot actually maneuvered the aircraft to point toward them, it is worth noting that the "aircraft impacted...into an undeveloped, partially wooded tract" and the jettisoned, external centerline fuel tank "fell into a similar area."[114]

Thus, our conclusions that this accident occurred in the Landing phase of flight and that the pilot could have avoided the proposed PFSF are correct and clearly supported by the information in the aircraft accident report.

Q109. What is your assessment of the State's contention concerning the 31 July 92 accident?

A109. Accident Synopsis.[115] This accident occurred shortly after takeoff, at night (4:00 a.m.) and in poor weather. The accident aircraft, Retro 34, was number four (4) of eight (8). Shortly after takeoff, the pilot of the accident aircraft (Retro 34) made a radio call that he had acquired the aircraft ahead of him on his radar, and then a second call that he had a "problem". The pilot ejected just prior to aircraft impact and was killed. The plane crashed approximately 7 miles from the air-field. The airframe and aircraft systems were functioning normally prior to im-pact.

PFS categorized this accident as in the 1) Takeoff phase of flight, 2) not Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident and 4) not a Skull Valley type event.

The State contends this accident should have been classified in Normal flight, and as a Sevier B MOA and a Skull Valley type event.[116] The State agrees with PFS that the pilot would not have been able to avoid the proposed facility.

Our analysis is based upon the following logical sequence of events.[117]

1. Retro 34, the accident aircraft, takes off (number four of eight).
2. Shortly after takeoff, Retro 34 enters the weather.[118]

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[114] Id.

[115] July 31, 1992 Aircraft Accident Investigation Report.

[116] Horstman Decl. ¶ 49; PFS Exhibits X and Y.

[117] See July 31, 1992 Aircraft Accident Investigation Report at pp. 2-4.

3. Retro 34 establishes radar contact with the airplanes in front of him (indicated by the "fours tied" radio call).
4. Retro 34 becomes spatially disoriented ("fours got a problem" radio call).
5. Retro 34 is unable to maintain control of his aircraft due to spatial disorientation.
6. Retro 34 realizes he is in a very dangerous situation and ejects.
7. Retro 33, who had 4 of the 5 aircraft that took off behind in sight, makes a radio call to the aircraft he erroneously assumes is Retro 34 directing him to turn right. At that time the actual Retro 34 impacts the ground (70 degrees nose low, 20 degrees right bank). The flash in the clouds caused by the explosion[119] is seen by Retro 31 and Retro 33.

The State has incorrectly assessed the timing of the events, specifically when Retro 34 (the accident aircraft) experienced the problems leading up to the accident.

The State contends that a lightning strike caused the accident[120] and occurred at the same time Retro 33 (the aircraft that took off 20 seconds before Retro 34) made a radio call to Retro 34. This is inconsistent with the timing and sequence of events listed in the report. The last radio call made by Retro 34 was "fours got a problem".[121] The report then states "...after Retro 34 made his radio call on VHF about a problem, there were numerous other transmissions on the UHF as well as VHF (none from Retro 34)".[122] It was after these "numerous other transmissions" that Retro 33 made the "turn right" radio call to Retro 34. This radio call was coincident with the flash in the clouds. Therefore, it is clear that Retro

Footnote continued from previous page

[118] The reported weather at the time of the accident was 1,000 ft. overcast, intermittent 700 ft. overcast, visibility 7 miles, intermittent 3 miles light rain, winds were 320 at 10 knots, thunderstorms in the vicinity with tops of the overcast weather at 4,500 ft. and clear above. See July 31, 1992 Aircraft Accident Investigation Report at 3. There are no reports of lightning in the accident report.

[119] The State contends that the fireball from the crash could not have been seen through the weather although there is no factual basis provided for that conclusion. In addition, the State has mistakenly stated the accident occurred during the day instead of at night. See Horstman 2nd Dep. at 107-108.

[120] Id. at 104, 107.

[121] July 31, 1992 Aircraft Accident Investigation Report at 3.

[122] Id.

34 was experiencing problems prior to the flash and that the flash which the State assumes was lightning[123] – was not coincident with the initiating event.

Second, at the time of the flash, Retro 33 (the third aircraft) had sight of four of the five aircraft[124] that had taken off behind him. Thus, if Retro 34 had been flying the prescribed flight path and altitudes, he should have been above the clouds and in a position to be seen by Retro 33 at the time of the alleged lightning strike.

Third, the report states "the airframe and aircraft systems evaluated were functioning normally prior to impact".[125] While this does not rule out the possibility of a lightning strike, it does make the probability that lightning caused the accident by inducing an unspecified malfunction highly unlikely.

Our analysis attributed the accident to spatial disorientation encountered shortly after takeoff when the pilot entered the weather. This is consistent with the weather (1,000 ft. ceiling with an intermittent 700 ft. ceiling, tops of the overcast 4,500 ft. and clear above).[126] In addition, the transition from visual flight conditions at takeoff using the runway lights and the surrounding environment for reference, to instrument flight conditions in the weather is difficult. This transition can be further complicated during night operations because the pilot often cannot see the clouds and does not know when he will be entering the weather.

There are supporting elements to this analysis which are not brought out in the accident report. First, when a pilot becomes spatially disoriented, he may have difficulty properly assessing the current aircraft attitude and the operation of the aircraft systems. He may then focus on these problems to the exclusion of making radio calls. Thus, Retro 34's radio silence after making the "fours got a problem" radio call is not unprecedented. Second, if the pilot is severely disoriented, it may be very difficult for the pilot to control the aircraft. Thus, Retro 34 may not have been able to fly the prescribed ground track for the takeoff and departure ("right

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[123] The State agrees that Aircraft Accident Investigation Report does not state that the aircraft was struck by lightning. Horstman 2nd Dep. at 108.

[124] July 31, 1992 Aircraft Accident Investigation Report at p. 3. The report does not identify which aircraft they were.

[125] Id. at . 6.

[126] Id. at 3.

turn on course").[127] If Retro 34 was unable to maintain the same ground track as the rest of the flight, this could the explain Retro 33's observation that one of the aircraft was further back than it should have been. If the four aircraft Retro 33 had in sight were Retro 35-38,[128] the gap in spacing reported by Retro 33 would be explained by the absence of Retro 34.

Finally, the State contends that the accident should be categorized as ACRAM "Normal" instead of "Takeoff". There is nothing in the report to indicate the accident aircraft ever entered into a "normal" phase of flight. The problems leading up to the accident began shortly after takeoff and the pilot never successfully transitioned to the normal phase of flight. In addition, the aircraft impacted approximately 7 miles from the airport which is consistent with the ACRAM takeoff categorization. Therefore, the original classifications of this accident as in the Takeoff phase of flight and not Sevier B MOA or Skull Valley type events were correct.

Q110. What is your assessment of the State's comments concerning the September 16, 1997 accident?

A110. Accident Synopsis.[129] This accident occurred after takeoff at night during a stair-stepped climb to cruise altitude enroute to the planned working area. The flight had made a short intermediate level off at 7,000 ft. altitude and was in a climb to 14,000 ft. at the time of the accident. The flight was planning to use Night Vision Goggles (NVGs) in the working area and had gone through initial steps to calibrate the NVGs. While doing this, the pilot in the trailing aircraft failed to properly monitor his airspeed and closure on the lead aircraft. As a consequence, the trailing aircraft hit the leading aircraft and led to the loss of one airplane and significant damage to the other. The accident was caused by pilot error.

We categorized this accident as 1) in the Takeoff phase of flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, and 4) not a Skull Valley type event.

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[127] Id.

[128] The accident investigation report does not identify which four aircraft Retro 33 had in sight at the time of the flash.

[129] See September 16, 1997 Aircraft Accident Investigation Report.

The State contends the accident should be classified as in the "Normal" flight category, not Able to Avoid a specific ground site and as both a Sevier B MOA type accident and a Skull Valley type event.[130]

Originally, we did not categorize the accident as a Skull Valley type event because we believed at the time of the analysis that the 388th FW did not have or use night vision goggles, so this type of collision would not occur in or around Skull Valley. Further, the crews in this accident were attempting to put the night vision goggles on prior to entering any maneuvering flight, and we did not believe it reasonable to assume that the 388th pilots would attempt to do this at the lower altitudes in Skull Valley if they had such goggles.[131] Therefore, we believed that this accident was simply irrelevant to what could occur in Skull Valley in the vicinity of the PFSF. However, we have since learned that the 388th FW has begun using night vision goggles as part of their training program. Based upon this new information, although climbing stair-step to 14,000 ft. AGL does not appear likely to occur before or over Skull Valley, this accident could now be possibly classified as a Skull Valley type event (i.e. an event which could have occurred in Skull Valley even though it was not a true Skull Valley profile.)

Second, we had also originally evaluated the aircraft as being Able to Avoid a specific site on the ground because the pilots continued to fly it for 30 seconds after the midair collision which would be enough time to turn to avoid a site on the ground. Although the pilots attempted to fly the airplane for approximately 30 seconds after the impact, from the accident report it appears that both hydraulic system lines had been ruptured during the collision and the pressure in both hydraulic systems went to zero shortly after the impact. Since at least one hydraulic system must be operating to position the flight controls, this loss of all pressure would preclude the pilots from being able to effectively change the flight path or control the aircraft. Upon further consideration, although the pilots attempted to fly the aircraft, it is unlikely that the pilots would actually have had control over the aircraft for sufficient time to direct it away from a site on the ground. Consequently, we now believe that this accident should be considered "not Able to Avoid."

[130] Horstman Decl. ¶ 50; PFS Exhibits X and Y.

[131] We believed that they would have put them on before entering Skull Valley.

Third, we classified the accident as not occurring under "Sevier B MOA flight conditions" because it occurred well above the maximum altitude of Sevier B MOA. The State's contention that the accident should be classified as a Sevier B MOA accident is simply incorrect, since the collision occurred at 14,000 ft. AGL, well above the maximum Sevier B MOA altitude of 5,000 ft. AGL. Moreover, as we noted above, in our view it is unlikely that pilots would attempt to put on night vision goggles while transiting Skull Valley within the altitudes of the Sevier B MOA. Thus, our original classification was correct.

Finally, we originally evaluated the accident as occurring during the "Takeoff" phase of flight. The aircraft had just taken off and was in an initial stair-step climb on its way to its cruise and initial operating altitude. The ACRAM study[132] defines the Takeoff phase of flight as including the initial climb portion of a flight so it is appropriate for this accident to be categorized as such. Also, in evaluating the parallel with an F-16 taking off from Hill AFB, such an aircraft will climb to a level off altitude over the Great Salt Lake, cruise at that altitude for a short time, then begin a cruise descent into Sevier B MOA. The portion of flight prior to the level off could be considered as the initial climb after takeoff.

Citing the altitude the aircraft had reached (13,760 ft.) and its distance from the airport (40 nm) at the time of the accident, the State contends that the plane was no longer in its initial climb but in cruise climb, which is part of the normal phase of flight under the ACRAM definition. We recognize that the point at which an aircraft transitions from "initial climb," considered part of the take-off phase under ACRAM (and which often may be a stair-step climb as occurred here), to "cruise climb," part of the normal phase of flight under ACRA,M, is not clear cut and may be the subject of reasonably differing professional opinions. If one were to accept the State's position on this judgment call, this accident could be considered to have occurred in the "Normal" phase of flight.

Thus, because we now have new information regarding the use of night vision goggles and having reconsidered our previous assessment of some of the other facts regarding the accident, it would no longer be categorized as Able to Avoid,

[132] Kimura et al., "Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard" at 4-4.

and it might also now be categorized as in Normal flight and as a Skull Valley type event. It would remain, however, not a Sevier B MOA type event.

If these different categorizations were incorporated into our probability calculations, the probability of being able to avoid a specific ground site in the Skull Valley type event case would decrease slightly (to at least 59/62 from at least 59/61, or at least 95% vs at least 97% (Aircraft Report, Tab H, page 20). With respect to the ACRAM Normal flight category, the probability of avoidance would decrease slightly also, from a range of between at least 89% to 100% to a range of between at least 85% to 95% (Aircraft Report, Tab H, page 25). The probability in the Sevier B MOA case (Aircraft Report, Tab H, page 27, at least 89% to 100%) would not change.

Q111. How do you assess the State's comments concerning the February 19, 1993 accident?[133]

A111. Accident Synopsis.[134] This accident occurred while on a bombing range. The accident aircraft, callsign Rolex 24, had just completed its fifth bombing pass when the first indications of an engine problem occurred. The pilot quickly terminated further bombing range activities, climbed to just below the cloud cover at 2,000 ft. while trying to determine the nature of the problem and take appropriate actions. The situation continued to degrade to a confirmed fire. Shortly thereafter, the aircraft began an uncommanded pitch up maneuver and entered the clouds. The pilot ejected. The accident was caused by an engine failure which led to a fire.

We categorized this accident as occurring in 1) Special Operations flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, but 4) a Skull Valley type event.

The State originally contended that this accident should be classified as being not Able to Avoid a specific ground site.[135] The State first erroneously claimed that the pilot intentionally flew up into the clouds and was unable to see the ground[136]

[133] The State incorrectly listed this accident as the "February 2, 1993" accident in paragraph 51 of the January 30, 2001 Horstman declaration. This error was corrected in the July 2001 Horstman deposition, page 117.

[134] See February 19, 1993 Accident Aircraft Investigation Report.

[135] Horstman Decl. ¶ 51; PFS Exhibits X and Y.

[136] Id.

when, as discussed below, in fact the uncommanded climb occurred 26 seconds after the onset of the emergency from a level below the clouds. Six months later, the State added that it should also be classified in the Normal flight phase and that it was a Sevier B MOA type event.[137]

As noted in the accident report "The Mishap Pilot, Rolex 24, had just completed his fifth bombing pass and his turn to downwind[138] at 400-450 KCAS, when he heard and felt a loud 'bang' or 'thump.'"[139] It is clear that the pilot was on the range actively involved in bombing passes. The ACRAM data development document states that "special in-flight includes low level and maneuvering operations in restricted airspace."[140] Therefore, the general flight category of "special operations" is appropriate.

The accident report (at page 2) states that the "mishap pilot immediately initiated a climb to achieve maximum altitude available below the cloud cover deck." About 26 seconds later, the plane began an uncontrolled climb up into the clouds. Id. at 3. The State acknowledges the mishap pilot maintained control of the aircraft for approximately 26 seconds prior to the onset of the pitch up maneuver.[141]

Although, the State does not give any credence to a pilot taking actions to avoid the proposed PFSF if the facility were a factor, our analysis did. Bombing ranges are by necessity located in sparsely populated areas. Therefore, pilots do not routinely have to take into consideration areas such as the proposed PFSF when they encounter mechanical problems on the range because they are not there. However, it is reasonable to assume that if this engine failure had occurred in Skull Valley, the pilot would have been cognizant of something such as the proposed PFSF and would have taken action to avoid it in the 26 seconds while attempting to identify the nature of his problem and take other appropriate actions.

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[137] Horstman 2nd Dep. at 134.

[138] "Downwind" is a part of the bombing pattern heading away from the target (it is not related to the wind direction).

[139] February 19, 1993 Aircraft Accident Investigation Report at 2.

[140] Kimura et al., Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard at 4-5; see also Aircraft Report at 12.

[141] Horstman 2nd Dep. at 108.

Finally, at the time of the accident, the mishap aircraft was making bombing passes. Dropping ordnance in the Sevier B MOA is strictly prohibited, therefore including this accident in the Sevier B category is inappropriate.

However, because it was a mechanical failure of the engine, it is appropriate to include the accident as a Skull Valley – type event, as was done in Tab H of the Aircraft Report. As stated earlier, this broader category includes all accidents from causes that could have reasonably happened in Skull Valley near the PFSF, even if they happened under circumstances not associated with flight through Skull Valley.

Therefore, our categorization of this accident as in Special Operations flight, Able to Avoid a specific ground site, and not a Sevier B MOA type accident is correct.

Q112. What is your assessment of the State's contentions concerning the 13 Jan 95 accident?

A112. Accident Synopsis[142]. This accident was caused by an engine failure during a low level navigation flight. The pilot was flying in Belgium between 5,000 ft.-7,000 ft. MSL over an undercast when the engine problems started. The pilot zoomed the aircraft and attempted to restart the engine. The pilot ejected as the aircraft was descending toward the clouds, approximately 1 minute and 44 seconds after the onset of the engine failure.

We categorized this accident as occurring in 1) Normal flight, 2) Able to Avoid the PFSF, 3) a Sevier B MOA type accident and 4) a Skull Valley type event.

The State agrees with the initial analysis with the exception of the pilot being Able to Avoid the PFSF. The State contends that the undercast clouds would have precluded the mishap pilot from avoiding the proposed PFSF.

When reviewing this accident, it is important to remember that the terrain and population distribution in Belgium and Skull Valley are radically different. The terrain in Belgium tends to be characterized by rolling low hills, with towns, villages and farms distributed throughout. Skull Valley, on the other hand, is marked by flat terrain, with relatively high mountain ranges on both sides. In addition, the population in Skull Valley is very small, with the only concentration

[142] See January 13, 1995 Aircraft Accident Investigation Report.

anywhere near the PFSF being the approximately 30 Skull Valley Band members who live in the tribal village, approximately 3.5 miles east-southeast of the PFS site. See FEIS at 2-1 to 2-3.

At the time of the engine failure, the pilot was flying at approximately 4,000 ft. AGL.[143] Since the aircraft had to be at least 1,000 ft. above the clouds, the clouds could have been no higher than 3,000 ft. AGL. Had the pilot been flying in Skull Valley over this undercast, the Stansbury Mountains on the eastern side of the valley would have been clearly visible, thereby providing the pilot with an excellent visual reference to assist in maintaining his situation awareness. In addition, portions of the Cedar Mountains to the west may also have been visible. Therefore, the pilot would have had visual cues to help assist him with his navigation and general positional awareness that would not typically be available under similar weather circumstances in Belgium.

Due to the lack of any other significant cultural features in Skull Valley, the proposed PFSF will become well known with respect to its location within the Valley. In fact, although we do not agree with the supposition, the State has alleged that the F-16 pilots would be likely to use the site at a turning point or a sensor update point. Therefore, there is general agreement by both parties that the location of the PFSF within Skull Valley will be well known by the pilots.

It is therefore reasonable to assume that a pilot who experiences an engine problem above a low undercast in Skull Valley would be cognizant of the approximate position of the PFSF and would be able to take reasonable measures to avoid it, if necessary.

We therefore correctly categorized this accident as being one in which the pilot is Able to Avoid a specific ground site.

Q113. Please provide your assessment of the State's comments concerning the 29 Jan 97 accident.

A113. Accident Synopsis.[144] ORCA 2, the accident aircraft, was in the egress phase of his first bombing attack when the engine failed. He zoomed and turned toward

[143] January 13, 1995 Aircraft Accident Investigation Report at 3, para 5.

[144] See January 29, 1997 Aircraft Accident Investigation Report.

Gila Bend AFAF, approximately 12.5 miles away, intending to fly a straight in emergency pattern and landing. He was unable to restart his engine or to glide to the field. He ejected and the aircraft impacted approximately 2.5 miles from the airfield.

We categorized this accident as 1) in the Landing phase of flight, 2) Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, but 4) a Skull Valley type event.

The State agrees with our analysis with the exception of the phase of flight. The State contends that this accident should be classified as in "Normal" flight instead of "Landing."[145] The State has made two errors in its analysis, the first on the phase of flight, the other concerning the cause of the engine failure.[146]

As noted previously,[147] this is a definitional issue. The pilot was attempting to fly an engine flamed-out approach and landing; when it became obvious he would not be able to glide to the runway he ejected. As the accident report stated, "A few seconds later, ORCA 2 [aircraft radio callsign] felt the MA [mishap aircraft] vibrate violently and, realizing he had lost engine power, continued a zoom climb toward Gila Bend AFAF, Arizona approximately 12.5 miles to the northwest. He intended to land at Gila Bend by performing a straight in flameout approach."[148] The report goes on to state "[t]he aircraft impacted the ground on government property approximately 2.5 miles southeast of Gila Bend AFAF…."[149] It is clear that this accident falls well within the ACRAM category for landing, which includes accidents within 10 miles of the end of the runway. Even if the initiating event were considered by itself, it occurred while the aircraft was in a high –speed egress from the target on a bombing range, which is part of Special Operations, not Normal flight.

[145] PFS Exhibits X and Y.

[146] Horstman Decl. ¶ 52.

[147] Aircraft Report, Tab H, p. 10; responses in this testimony to the State's contentions concerning the February 20, 1991, June 8 1991 and July 31, 1992 accidents.

[148] January 19, 1997 Aircraft Accident Investigation Report at 2, para 4.

[149] Id. at 2, para 5.

Second, the State erroneously states that the engine failure was caused by a bird strike.[150] Although the pilot initially assumed "he had hit a bird or bomb fragment,"[151] the problem was in fact caused by internal engine component failure. As noted in the report, "[a] fatigue crack in the attachment area of a fourth stage blade grew over time to the point at which the remaining material could no longer support the normal operating stresses to which the blade was subjected."[152]

Thus, the original analysis categorization of this accident as occurring in the AC-RAM Landing phase of flight is correct and the accident was caused by a mechanical failure of the engine.[153]

Q114. What is your assessment of the State's contentions concerning the 13 May 98 accident?

A114. Accident Synopsis.[154] This accident was caused by the impact of at least five American White Pelicans,[155] weighing 12.5-15.5 pounds while the accident aircraft was flying at 830 ft. AGL and 520 knots.[156] The bird impacts caused significant damage to the airplane, the cockpit and the engine. The pilot ejected immediately after striking the birds.

We categorized this accident as occurring in 1) Normal flight, 2) not Able to Avoid a specific ground site, 3) not a Sevier B MOA type accident, and 4) not a Skull Valley type event.

The State agrees with the original analysis with the exception that it contends the accident should be classified as a Skull Valley Type event.[157]

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[150] Horstman Decl. ¶ 52.

[151] January 29, 1997 Aircraft Accident Investigation Report at 2, para 4.

[152] Id., p. 4, para 13.a.

[153] Even if the State's logic were correct, increasing the number of Normal accidents would increase the calculated probability that a pilot would be able to avoid a site on the ground in the event of an accident.

[154] See May 13, 1998 Aircraft Accident Investigation Report.

[155] Id at 1, para 3.a.

[156] Id. at 3, para e.

[157] PFS Exhibits X and Y.

There were three main considerations which were evaluated during our original analysis which eliminate this accident from reasonably occurring in Skull Valley, and thus eliminate it from the Skull Valley type event category.

First, according to information provided to us by PFS, there are no flocks of large birds in the Skull Valley area near where the PFSF is proposed. There is no water in Skull Valley near the PFSF to attract such birds and none have been observed in the Valley.

Second, the pilot was flying below 1,000 ft. AGL at speeds significantly higher than typically flown in Skull Valley. According to the Air Force, bird strike rates decrease significantly as altitude increases. Approximately 83.1% of all bird strikes during low level cruise and range operations occur at altitudes of 1,000 ft. or below.[158] Flying higher than the 840 ft. where this accident occurred significantly reduces the risk of striking a bird. Since the F-16s are required to fly above 1,000 ft. AGL and generally fly at 3,000 to 4,000 ft. AGL, the risk of any birdstrike is very low. In addition, the very high speed (540 knots) of the 13 May 98 accident significantly increases the kinetic energy associated with the birdstrike ($E=1/2MV^2$), giving the bird carcass more power to penetrate a windshield/canopy or do other serious damage to the aircraft. The much lower speeds (350 to 400 knots) typically flown by the F-16s in Skull Valley greatly reduce the risk of canopy being penetrated.

Third, according to the Air Force, the nearest birdstrike to Skull Valley on record for the last 15 years was 25 miles away, across the Cedar Mountains in the UTTR. The next closest on record was 37 statute miles away. In these 15 years, none of the 7 birdstrikes within 50 miles of the PFSF occurred at an altitude over 800 ft. AGL.[159] This was also corroborated by the Hill AFB staff, which stated that the likelihood of a bird strike in Skull Valley was so low that it was normally not a part of mission planning.[160]

[158] Air Force Safety Center's bird strike database.

[159] Air Force Safety Center's Bird Avoidance Model.

[160] NRC/Hill AFB September 7, 2001 Meeting Summary.

Due to these three factors, our analysis was correct in discounting this scenario as one that could be reasonably expected to occur in Skull Valley and therefore not including it as a Skull Valley type event.

Q115. Do any of the State's challenges to PFS's assessment of the F-16 accident reports give you any reason to change your assessment of the probability that an F-16 transiting Skull Valley would crash and impact the site.

A115. The assessment we conducted was analytically sound, carefully conducted and professionally analyzed. Our reference materials for the assessment were 10 years worth of USAF 51-503 Accident Investigation Board Reports, which constitute the best and most authoritative source material for such assessment. In only one case, the mid-air collision on September 16, 1997, is a revision logical, and this is based on new information concerning the use of night vision goggles at Hill AFB. We had previously thought that they were not in use there and discounted this accident as irrelevant to our analysis. On further examination, as elaborated in the discussion above, one might change our classification to "Skull Valley-type event" and "Normal" phase of flight. Assuming such changes in the accident classification results in a change to our calculated probability of being able to avoid a specific ground site in the Skull Valley type event classification, from at least 97% to at least 95%. With respect to the ACRAM Normal flight, the probability of avoidance would decrease slightly also, from a range of between at least 89% to 100% to a range of between at least 85% to 95%. The probability in the Sevier B MOA case would remain the same: at least 89% to 100%. Since these new rates still support our conservative assessment of a 90% probability of a pilot being able to avoid a specific site on the ground, we believe our original assessment should stand unchanged.[161]

g. Statistical Inferences from F-16 Data

Q116. How does the State take issue with PFS's drawing of statistical inferences from its F-16 accident data?

[161] Moreover, there are accidents we conservatively included in our categorizations that we could have excluded. As discussed above and in Tab H of the Aircraft Report, we could have excluded the accidents of 25 May 1990 and 4 April 1991 (the 4 Apr. 91 was already excluded from the Sevier B MOA category). This would have increased the calculated probability of being able to avoid a site on the ground.

A116. The State claims that it is inappropriate for PFS to project the future on the basis of historical F-16 accident data, in that frequency distributions must be subject to statistical manipulation to meaningfully project future probabilities. Dr. Resnikoff asserts that PFS cannot project F-16 accident rates on the basis of historical data because it is impossible to tell where on the slope of an expected trend the current accident rate lies. Specifically, Dr. Resnikoff asserts that "accident rates for planes generally exhibit a decreasing, then steady, then increasing rate over the lifetime of service." Resnikoff Decl. ¶ 86.

Q117. Is the State correct?

A117. No. We, have analyzed over 10 years of data regarding F-16 accidents of reports of using a large and stable statistical sample 121 out of a possible 139 destroyed F-16 aircraft, and have also assessed the effects that might result from the introduction of new aircraft into the Air Force in the future. The State's theory behind this argument is that accident rates will exhibit the "bathtub effect" and thus will increase as the F-16 becomes older. Id. We have addressed this theory above and have shown that it has no basis in fact as far as the F-16 is concerned. The State has not provided any other reason to believe that accident rates for aircraft transiting Skull Valley will increase over the life of the PFSF. With no further facts or explanations regarding accident rate trends to support the State's claim, it is mere speculation.

Q118. Does the State take issue with PFS's use of F-16 crash statistics in any other respect?

A118. Yes. The State claims that PFS's assessment "fails to account for 16 out of 142 destroyed F-16s (Class A accidents) which may significantly skew its frequency distribution." State Mot. Resp. at 15; see Horstman Decl. ¶ 37. The State claims that PFS should assume that all of the missing accident reports should be assumed to fall into the categories that would produce the highest calculated crash impact probability. See State Mot. Resp. at 15 n.18.

Q119. Is the State correct?

A119. No. We requested the accident reports for all F-16 Class A mishaps in Fiscal Years 1989 through 1998 (10 years). We initially obtained a total of 122 F-16 accident reports from the Air Force out of a total of 142 Class A F-16 mishaps for the period from FY89 to FY98. Aircraft Report, Tab H. Subsequently, in June

2000, the Air Force found and provided four additional mishap reports, which PFS accounted for in the August 2000 revision of the report. Id. In total, we have reports for 121 out of 139 F-16s that were destroyed in the period from FY 89 to FY 98.[162] The Air Force stated that the reports that it did not provide to us were lost and could not be located or were never prepared.[163]

Given the Air Force's statement as to why it did not provide the reports to us, the missing reports should be treated as being removed from the population of destroyed F-16 reports at random, i.e., there is no correlation between the lost reports and the events that occurred during the mishaps reported, the units the F-16s were from, or the conditions under which they were flying. In fact, the large number of reports we have analyzed makes our statistical evaluation of F-16 crashes and the likelihood that a pilot would remain in control of a crashing F-16 using those reports robust and not subject to doubt on the grounds alleged by the State.

h. Conclusion Regarding State Challenges to PFS F-16 Assessment

Q120. What are your conclusions regarding the State's challenges to your assessment of the probability that an F-16 transiting Skull Valley would crash and impact the site?

A120. We have fully evaluated the State's challenges and, as set forth above, no change is warranted to our conclusion regarding the probability that an F-16 would crash and impact the site.

C. Aircraft Conducting Training on the UTTR

1. PFS Assessment

Q121. What kind of operations are conducted on the UTTR?

A121. Aircraft on the UTTR South Area conduct a variety of activities, including air-to-air combat training, air-to-ground attack training, air-refueling training, and transportation to and from Michael Army Airfield (which is located beneath UTTR

[162] Note that a Class A mishap does not necessarily constitute a destroyed aircraft. We have focused on destroyed aircraft because they are relevant to the potential hazard to the PFSF.

[163] Letter from Col. David R. Stinson, USAF, Deputy Director Communications and Information Systems, Air Combat Command, May 5, 2000.

airspace). Aircraft Report at 29. Issues regarding aircraft conducting air-to-ground attack training and weapons testing using air-delivered ordnance and aircraft conducting air refueling training were resolved by summary disposition. See Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-01-19, 53 NRC 416, slip op. at 41 (2001). In this testimony we address hazards posed by aircraft flying to and from Michael Army Airfield on Dugway separately from the hazards posed by UTTR operations per se. (See Section E below) Thus, the only activity we consider at this point is air-to-air combat training on the UTTR.

Q122. What hazard do aircraft conducting air-to-air combat training on the UTTR pose to the PFSF?

A122. We assessed it to be a negligible hazard and moreover the State's witness Lt. Col. Horstman agrees with us.[164] As discussed on pages 17-20 of the Revised Addendum, we concluded that the hazard to the PFSF from aircraft conducting air-to-air combat training on the UTTR is negligible relative to other aircraft crash hazards, i.e., less than 1 E-8. This is primarily because the activity on the UTTR occurs too far away from the PFSF to pose a hazard to the facility. This conclusion is supported by two points in our analysis:

- First, our assessment, set forth in Tab Y of the Aircraft Report, of the F-16 crash reports for accidents occurring during special in-flight operations (i.e., operations involving aggressive maneuvers on a training range) in which the pilot does not maintain control of the aircraft (e.g., a mid-air collision or G-induced loss of consciousness) indicates that most such accidents would occur toward the center of the restricted ranges and that most likely such crashing aircraft would travel less than 5 miles horizontally before impacting the ground.

- Second, our assessment of accidents in which a pilot does maintain control indicates that invariably the pilot would steer the aircraft away from a large facility on the ground, such as the PFSF, and would particularly have the capability to do so from a distance of five miles or more.

The PFSF is located 2 miles from the UTTR restricted areas and, on the basis of where F-16s fly on the UTTR, our analysis assumed a 3-mile buffer zone just inside the UTTR restricted areas as a practical limit in defining where aircraft do

[164] See Horstman 1st Dep. at 218.

not fly while conducting aggressive maneuvering flight operations in UTTR restricted areas. See Aircraft Report at 37c-37d, 39. Aggressive maneuvering, during simulated air-to-air engagements at visual or beyond visual ranges tends to take place toward the center of the restricted areas. Id. at 37-37a. Aircraft will be separated from each other by greater distances during beyond visual range intercepts, but even in those exercises they will tend to remain more than 10 miles from the boundary of the restricted area range. Id. at 37a. Any maneuvering that takes place closer to the boundary is routine and low risk. Id. Furthermore, the Cedar Mountains provide a clear visual indication to pilots of the eastern edge of the restricted area and Clover Control provides warnings to pilots as they approach within 5 miles of the edge of the restricted area to prevent them from straying outside. Id. at 37c. Therefore, the 3-mile buffer zone that we used in the model reflects what actually takes place on the range and corresponds to the practical limit that pilots observe while flying training exercises on the UTTR. Id. at 37d.[165] Thus, the PFSF is located 5 miles east of the closest point at which an event leading to a crash would be expected to occur. Hence, a crashing aircraft on the UTTR either would not be able to reach the facility before impacting the ground (if it were out of control) or would be steered away from the facility (if it were in control).

Therefore, since aircraft on the UTTR would rarely if ever operate within five miles of the PFSF, the hazard posed to the PFSF by aircraft operation on the UTTR would as a practical matter be zero. Furthermore, in addition to our analysis, the State's witness, Lt. Col. Hugh Horstman, agrees that aircraft operating on the UTTR would pose no hazard to the PFSF.[166]

Q123. Please elaborate on the point regarding the likely location for crashes on the UTTR.

A123. As stated in Tab Y of the Aircraft Report, the aggressive maneuvering on the UTTR most likely to result in an accident in which a pilot does not maintain control of the aircraft occurs toward the center of the restricted area ranges, not near the edges. Our analysis of the F-16 mishap reports further shows that virtually all

[165] See also AFI 13-212, UTTR SUPPLEMENT 2 (TRAINING) 23 OCT 2000 ¶ 3.2.4 ("Aircrews will maintain their own separation when established in assigned working sectors and maintain a 2 ½ mile buffer zone from all external boundaries.").

[166] Horstman 1st Dep. at 218.

of the accidents on the UTTR in which a pilot would not maintain control of the aircraft would occur during high-stress, aggressive maneuvering and that the crashing aircraft do not travel far from the point at which the event causing the mishap occurs. Even in the event of G-induced loss of consciousness, which is the type of accident that would not leave the pilot in control but would cause the aircraft to travel the greatest distance before hitting the ground, the aircraft would travel no more than about five miles. We reached these conclusions based on our Air Force flight experience as well as our in-depth analysis (as part of our review of the 126 F-16 mishap reports) of the 35 reports concerning special inflight operations accidents in which the pilot could not have avoided a ground facility. Therefore, accidents on the UTTR that did not leave the pilot in control of the aircraft would not pose a hazard to the PFSF.

Q124. Please elaborate on the pilot's ability to avoid the PFSF if he remained in control of the aircraft after an in-flight emergency.

A124. If an in-flight emergency did leave the pilot in control of his aircraft, then, as discussed in the Aircraft Report (Section III.A.5 and Tab H, p. 28, note 22), the pilot would be able to direct his aircraft away from the PFSF. Throughout the F-16 mishap reports we reviewed, there were numerous references to the pilot consciously considering vulnerable structures or populated areas on the ground and turning his aircraft so as to avoid them. In no case was it mentioned that a pilot had the opportunity to avoid a facility or populated area on the ground but failed to do so. That data supports assigning a percentage approaching zero for the likelihood that a pilot with the time, opportunity and awareness of the PFSF would fail to direct a crashing F-16 away from the facility.

Furthermore, by its very purpose, the UTTR, itself, is a significant safe area to receive a descending aircraft (thereby increasing a pilot's opportunity to avoid a manned site on the ground). Therefore, an aircraft experiencing an engine failure in the restricted areas of the UTTR would not glide across the Cedar Mountains toward the PFSF in the middle of Skull Valley – which would be over 5 miles away and off the range – and impact it while under a pilot's control. The extensive training program for military pilots instills a responsibility to avoid inhabited, populated areas if possible in the event of an emergency in order to avoid harm to the general public. Therefore, if a pilot were to suffer an in-flight emergency in the restricted areas of the UTTR that left him in control of the aircraft (e.g., an engine failure), before ejecting he would guide the aircraft toward an open area on the range where the aircraft would do no collateral damage when it struck the ground before ejecting or toward Michael Army Airfield on Dugway Proving Ground if the aircraft were within range to make a forced landing there.

Q125. In conclusion, what hazard to the PFSF would be posed by air operations on the UTTR?

A125. This analysis shows that, as a practical matter, air operations on the UTTR pose no risk to the PFSF. Indeed, Lt. Col. Horstman, the State's expert witness, readily agreed that "if an airplane has a problem up there [on the UTTR], it's not going to make it to Skull Valley, it's going to go to Michaels [Army Airfield] or it's going to crash before it gets there, it's that simple." Horstman 1st Dep. at 218 (Revised Addendum Tab BB). This confirms our conclusion of no consequential hazard to the PFSF, and it is reasonable to conclude that aircraft conducting training on the UTTR pose a negligible hazard to the Facility.

Q126. Did you ever calculate that aircraft conducting air-to-air combat training on the UTTR posed a different hazard to the PFSF?

A126. Yes. In Section IV of the Aircraft Report, we conservatively calculated the theoretical hazard posed by air-to-air combat operations on the UTTR to the PFSF using the following relationship:

$P = C_a \text{ x } A_c \text{ x } A/A_p \text{ x } R$, where

P = annual crash impact probability

C_a = total air-to-air training crash rate per square mile on the UTTR

A_c = the area of the UTTR from which aircraft could credibly impact the PFSF in the event of a crash (i.e., the "cut-out" area)

A = effective area of the PFSF in square miles

A_p = the footprint area, in which a disabled aircraft could possibly hit the ground in the event of a crash

R = the probability that the pilot of a crashing aircraft would be able to take action to avoid hitting the PFSF

In the Aircraft Report, using crash rate data as of FY 1998, we calculated a probability of 7.35 E-8 for risk from the UTTR based on the assumption that aircraft experiencing an in-flight emergency within 10 miles of the PFSF that led to a crash could possibly impact the PFSF. Aircraft Report at 43-44. However, as we noted in the Report, because of substantial conservatism in the calculation "the true impact hazard would be much lower" and "as a practical matter, air operations on the UTTR pose very little, if any, risk to the PFSF." Id. at 44.

As discussed above, based on our analysis of actual uncontrolled aircraft crashes in the Special Operations flight phase, we believe that the correct assumption is that only a crashing aircraft on the UTTR within 5 miles of the PFSF—not 10 miles—would have some chance of impacting the PFSF. As shown in Section IV.8 of the Aircraft Report, if one were to incorporate the 5-mile distance within which a crashing aircraft might pose a hazard to the PFSF into its analysis, which would be more than amply supported by the accident data, it would define the "cutout area" (A_c) (the area from which an aircraft could possibly impact the PFSF in the event of a crash) by drawing an arc with a radius of 5 miles centered at the PFSF. Because the PFSF is five miles from the edge of the area inside the UTTR restricted areas in which pilots conduct aggressive maneuvers that could result in a crash, this reduces the calculated hazard for aircraft operating on the UTTR effectively to zero. Therefore, following the same methodology, we can conclude, based on our assessment of the special operations accident reports, that the hazard to the PFSF of aircraft operating on the UTTR is negligible relative to other aircraft crash hazards, i.e., less than 1 E-8.

Q127. Why did you change your assessment?

A127. As noted above, we re-evaluated our original theoretical analysis in light of the actual F-16 accident report data we later received and concluded that the hazard probability to the PFSF from aircraft operating on the UTTR is negligible relative to other aircraft crash hazards, i.e., less than 1 E-8. The primary and controlling factor is that the activity on the UTTR occurs too far away from the PFSF to pose a hazard to the facility.

2. State Challenge

Q128. Did the State challenge PFS's assessment regarding the hazard posed to the PFSF by aircraft operations on the UTTR?

A128. Yes. The State challenged PFS's conclusion that air-to-air combat training over the UTTR would not pose a significant potential hazard to the PFSF. State Mot. Resp. at 22. The State then challenged specific data used in PFS's former crash impact assessment method (aircraft crash rate and probability that a pilot would be able to direct his aircraft away from the PFSF) and claimed that the impact probability would be higher than that formerly calculated by PFS. See State of Utah's Statement of Disputed and Relevant Material Facts (Jan. 30, 2001) ¶¶ 55-59; Resnikoff Decl. ¶ 43, Exh. G; Horstman Decl. ¶¶ 88-90.

Q129. Are the State's challenges still relevant to PFS's conclusion that air-to-air combat training on the UTTR would pose a negligible hazard to the PFSF?

A129. No. The State used our former assumption that any aircraft on the UTTR within 10 miles of the PFSF site experiencing an emergency leading to a crash might hit the site and simply changed the other input data in our former approach and produced a crash impact probability higher than the one we had formerly calculated. We kept the former analysis in the motion for summary disposition but we also noted that based on our most recent analysis the hazard for the UTTR was as a practical matter zero.

Q130. Did the State of Utah consider or address your new assessment based on actual F-16 accident reports?

A130. No. The State did not consider the new assessment in its response to PFS's motion for summary disposition—it only challenged various inputs to our former hazard calculation methodology and failed to address the fact that air combat training on the UTTR takes place too far from the PFSF to present, as practical matter, a threat to it. As we noted above, however, the State's expert witness, Lt. Col. Horstman, agreed in a deposition that "if an airplane has a problem up there [on the UTTR], it's not going to make it to Skull Valley . . . ." Horstman 1st Dep. at 218. Therefore the State's expert agrees with our assessment.

D. Aircraft Flying on the Moser Recovery

1. PFS Assessment

Q131. What is the Moser Recovery Route?

A131. Most of the F-16s returning to Hill AFB from the UTTR South Area exit the northern edge of the range (away from the PFSF) in coordination with air traffic control. However, some aircraft returning to Hill from the UTTR South Area may use the "Moser recovery route," which runs from the southwest to the northeast, with the centerline of the route approximately two miles from the PFSF site.

Aircraft Report at 48. The Moser route is only used during marginal weather conditions or at night under specific wind conditions which require the use of Runway 32 at Hill AFB. Id. at 48-48a.

Q132. How many aircraft use the Moser Recovery route?

A132. Based on information from local air traffic controllers, conservatively estimated (we doubled the controllers' estimate), the Moser recovery route is used by less than five percent of the aircraft returning to Hill. Id. at 48a-49. According to the Air Force, 5,726 F-16 sorties were flown on the UTTR South Area in FY 98, almost all of which flew from Hill AFB (not all aircraft transit Skull Valley en route to the South Area). Thus, at the very most, fewer than 286 aircraft (5% x 5,726) use the Moser recovery route on their return flights for FY 98. Id. at 49.

Q133. What hazard would those aircraft pose to the PFSF?

A133. The average annual crash impact probability for aircraft flying the Moser recovery route was calculated using the same method used for calculating the hazard from F-16 flights through Skull Valley. Aircraft Report at 49. The Moser recovery is defined as an airway with a width, *w*, of 10 nautical miles (11.5 statute miles) (equal to the width of military airway IR-420). Id. The number of aircraft, *N*, for the calculation in the original Aircraft Report was very conservatively taken to be 286; the crash probability, *C*, is equal to 2.736 E-8 per mile; the effective area of the site is 0.1337 mi^2; and it is calculated that 85.5 percent of all crashes would be attributable to events leaving the pilot in control of the aircraft, in which the pilot could direct the aircraft away from the PFSF. Id. at 49-49b. Thus, based on FY 98 data the annual crash impact probability was conservatively estimated to be 1.32 E-8. Id. at 49. Increasing this probability to reflect the sortie rates of FY 99 and FY 00 and the sorties that would be flown by additional F-16s assigned to Hill AFB, increased the probability by a factor of 1.516 to 2.00 E-8. Revised Addendum at 20. But as discussed, our estimate of the number of flights on the Moser recovery was very conservative to begin with, and thus this estimate, used in our cumulative probability, is likewise very conservative.

2. State Challenge

Q134. Did the State challenge PFS's assessment of the hazard posed to the PFSF by aircraft using the Moser Recovery?

A134. Yes. The State claimed that PFS's assumption that five percent of the F-16 flights from Hill AFB to the UTTR South Area would use the Moser Recovery on their return is too low because the conduct of training missions with night vision goggles at Hill since 1999 has increased the use of the Moser Recovery. Horstman Decl. ¶ 91.

Q135. Is the State correct?

A135. No. As discussed above, our estimate is based on information received from local air traffic controllers.[167] Further, the Hill AFB staff has advised the NRC Staff that there has not been an increase in the use of the Moser Recovery in recent years.[168] The State has provided no more than anecdotes in opposition to our assessment. Specifically, the State has provided nothing regarding the total number of Moser Recovery flights, only an assertion that they have increased in recent years.

E. Aircraft Flying to and from Michael AAF on IR-420

1. PFS Assessment

Q136. How do aircraft fly to and from Michael AAF on IR-420?

A136. Michael Army Airfield is located on Dugway Proving Ground, 17 statute miles south-southwest of the PFSF. Aircraft Report at 56. IR-420 is a military airway that runs from northeast to southwest and ends about 7 miles north of the PFSF site, at the northern edge of the Sevier B MOA (i.e., IR-420 runs from the edge of Sevier B to the northeast). Aircraft flying to and from Michael AAF from the northeast, including aircraft flying to and from Hill AFB, may fly in the direction of IR-420 and pass within a few miles of the PFSF site. The majority of the flights, to and from Michael AAF are F-16s from Hill AFB conducting training. We account for those aircraft using IR-420 in our Skull Valley-transiting F-16 calculation above.[169] Most of the remainder of the aircraft flying to and from Mi-

[167] In response to a PFS FOIA request, Hill AFB stated that it had no records of the number of flights on the Moser Recovery.

[168] NRC/Hill AFB September 7, 2001 Meeting Summary.

[169] Any F-16 using IR-420 would necessarily fall into the Sevier MOA traffic count as IR-420 ends where the Sevier MOAs begin at the north end of Skull Valley. Any F-16s that went to Michael AAF without transiting Skull Valley would not be relevant to the hazard to the PFSF.

chael AAF are cargo aircraft such as the C-5, C-17, C-141, C-130 and the smaller C-21 and C-12. Id. at 51. We account for those aircraft here.

Q137. How did PFS calculate the hazard to the PFSF posed by aircraft flying to and from Michael AAF?

A137. The same method used to calculate the hazard to the PFSF from F-16s transiting Skull Valley was used to estimate the probability of an aircraft impacting the PFSF from aircraft flying to and from Michael AAF (i.e., $P = C \times N \times A / w$). Id. NUREG-0800 provides an in-flight crash rate of 4 E-10 per mile for large commercial aircraft, which is appropriate to apply to the types of large cargo aircraft flying to and from Michael AAF. Aircraft Report at 51-53. Information provided to PFS by Dugway Proving Ground in 1997 stated that there are approximately 414 flights annually at this airfield. Id. at 55. The effective area of the PFSF is 0.2116 mi^2, calculated for the types of aircraft flying to and from Michael AAF, using the same method as was used to calculate the effective area of the PFSF for an F-16 above. Id. at 53a-54. The width of the airway is 10 nautical miles (nm), or 11.5 statute miles. Id. at 55. Therefore, the probability of an aircraft impacting the PFSF, based on the calculation in the Aircraft Report using 1997 data is 3.0 E-9 per year. Id.

Q138. Have the number of flights or the types of aircraft that fly to and from Michael AAF in the direction of IR-420 changed significantly since 1997?

A138. For the purposes of our calculation, no. Michael AAF has stated that 1,929 flight operations were conducted at the airfield in FY 00.[170] It stated that 1,359 operations occurred in FY 99 and 895 in FY 98.[171] It also stated that 89 percent of "flight operations" at Michael are conducted by aircraft originating from Hill AFB.[172] The remaining 11 percent of the flights that utilize the airspace or land at

[170] April 10, 2001, FOIA Response from Dugway Proving Ground (Michael AAF), Teresa Shinton, FOIA Manager, Dugway Proving Ground, Utah.

[171] Letter from Lt. Col. Gaylen Whatcott, U.S. Army Command Judge Advocate, Dugway Proving Ground, to Maj. Gen. John L. Matthews, USAF (Ret.) (Nov. 15, 1999).

[172] Id. This and other recent MAAF FOIA responses deal only with the "flight operations" in their airport traffic area (i.e., within a 5-mile radius and up to and including 2,999 ft. above ground level), which are defined to include takeoffs, approaches, landings, and flights through the airport traffic area. See U.S. Department of Transportation Order 7210.3R, February 24, 2000, Chapter 9 – Operational Count Data. Thus, a flight to Michael AAF by a single aircraft could represent more than one "flight operation." For example, if as part of recurring training requirements an F-16 pilot does a low approach and a go-around, that counts as two flight operations. If a pilot were to do three

Footnote continued on next page

Michael originate from "mostly military airfields within 200 to 350 nautical miles" of Michael.[173] Further, the "majority" of all types of aircraft that use the Michael airspace or land at Michael are F-16 jet fighters that use Michael for "re-curring training" on approaches and landings required by Air Force Standards.[174] This training could be accomplished at the end of a range mission and doesn't necessarily entail a flight on IR-420. Even if it did entail a flight on IR-420, those missions would be included in the count of F-16 flights transiting Sevier B MOA.

Based on this information, approximately 1,717 of the 1,929 operations in FY 00 would have been associated with aircraft originating from Hill, the large majority of which would have been F-16s already accounted for elsewhere in our calculations. The remaining 212 would have been associated with various airfields around the country and could have approached Michael from any direction. Some small proportion of the 1,717 operations originating from Hill would have been non-F-16 traffic not otherwise accounted for in our F-16 calculations, that could pass near the PFSF and should be counted as potential IR-420 traffic, while a large proportion of the 212 flights from around the country would likely not pass near the site since they could approach Michael from any direction and should not be counted. Since the large portion of flights from around the country that would not fly near the proposed PFSF site should more than offset the non-F-16 operations associated with flights that originate from Hill that might pass near the PFSF, we believe that a reasonable, conservative estimate to use for FY 00 for purposes of the IR-420 calculation would be the 212 flight operations associated with the 11% of the aircraft not originating at Hill. This total estimate is significantly less than the 414 flights for IR-420 assumed in the Aircraft Report, based on a Michael AAF (Dugway Proving Ground) provided figure for FY 97.

Footnote continued from previous page
low approaches and go-arounds prior to departing MAAF and returning to Hill, that would be total of six flight operations.

[173] In its FOIA response to the State (note 171, supra), MAAF states that representative airfields included Nellis AFB, Nevada; Boise, Idaho; Mountain Home AFB, Idaho; NAS Fallon, Nevada; Ellsworth AFB, South Dakota; McConnell AFB, Kansas; Yuma MCAS, Arizona; Aberdeen Proving Ground, Maryland; Yuma Proving Ground, Arizona, Salt Lake International Airport, Wendover, and assorted civilian airports throughout the Wasatch. Approximately 2% of the 11 % originate from the East Coast.

[174] MAAF Response to State FOIA Request, note 171, supra.

Q139. What about takeoffs and landings at Michael AAF, would they pose a hazard to the PFSF?

A139. Takeoff and landing operations at Michael AAF would pose a negligible hazard to the PFSF because the airfield is over 17 miles from the PFSF. Aircraft Report at 56-60.

2. State Challenge

Q140. Did the State challenge PFS's assessment of the hazard posed to the PFSF by aircraft flying to and from Michael AAF in the direction of IR-420?

A140. Yes. The State claims that PFS assumed that too few aircraft per year flew to and from Michael AAF in the direction of IR-420. The State asserts that in FY 99, Michael reported 1,359 flight operations, 89 percent of which involved aircraft from Hill AFB and thus PFS should have used a higher number of flights than the 414 that it did. Resnikoff Decl. ¶ 83.

Q141. Does your analysis take into account all of the traffic that might fly to and from Michael AAF in the direction of IR-420?

A141. Yes. As discussed above, Michael AAF indicated that 1,929 operations took place in FY 00, approximately 89 percent of which involved aircraft Hill AFB. This is more than the 1,359 in FY 99. Based on a larger number of operations (1,929 vs. 1,359) and the same fraction originating from Hill AFB as opposed to elsewhere (89%), we estimated that 212 flights would pass near the PFS site. This total estimate is significantly less than the 414 flights for IR-420 assumed in the Aircraft Report. Thus, we do not need to change our IR-420 estimate.

F. Military Ordnance Hazard

1. PFS Assessment

a. Direct Impact

Q142. Would the potential for the inadvertent release of ordnance by F-16s transiting Skull Valley pose a hazard to the PFSF?

A142. No. The hypothetical potential for the inadvertent release of ordnance would not pose a hazard to the PFSF. The U.S. Air Force has specifically stated that "[n]o aircraft flying over Skull Valley are allowed to have their armament switches in a release capable mode. All switches are 'SAFE' until inside DOD land boundaries." Aircraft Report at 77. The Air Force has also stated that "[t]he UTTR has not experienced an unanticipated munitions release outside of designated launch/drop/shoot boxes" Id. The UTTR has been in use for decades and during FY 1998 alone there were 13,367 total sorties in the UTTR with 5,083 in the North and 8,284 in the South. These numerous sorties over the years all were accomplished with obviously no inadvertent munitions releases outside of designated launch/drop/shoot boxes. Consequently, the likelihood or probability of an inadvertent weapons release from F-16s flying over Skull Valley impacting or affecting the PFSF is as a practical matter zero.

Q143. Could the ordnance carried by F-16s pose a hazard to the PFSF in any other respect?

A143. Only a minimal hazard. We have calculated an impact probability for ordnance jettisoned from a crashing F-16 in Skull Valley that could potentially hit the PFSF. Aircraft Report at 79-83. Some of the F-16 flights through Skull Valley carry ordnance (live or inert). In the event of an incident leading to a crash in which the pilot would have time to respond before ejecting from the aircraft (e.g., an engine failure), one of the pilot's first actions would be to jettison any ordnance carried by the aircraft. Id. at 79. We used an approach similar to the approach described above for calculating the aircraft impact probability to calculate the probability that jettisoned ordnance would impact the PFSF. See id. at 79-82. Specifically, we calculated the probability, P, that the ordnance would impact the PFSF using the equation $P = N \times C \times e \times A/w$, as described in the paragraph below. Id.

Q144. What did you calculate as the hazard from ordnance to the PFSF?

A144. We followed the same approach that we used in calculating the hazard to the PFSF for F-16s transiting Skull Valley by using the average of F-16s carrying ordnance through Skull Valley for FY 99 and FY 00 increased proportionally to account for the increased aircraft in FY 01. Based on FY 99 and FY 00 data from Hill AFB, the fraction of the 5,870 F-16s transiting Skull Valley per year (accounting for the aircraft that were added in FY 01) that would be carrying ordnance that could be jettisoned was determined to be 2.556 percent. May 31 Response at 14. This accounts for aircraft from both the 388th FW and the 419th FW at Hill AFB. See id. at 12 n.27; id. at 14. Thus, the number of aircraft carrying live or inert ordnance through Skull Valley per year, N in the equation above, would be 150. The crash rate for the F-16s, C, was taken to be 2.736 E-8 per mile. Aircraft Report at 82; see May 31 Response at 15. Nonetheless, the pilot was assumed to jettison ordnance in only 90 percent of all crashes, the fraction of the crashes, e, assumed to be attributable to engine failure or some other event leaving him in control of the aircraft (in crashes attributable to other causes it was assumed that the pilot would eject quickly and would not jettison ordnance). Aircraft Report at 82; see May 31 Response at 15. Skull Valley was treated as an airway with a width, w, of 10 statute miles. Aircraft Report at 82; see May 31 Response at 15.

As with the calculation for F-16s transiting Skull Valley, we conservatively assumed that the F-16s are uniformly distributed across the 10 miles, despite the fact that their predominant route of flight is down the eastern side of the valley. In fact, the potential for direct overflights of the PFSF is low given the two-mile buffer zone on the western edge of the MOA maintained by the pilots and the fact that the PFSF is only located two miles east of the western edge of the MOA.

The area of the PFSF, from the perspective of ordnance jettisoned from an aircraft flying from north to south over the site, A, was taken to be the product of the width and the depth of the cask storage area (assuming a full facility with 4,000 casks) plus the product of the width and depth of the canister transfer building, in that pieces of ordnance are small relative to an aircraft and impact the ground at a steep angle. Aircraft Report at 80 & n.82, 82; see May 31 Response at 15. Thus, the area of the PFSF was calculated to be 0.08763 sq. mi. Aircraft Report at 82. Therefore, using the equation $P = N \times C \times e \times A/w$, the probability that jettisoned ordnance would impact the PFSF is calculated as follows:

$$P = 150 \times 2.736\text{ E-8} \times 0.90 \times 0.08763 / 10 = 3.2\text{ E-8}$$

See May 31 Response at 15.

Q145. Did anything change since FY 98 regarding the carrying of ordnance by F-16s transiting Skull Valley?

A145. Yes. The ordnance calculation in the original Aircraft Report (PFS Exhibit N) was based on ordnance carried by the 388th FW in FY 98. As explained above, we based our calculation in the Revised Addendum (PFS Exhibit O) on the average fraction of 388th FW and 419th FW aircraft carrying ordnance for FY 99 and FY 00.

Q146. What if you assume that the FY 00 sortie count for F-16s transiting Skull Valley is the appropriate baseline for calculating risk rather than the average of the FY 99 and FY 00 sortie counts?

A146. As stated above, our aircraft crash hazard calculation is based on 5,870 flights which was the approximate average of F-16 flights through Skull Valley for FY 99 and FY 00 (4,250 +5757 divided by 2), increased by 17.4% to account for the increased numbers of F-16s to be stationed at Hill AFB. Nonetheless, we also performed a sensitivity analysis assuming that the FY 00 F-16 Skull Valley sortie number of 5,757 would be the expected norm. May 31 Response at 15. Adjusting this number upward by 17.4% to account for the additional F-16s, the Skull Valley sortie number under this assumption would be 6,759. Id. Using the FY 00 fraction of aircraft carrying ordnance of 0.018 calculated above, adjusted upward proportionally to 0.0230 to include the 419th FW, id., results in a hazard from jettisoned ordnance for this FY 00 sensitivity analysis of:

P_0 = 6,759 x 0.0230 x 2.736 E-8 x 0.90 x 0.08763 = 3.4 x E-8

b. Near Impact and Explosion

Q147. Could ordnance carried by F-16s transiting Skull Valley pose a hazard to the PFSF in any other respect?

A147. Only hypothetically. In addition to the potential hazard posed by direct impacts of crashing aircraft and jettisoned ordnance, we also calculated the hazard to the PFSF posed by jettisoned live ordnance that might land near the facility and explode on impact, as well as the hazard posed by a potential explosion of live ordnance carried aboard a crashing aircraft that might impact the ground near the PFSF. Aircraft Report at 83a-83l. At the outset, as stated above, Air Force pilots do not arm the live ordnance they are carrying while transiting Skull Valley near the PFSF. Id. at 83a. Furthermore, the U.S. Air Force has indicated that the likelihood that unarmed live ordnance would explode when impacting the ground after being jettisoned is "remote" and the Air Force has no records of such incidents in the last 10 years. Id. at 83b, Tab Q. Thus, it is highly unlikely that jettisoned live ordnance or live ordnance carried aboard a crashing aircraft that did not directly impact the PFSF would damage the facility.

Q148. Did you calculate the hazard that could be posed by nearby explosions of jettisoned ordnance?

A148. Yes. To calculate a numerical hazard to the facility, we conservatively assumed that such ordnance would have a 1 percent chance of exploding and assessed that damage to the PFSF that would result if an explosion occurred close enough so that the blast overpressure would damage a storage cask or the Canister Transfer Building, without hitting either one. Id. at 83g-83i.

Q149. How did you determine whether a nearby explosion would damage a spent fuel cask or the Canister Transfer Building?

A149. As described in the testimony of Jeffrey Johns, the explosive overpressure limit for a storage cask was taken to be 10 psi. See also Aircraft Report at 83b-83c. The limit for the Canister Transfer Building was taken to be 1.5 psi. Johns Testimony; Aircraft Report at 83c. As further described in the testimony of Jeffrey Johns, from those overpressure limits the distances from the explosion at which damage was assumed to occur were calculated. We used those distances to calculate the probability of the damage.

Q150. Given those assumptions, how did you calculate the hazard posed by nearby explosions?

A150. We assumed that the ordnance in question was a live 2,000 lb. bomb, the largest single piece of ordnance carried by the F-16s that transit Skull Valley. Id. at 81, 83j. Based on information provided by Hill AFB, approximately 193 F-16s transited Skull Valley in 1998 with live ordnance (only 75 of them would have carried 2,000-lb. bombs). Id. at 83h. We calculated the probability that an F-16 carrying live ordnance would jettison the ordnance so as to impact near the PFSF, or crash near the PFSF without jettisoning the ordnance, following the same method we used to calculate the probability that an F-16 would crash and impact the facility. The results of our final calculation showed that the annual probability that a storage cask or the Canister Transfer Building would be damaged by an explosion of live ordnance jettisoned from a crashing aircraft or carried aboard a crashing aircraft that impacted the ground near the PFSF was equal to 2.43 E-10. Id. at 83k-83l. This is exceedingly low and is insignificant relative to the other aircraft crash and jettisoned ordnance impact hazards calculated for the PFSF.

Q151. How is this affected by the changes in the carrying of ordnance by F-16s transiting Skull Valley since FY 98?

A151. If the probability is increased to reflect the additional sorties transiting Skull Valley in FY 99 and FY 00 and to account for the additional F-16s based at Hill AFB—i.e., it is increased by a factor of 1.516 and it is then reduced by approximately a factor of five to account for the reduction in sorties carrying ordnance since FY 98, it falls below 1 E-10. See Revised Addendum at 31.

Q152. What if an F-16 were to crash with two pieces of ordnance onboard or were to jettison two bombs at once?

A152. As set forth on page 831 of the Aircraft Report, in footnote 88M:

> The calculated risk to the PFSF from an explosion of live ordnance aboard or jettisoned from a crashing aircraft is largely insensitive to the quantity of explosives involved in the explosion, because the explosive radius, r_e, is proportional to the quantity of explosives to the 1/3 power. (The near miss area, a_{nm}, is approximately directly proportional to r_e, and the risk to the PFSF is directly proportional to a_{nm}) Thus, for example, if the quantity of explosives involved in the explosion were doubled [e.g., by the simultaneous explosion of two bombs], the risk would only increase roughly by a factor of $2^{1/3}$ or 1.25.

If the bombs did not explode simultaneously, the increase in peak overpressure would be even less.

2. State Challenges

Q153. Did the State challenge PFS's assessment of the hazard posed to the PFSF by jettisoned ordnance?

A153. Yes. The State claims that aircraft jettisoning multiple pieces of ordnance would increase the effective area of the PFSF, in that there would be a slight (1/3 of a second) delay between the release of the first piece and the release of the second. The State asserts that the distance the aircraft travels during the delay should be added to both ends of the effective area of the facility, north to south. Lamb/Resnikoff Memo at 10.

Q154. What would be the effect of increasing the effective area as proposed by the State?

A154. The 1/3-second delay at 471.8 miles per hour is equivalent to 231 feet. This would be added to the front of the area only in calculating effective area from the perspective of jettisoned ordnance. On the back side, if the first weapon released hit the very back edge of the facility, it would not matter for the probability calculation that another hit 231 feet beyond the site. Since the length of the cask storage area is 1,590 ft., the effect of the delay would be to increase the site area by 231/1590 or 14.5 percent. Even if one assumed that all F-16s carried only multiple weapons (which they do not), the effect would only be to increase the hazard from jettisoned ordnance from 3.2 E-8 per year to 3.7 E-8 per year, which would only be a small change relative to the total calculated hazard.

Q155. What other claims does the State make with respect to PFS's analysis of jettisoned ordnance?

A155. The State claims that PFS's assessment of the probability that jettisoned ordnance would strike the PFSF is wrong, in that PFS did not use a "skid area" in front of the PFSF to account for ordnance sliding along the ground before impacting the PFSF. See Resnikoff Decl. ¶ 39.

Q156. Is the State's claim correct?

A156. No. We have determined the angle at which jettisoned ordnance from an F-16 flying toward the PFSF would strike the ground. Using the conservative bounds of the speeds and altitudes generally flown by F-16s transiting Skull Valley, 400 knots at 3,000 ft., the impact angle of a Mark 84 2,000-pound bomb would be 34 degrees (i.e., 56 degrees from the vertical), as measured by the Joint Munitions Effects Manual Trajectory Model, by the Joint Technical Coordinating Group, Eglin AFB, FL. If the aircraft had engine failure and was beginning a zoom maneuver to climb at a 30-degree angle and was in a 15 degree climb at the point of release, the impact angle would be 37 degrees. We believe that an angle in this range (34 to 37 degrees, or 53 to 56 degrees from the vertical) would be appropriate as a typical impact angle. (From higher altitudes the ordnance would impact the ground at a steeper angle) At such an angle, the ordnance would not skid along the ground. If it hit in front of the PFSF it would penetrate into the ground without sliding into the facility.

Q157. Did the State make any other claims with respect to PFS's analysis of jettisoned ordnance?

A157. The State claimed that PFS's assessment was not conservative because an F-16 might jettison ordnance in the event of an incident that does not result in a Class A or B mishap but PFS only considered the Class A and B mishap rate when determining the probability that ordnance would be jettisoned and impact the PFSF. State Mot. Resp. at 24; see Horstman Decl. ¶ 33.

Q158. Is the State's claim correct?

A158. While it is certainly correct that ordnance could be jettisoned from an aircraft which did not result in a Class A or Class B mishap, and thus not be incorporated in our analysis, we believe that such a possibility is very remote.

There are no statistics on jettisoned ordnance kept by the Air Force. The most likely cause of jettisoned ordnance is in a controlled environment, where for example, a hung bomb that cannot be released normally is jettisoned in an area approved for the activity before the aircraft returns to land. This would not result in a Class A or B mishap. If ordnance is jettisoned in an incident in which the aircraft subsequently crashes, this event would be captured in the accident data.

If the ordnance were jettisoned as a precaution in a uncontrolled, off range area, for example if the engine was running rough or stopped and was restarted, but the aircraft made it back to its base, this might or might not be captured in the Class A or Class B data, depending on how much damage the ordnance did when it hit the ground. If it hit anything significant in monetary terms, it would be in at least the Class B data.

We believe that any ordnance dropped that did not cause significant damage was either 1) too small (e.g., 25 lb. small inert bombs with a spotter charge) to be of any hazard to a site such as the PFSF, or 2) by the positive actions of the pilot or as a matter of chance, avoided striking a person or structure on the ground. If there was no damage because the pilot took action to avoid a structure, such ordnance would not constitute a threat to the PFSF.

For the purposes of our analysis, we believe the last category (dropped as a precaution and no significant damage on the ground because of chance) has a very small probability of occurrence and is subsumed in the conservatism of using an accident rate including all Class A and Class B incidents (as opposed to just destroyed aircraft) in the first place.

Q159. Did the State challenge PFS's assessment of the hazard posed by potential nearby explosions of jettisoned ordnance or ordnance carried aboard crashing aircraft?

A159. The State claimed that the hazard would be higher because ordnance could explode in a fire (as opposed to exploding on impact), but the State did not assert how high the probability would be. Resnikoff Decl. ¶ 78.

Q160. How does the State's claim affect your assessment?

A160. The possible effect of a fire on the hazard posed by aircraft with live ordnance crashing nearby the PFSF is insignificant. First, the potential for a fire only applies to aircraft that crash with live ordnance on board. Fire would not be an issue with ordnance that was jettisoned before the aircraft hit the ground. As shown in the Aircraft Report, the hazard posed by the potential nearby explosion of live ordnance carried aboard crashing aircraft was calculated to be 2.01 E-11 per year. Aircraft Report at 83j. Even if that hazard was increased by a factor of 10 to model an assumed increase of the probability that the ordnance would explode (based on Air Force information that the possibility is remote and none have been recorded in 10 years, our calculations conservatively assume that there is a 1 percent chance that the ordnance will explode on impact without a fire), the hazard would remain negligible at 2 E-10. Furthermore, in fact, the hazard posed by the explosion of any piece of ordnance as a result of a fire would be lower than the hazard we calculated. An explosion caused by a fire would be a lower order, i.e., less powerful, explosion, while our calculations assumed that any explosion of ordnance would be a higher order explosion, i.e., an explosion as powerful as what would result if the ordnance were detonated by its fusing mechanism. Therefore, the potential for fire involving aircraft crashing with live ordnance on board would have no significant effect on our hazard assessment.

G. Cumulative Hazard to the PFSF from Aircraft Accidents

Q161. What is the cumulative aircraft crash and jettisoned ordnance impact hazard to the PFSF?

A161. The cumulative aircraft crash (and jettisoned ordnance) impact hazard to the PFSF is shown in Table 1 (see Answer 28), which is repeated below. The table includes the latest values for all probabilities.

Table 1 Calculated Aircraft Crash Impact Probabilities	
Aircraft	**Annual Probability**
Skull Valley F-16s	3.11×10^{-7}
UTTR Aircraft	$< 1 \times 10^{-8}$
Aircraft Using the Moser Recovery	2.00×10^{-8}
Aircraft on Airway IR-420	3.0×10^{-9}
Aircraft on Airway J-56	1.9×10^{-8}
Aircraft on Airway V-257	1.2×10^{-8}
General Aviation Aircraft	$< 1 \times 10^{-8}$
Cumulative Crash Probability	$<3.85 \times 10^{-7}$
Jettisoned Military Ordnance	3.2×10^{-8}
Cumulative Hazard	$<4.17 \times 10^{-7}$

Q162. What effect would your sensitivity analysis regarding the number of F-16 flights down Skull Valley have on the cumulative hazard?

A162. As noted above, we have performed a sensitivity analysis assuming that the FY 00 F-16 Skull Valley sortie number of 5,757 was the expected norm (as opposed to the average of the FY 99 and FY 00 numbers of sorties). Adjusting this number upward by 17.4%, (to account for the additional aircraft to be based at Hill AFB), the new steady state number would be 6,759. While we do not believe this number is likely to be the steady state number, using it would increase (1) the Skull Valley F-16 crash impact probability from 3.11 E-7 to 3.58 E-7; (2) the Moser Recovery crash impact probability from 2.00 E-8 to 2.30 E-8, and (3) the Jettisoned Military Ordnance crash impact probability from 3.2 E-8 to 3.32 E-8 (accounting also for the reduced fraction of aircraft carrying ordnance in FY 00). Thus, the Cumulative Hazard probability in the above Table would be 4.65 E-7. [175]

H. Conservatism Remaining in PFS's Assessment

Q163. Does your aircraft crash hazard assessment remain conservative?

[175] We also did a second sensitivity analysis assuming that the new expected norm for Skull Valley flights would be the sum of FY 00 operations for Sevier B and Sevier D MOA, adjusted upward by 17.4%. This second sensitivity analysis would result in a cumulative hazard of <4.90 E-7. May 31 Response at 15-16.

A163. Yes. Even though we have now quantified some of the conservatisms identified in the Aircraft Report, the calculated cumulative hazard to the PFSF set forth in the Table above still retains other substantial conservatisms. First, with respect to the F-16s transiting Skull Valley and flying on the Moser Recovery, we used a crash rate that included not only destroyed aircraft, but also Class A and B mishaps in which no aircraft was destroyed. Aircraft Report at 25; id. Tab H at 4 n.8. Since, in the 10 years from FY 89 to FY 98 there were 162 Class A and Class B mishaps but only 139 destroyed aircraft, the crash rate is overstated by 16.5%, which reasonably applies to both the normal and special in-flight operations accident rates used in the analysis. In other terms, for this conservatism alone, the correct calculated impact hazards are about 14% lower than those shown. Using this factor alone, the Skull Valley F-16 hazard would be reduced from 3.11 E-7 to 2.67 E-7 per year and the Moser recovery hazard would be reduced from 2.00 E-8 to 1.72 E-8 per year.

Secondly, and more significantly, we assumed that any crashing F-16 that impacted the site could potentially cause a release of radioactive material. In fact, those F-16s that impacted the site after a mishap that left the pilot in control of the aircraft would hit at a velocity of roughly 170 to 210 knots. Aircraft Report at 21. As discussed in Section XI of the Report and in the testimony of Jeffrey Johns, this would be too slow to penetrate a spent fuel storage cask. We have determined that at least 90 percent of all mishaps that would otherwise result in an impact at the PFSF would leave the pilot in control, and in no more than 5 percent of those the pilot would fail to avoid the PFSF. Accordingly, in 0.90 x 0.05 = 0.045 or 4.5% of the total accidents, the plane would impact the site at these relatively low speeds. The other 10 percent of the mishaps would not leave the pilot in control and could result in an impact at higher speeds, depending on the location of the aircraft when the mishap took place (i.e., it is still possible that such mishaps would not result in high speed impacts).

Thus, at least approximately 30 percent of all potential impacts (0.045 / (0.045 + 0.10)) would hit at a velocity clearly insufficient to penetrate a cask and hence the F-16 crash hazard to the PFSF from F-16s transiting Skull Valley and using the Moser recovery could be reduced by 30 percent. This factor alone would reduce the Skull Valley F-16 hazard from 3.11 E-7 to 2.18 E-7 per year and the Moser recovery hazard from 2.00 E-8 to 1.4 E-8 per year.

Thirdly, as shown in the testimony of Jeffrey Johns, the crash impact penetration resistance of the spent fuel storage casks would also protect against many higher speed impacts in which aircraft impacted the side or lid of the cask at an angle. PFS's assessment of the impact velocity required to penetrate a cask presumes an impact perpendicular to the steel cask surface. In fact, a crashing aircraft would most likely hit a cask at an angle, which would reduce the velocity perpendicular to the cask and hence the penetration distance. This effect reduces the already extremely low risk to the PFSF from potential high-speed F-16 crashes. This effect would most likely be a significant factor but is not quantifiable because of the many potential geometries involved.

Fourthly, our calculated hazard from jettisoned ordnance is also conservative in a number of respects. First, as discussed in Section X of the Aircraft Report, the calculation does not take into account the fact that half of the cask storage area at the PFSF will consist of open space where ordnance could impact and do no damage. Aircraft Report at 83. Second, a letter to the State of Utah from the Air Force states that none of the inert munitions listed in the letter as having been tested by the Air Force would penetrate the lid of a storage cask if they struck it.[176] Those weapons tested included the Mark 82, Mark 84 and CBU-87 which make up the great majority of the jettisonable ordnance carried by F-16s on the UTTR (See Table 4 in the Aircraft Report at 81 and May 31 Response at 13). The Mark 84 (2000 lb. bomb) could penetrate the outside wall (but not the lid) of the cask (if it struck the wall as opposed to the lid), but it is unclear from the Air Force letter if it would then penetrate the 2-inch steel inner shell or fuel canister shell. Since sorties carrying Mark 84s make up only 22% of the sorties carrying jettisonable ordnance (May 31 Response at 13) and only 0.4% of the total F-16 sorties on the South UTTR,[177] in any event the actual risk from jettisoned ordnance is probably well below the figure of 3.2 E-8 calculated above, and is probably on the order of 7 E-9.[178]

[176] Letter from Col. Lee Bauer, USAF, Deputy Associate Director for Ranges and Airspace, to Connie Nakahara, Utah Department of Environmental Quality (Dec. 28, 2000) (included in Revised Addendum Tab EE).

[177] See Id. (21 Mk 84 live sorties + 7 Mk 84 inert sorties divided by 7,059 F-16 South UTTR sorties).

[178] The estimate of 7 E-9 is calculated by multiplying 3.2 E-8 by 22 percent. Thus, the estimate still does not take credit for the open area present within the PFSF restricted area. While the Air Force cask penetration assessment addressed only inert weapons, the assessment would also apply to live weapons that did not explode on impact. The

Footnote continued on next page

Fifthly, as discussed in Section III.A.8 of the Report, all of our calculations assume a fully loaded site with 4,000 spent fuel storage casks. In fact under the plan for the, PFSF, the facility would contain 4,000 casks for only one year during its 40-year lifetime. Aircraft Report at 26. If we considered a time-weighted average size for the cask storage area, the effective area of the site would be only 55 percent of the area of the site at full capacity. Thus, the average aircraft crash impact hazard for the PFSF is only 55 percent of the peak hazard. Since effective area is integral to all calculations of risk, the total risk could likely be reduced by a factor of approximately 45% for an average risk value. Inclusion of this factor in our assessment, which affects all of the separate risk factors, would alone reduce the cumulative hazard to the PFSF from 4.17 E-7 to 2.29 E-7 per year.

Finally, our assessment does not explicitly account for the fact that pilots now maintain about a two-mile buffer zone on the western edge of Sevier B MOA and the PFSF is only located two miles from the western edge of the MOA. By this fact alone, F-16s are unlikely to fly directly over the PFSF. Further, given that the F-16s tend to fly in formation with 1 to 2 miles separating each aircraft east to west, the easterly aircraft would rarely if ever fly over the PFSF. This significantly reduces the total number of aircraft that would fly over the PFSF. Thus, it significantly reduces the likelihood that a crashing aircraft or jettisoned ordnance would impact the PFSF.

Q164. What is the cumulative effect of all the conservatisms described above?

A164. The cumulative effect of the conservatisms listed here, though somewhat more difficult to quantify and therefore not included in Table 1 above, would reduce the Cumulative Hazard shown in the Table from 4.17 E-7 to 2.6 E-7 if no adjustment is made for the lifetime average site effective area. If this cumulative hazard is adjusted for the lifetime average site effective area, the hazard becomes roughly 1.43 E-7.[179]

Footnote continued from previous page
Air Force has stated that the likelihood that live but unarmed ordnance would explode on impact is "remote." Aircraft Report Tab Q.

[179] The estimates were made as follows. First, the hazard from F-16s transiting Skull Valley is reduced from 3.11 E-7 to 2.67 E-7 by accounting for Class A and B mishaps that do not result in destroyed aircraft. It is reduced further to 1.87 E-7 by accounting for the impact penetration resistance of the storage casks. The hazard from aircraft flying the Moser recovery is reduced from 2.0 E-8 to 1.72 E-8 by accounting for the Class A and B mishaps and to 1.2 E-8 by accounting for the penetration resistance of the casks. The jettisoned ordnance impact hazard is reduced from 3.2
Footnote continued on next page

IV. CONCLUSION

Q165. In conclusion, what is the cumulative aircraft crash and jettisoned ordnance hazard to the PFSF?

A165. The cumulative aircraft crash and jettisoned ordnance hazard to the PFSF is less than 4.17 E-7 per year.

Q166. How does this compare to the NRC established limit of 1 E-6 per year for a credible threat to the facility?

A166. The cumulative aircraft crash and jettisoned ordnance hazard to the PFSF is below the NRC established limit.

Document #: 1215328 v.1

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E-8 to 7 E-9 by accounting for the ordnance impact penetration resistance of the casks. If those hazards are summed, along with the other hazards listed in Table 1, the result is a cumulative hazard to the PFSF of 2.6 E-7. If that cumulative hazard is adjusted to account for the lifetime average site effective area, the hazard becomes 1.43 E-7.

Resume of James L. Cole

JAMES L. COLE • 7711 GRIFFIN POND COURT • SPRINGFIELD, VIRGINIA 22153

(703) 455-6630

EXECUTIVE MANAGER

PROFESSIONAL PROFILE: Twenty years top level executive decision-making experience in air transportation, aviation safety, aircrew training, and association management. Skilled in the U.S. Government interagency process. Accomplished public speaker with many keynote addresses and trips to Capitol Hill.

EDUCATION:

Executive Development Program, Cornell University
MBA, Auburn University
MA, Ohio State University
BS, U.S. Air Force Academy

2000-Present, Senior Director, Safety, Air Transport Association of America (ATA). ATA member airlines transport more than 95 percent of all passengers and cargo traffic in the United States. ATA assists its members by promoting aviation safety, advocating industry positions, conducting industry-wide programs, and ensuring public awareness and understanding of the airline industry. As Senior Director, Safety, serve as aviation safety point lead for the entire airline industry.

Manage issues for the ATA Safety Council, which is made up of air carrier Vice Presidents for Safety
Maintain effective liaison with the U.S. Congress, FAA, NTSB, and the entire aviation community
Represent ATA on the Commercial Aviation Safety Team (CAST) and other aviation forums

1996-2000, Executive Director, National Air Traffic Controllers Association (NATCA). Mission is improvement of air traffic safety and working conditions for air traffic controllers. Responsible for managing full time staff of forty, annual budget of $12 million, and maintaining effective liaison with the U.S. Congress, Federal Aviation Administration, National Transportation Safety Board, and the aviation community.

Forged coalitions with other aviation associations and expanded NATCA's safety advocacy role
Built corporate membership program and signed six corporate members
Prepared NATCA's input to White House Commission on Aviation Safety and Security

1994-1996, President and CEO, National Aeronautic Association (NAA). Mission is the advancement of the art, sport, and science of aviation and space flight. Sanctioned and certified aviation and space records. Awarded major aviation trophies. Represented the U.S. internationally as President of the "National Aero Club of the United States". Reorganized and reinvigorated NAA while achieving greatest single year of annual aggregate membership growth in over twenty years.

Doubled corporate members (added 23)
Tripled affiliate members (added 33)

1991-1994, Chief of Safety, U.S. Air Force. Directed U.S. Air Force Safety Program with authority and accountability for accident prevention and investigations for 500,000 personnel and 9,000 aircraft in all aspects of ground and air operations. Responsible for all flight, ground, and weapons safety as well as nuclear surety of all USAF nuclear weapons. Received National Safety Council Award of Merit for "Safest Year in USAF History."

Produced lowest number of aircraft mishaps and lowest mishap rate ever
Achieved lowest number of air and ground mishap fatalities ever

1990-1991, Assistant DCS Operations and Transportation, Air Mobility Command, U.S. Air Force. Directed all air operations and transportation functions for Air Mobility Command, including worldwide airlift, air rescue operations, aeromedical evacuation, and special operations.

Managed training, qualification, standardization, and evaluation of all aircrews
Maintained and managed worldwide positive command and control system
Worked DESERT SHIELD/DESERT STORM airlift of 482,000 troops and 513,000 tons of cargo

1989-1990, Inspector General, Military Airlift Command, U.S. Air Force. Managed Inspection and Safety functions for Military Airlift Command. Set operational standards and inspection criteria for active and reserve airlift units totaling 160,000 personnel and 1,400 aircraft.

Conducted all Operational Readiness and Management Effectiveness Inspections
Managed flight, ground, and weapons safety as well as nuclear weapons airlift surety
Investigated complaints and responded to Congressional inquiries

1986-1989, Senior Advisor for Joint Matters, Joint Staff, Joint Chiefs of Staff. Produced National Security papers and presentations for the Chairman, Joint Chiefs of Staff, and the service Chiefs of Staff for their scheduled meetings three times each week and their weekly meeting with the Secretary of Defense.

Prepared Chairman for National Security Council meetings with the President
Coordinated national policy and strategy issues in the U.S. Government Interagency Arena
Briefed Secretary of Defense, Joint Chiefs of Staff, and government agencies many times

1985-1986, Commander, 89th Military Airlift Wing , Military Airlift Command, U.S. Air Force. Planned, directed, and operated VIP air transportation for U.S. President, Vice President, senior government officials and foreign dignitaries. Assets included three flying squadrons, a flying detachment, a maintenance complex, a passenger and cargo terminal, and a supply organization.

Recruited and trained 1,500 top quality flight crew and support personnel
Managed a $10 million annual operating budget
Earned OUTSTANDING ratings on all Operational Readiness and Management Inspections
Won Flight Safety Achievement Award

SPECIAL SKILLS AND ACCOMPLISHMENTS:

AVIATOR - USAF Command Pilot with 6,500 total flying hours. Heavy Jet Flight Examiner and Instructor qualified. As Commander, 89th Airlift Wing, directed and operated VIP air transportation for U.S. President, Vice President, senior government officials, and foreign dignitaries. Certificated Flight Instructor/Commercial Pilot.

STRATEGIST AND PLANNER - As Senior Advisor for Joint Matters, Joint Staff, Pentagon, produced National Security papers and briefings for the Chairman, Joint Chiefs of Staff, and prepared the Chairman for National Security Council meetings with the President. Briefed cabinet members and accompanied U.S. Senators on trips overseas. As Assistant Professor of History, USAF Academy, taught World History, Modern European History and U.S. Military History. Course Chairman for Military History Honors course and History of Air Power course. Published several articles and many book reviews in professional journals.

AVIATION SAFETY CONSULTANT - Associate with Burdeshaw Associates, Ltd. Also served as member, Advisory Committee to Safety and Surety Assessment Center, Sandia National Laboratories.

Major General Wayne 0. Jefferson, Jr., USAF (Ret.)

Major General Jefferson is currently an Associate with Burdeshaw Associates, Ltd. (BAL) and with Parsons Associates.

From 1994 until the present, General Jefferson has been a consultant in management, management training, and quantitative probabilistic analysis.

From May 1992 to May 1994, General Jefferson was employed in private industry as Executive Director of LCC, Inc. and responsible for the accounting and finance, human resources and training functions of that company. He also served as the acting chief financial officer for 6 months. From May 1991 to May 1992, he was the General Manager of TSI, Inc., with total profit and loss responsibility for this rapidly growing company. Both of these companies were involved with engineering design support and deployment of the wireless elements of cellular telephone systems.

From 1989 to 1991, General Jefferson was President of Jefferson Associates, Inc., a consulting firm, and an Associate with Burdeshaw Associates, Ltd. (BAL).

General Jefferson retired from the U.S. Air Force on 11 July 1989 after more than 30 years of highly successful experience in leadership, decision-making, planning and management.

From April 1988 until completing service, General Jefferson served as the Joint Staffs Deputy Director for Defense-Wide C3 Support. In this position, he ensured the integrity, interoperablity, evolutionary capability and technical efficiency of all systems employed in the Defense Department's entire command, control and communications system.

From 1985 to 1988, he headed NATO's Communications and Information Systems Division on the International Military Staff in Brussels, directing NATO's highest level military C3 policy structure.

From 1984 to 1986, General Jefferson headed the Joint Staff's first Deputy Directorate for C3 Connectivity and Evaluation, directing the exercise and evaluation of the Defense Department's command and control systems in order to assure their operational capability under severe stress.

From 1980 to 984, General Jefferson held positions of rapidly increasing responsibility with the Strategic Air Command (SAC). In 1983-84, he was Assistant Deputy Chief of Staff for Operations, overseeing the entire scope of SAC's worldwide bomber, tanker, missile and reconnaissance operations, including training range development and flight operations. In 1982-83 he was SAC's Director of Command Control, responsible for the operation of SAC's tight command and control system, including the underground command center in Omaha and the airborne command post. In 1981, as SAC's Assistant Director of Plans and Policy, he was responsible for the analysis and development of SAC's future force requirements, the preparation of SAC's annual budget, and basing plans for new weapons systems. In 1980-81, he commanded a B-52 bomb wing with 17 B-52H bombers and 22 KC-135 tankers.

Prior experience included nuclear test and evaluation, Air Staff mission area planning, Vietnam flight operations, and faculty member at both the US Air Force Academy and the National War College in simulation, economics and management, focusing on operations research and quantitative decision making involving probabilistic methods.

Educational Background

- Senior Managers in Government Program, Harvard University
- M.S. in Operations Research, Stanford University
- M.B.A, Auburn University
- Technical University of Munich, Germany. Two years E.E. (in German)
- B.S., U. S. Air Force Academy (distinguished graduate)

National War College (graduate and faculty member)
Air Command and Staff College (distinguished graduate)

Overseas experience
Belgium, Germany, Vietnam
Language capability in German, French, and Spanish

Resume of
Wayne O. Jefferson

Resume of
Ronald E. Fly

RONALD E. FLY, Colonel, USAF (Retired)
901 S. Frankland Rd., Tampa, Florida 33629
(813) 254-2069

CAREER SUMMARY

Self-employed as a consultant and a partner for a Tampa based business. Has worked extensively as a Burdeshaw Associate with the National Imagery & Mapping Agency and the Shaw Pittman law firm.

Twenty-four years of demonstrated accomplishment in leadership, management and staff positions. Extensive operational experience to include leading three large organizations.

LEADERSHIP POSITIONS

Commander, 388th Fighter Wing, Led 2,200 personnel in nine squadrons with an annual budget of $66M.

- Maintained a 4% higher aircraft readiness rate at a 20% lower operating cost than two similar organizations, an annualized saving of $6,970,000.
- Executed the first "no-notice" Air Expeditionary Force, generated the tasked aircraft and 5 spares 12 hours ahead of schedule.

Commander, 8th Operations Group. In charge of 830 personnel in 3 squadrons with an annual budget of $24M.

- Exceeded every command readiness standard, fighter squadrons took first and second place in the command wide bombing competition.
- Aggressively managed aircraft engine repair flow to prevent the loss of 25 engines.

Commander, 63rd Fighter Squadron. Responsibilities for 325 personnel and an annual operations and maintenance budget of $10M.

- Turned the perennial "also ran" into the wing's premier fighter squadron. Won the Annual Top Combat Unit competition by the largest margin on record and swept every major maintenance and operational category.
- Maintained the wing's highest readiness rate using only 54% of the operations and maintenance budget.

STAFF POSITIONS

Chief, Defense and Space Operations Division, The Joint Staff. Responsible for operational cognizance over all air and missile defense matters, and space operations. Worked extensively at the inter-agency level on Intelligence and Missile Defense. Co-chaired the Quadrennial Defense Review Navigation Warfare subpanel.

Action Officer, International Affairs Division, Headquarters USAF. One of only six officers designated by the Secretary of the Air Force with the authority to release sensitive classified and unclassified information and technologies to foreign governments and international organizations.

OPERATIONS

Seventeen years experience in all phases of aviation to include, flight operations, maintenance, logistics, quality assurance, training and scheduling.

STRATEGIC PLANNING

Co-chaired the operations panel for the 1995-96 Advanced Battlespace Information Study commissioned by the Undersecretary of Defense Deputy for Research and Engineering and the Joint Chiefs of Staff. The Department of Defense accepted the report recommendations and redirected command and control research funds to those programs which supported the study's technology roadmap. This study, published in 1996, served as a cornerstone for the Joint Chiefs of Staffs 15 year strategic plan, *Joint Vision 2010.*

Instituted an infrastructure planning process addressing the unit's 77 buildings and 1.3 million square feet of floor space. Procured $80,000 from regional headquarters for a long-term engineering development plan.

OPERATIONAL ANALYSIS

Used unit cost and repair data to isolate a low-cost, high failure rate item in the F-16 wheel brake system. Formed and directed a team of technical experts to investigate the problem and develop corrective actions. The locally developed procedures were adopted Air Force wide in 1995.

Developed a unit based metric for tracking aircraft engine transportation to and from the Pacific regional repair facility. This metric was adopted throughout the Pacific Air Forces in 1995 and led to an asset reallocation reducing the transportation time 375%.

EDUCATION

National Security Manager's Course, Syracuse University, 1996
(2 month executive education)
Master of Science (Management), Troy State University 1985
Bachelor of Science (Economics), US Air Force Academy, 1974

PROFESSIONAL MILITARY EDUCATION

NATO Defense College, Rome, Italy, 1994
Air War College, 1988
Air Command and Staff College, 1985

RONALD E. FLY, Colonel, USAF (Retired)
Addendum

EDUCATION & TRAINING

Member, Board of Directors, Air Combat Command's Professional Military Education. Set the education and training policy and guide lines for approximately 90,000 USAF personnel.

Eight years experience as a formal course instructor.

- Wrote course objectives, study guides, teaching manuals, tests and other academic courseware.
- Designed syllabi to include integrated academic and advanced practical training flow.
- Academic instructor, taught all phases of aerial combat, air-to-air munitions, radar, electronic countermeasures, and aerospace physiology.
- Multiple awards as the Top Academic Instructor and the Best Instructor Pilot.

INTERNATIONAL AFFAIRS

Over four years experience in the HQ USAF International Affairs Division Office of the Vice Chief of Staff.

- 2½ years on the Middle East Africa desk, 2 years as the NATO and multinational desk officer
- Daily interaction with foreign attaches concerning access to USAF information and visits to USAF installations
- Technology Transfer . . . served as the gatekeepers for technology
    - Chairman, F-16 Multinational Technical Coordinating Group (US and the four NATO F-16 co-production partners). Responsible for resolving all technology transfer issues within the group.
    - Recognized expert in weapons systems, fighter aircraft, radars, and electronic countermeasures
    - Authored the USAF LANTIRN release policy, approved by CSAF

- IIQ USAF lead on the UK and French E-3 AWACS sale, adroitly handled several key issues concerning software and technical drawings.

SPACE OPERATIONS

Planned and led the ICS sponsored Tactical Exploitation of National Capabilities (TENCAP) Special Project 97 exercise. Focused on providing national capability to support theater ballistic missile defense initiatives.

Defense Support Program. The JCS lead for the current shared early warning program. Met the aggressive schedule directed by the President to provide Israel with an early warning capability, established the baseline architecture for the growing SEW initiative.

Routinely Co-chaired the NIMA Customer Advisory Board involving over 12 different agencies. Helped ensure a smooth transition as NIMA was formed by merging other agencies.

NATIONAL MISSILE DEFENSE

Designed and developed the exercise evaluation program to test NMD weapons engagement scenarios and weapons release authority levels.

PLANNING

Planned and procured funding for $7M major runway infrastructure repair project at Kunsan AB, Korea. The project, involving moving over 600 personnel and $1B dollars worth of assets to two other operating locations, was successfully executed providing much needed infrastructure repair and enhancement.

CONTINGENCY EXECUTION

Led the Hurricane Andrew evacuation, involving 75 airplanes and over 200 personnel, from MacDill AFB, FL to Dobbins AFB, GA. The short notice evacuation was smoothly executed with minimum problems.

OPERATIONAL TEST AND EVALUATION

Commander of the Utah Test and Training Range., the largest overland range in the free world and the only overland range authorized for test of cruise missiles and other large safety footprint weapons.

- Directed the use and implementation of test range assets for calibration of airborne laser targeting systems. Leveraged the use of test equipment to improve operational capability.

- Implemented new procedures to increase range safety and minimize the possibility of damage to non-test facilities located on the range.

LOGISTICAL SUPPORT

Identified problems with a high cost, high failure rate component of the F-I 6 radar.

- Developed local operational and repair procedures to increase the mean time between failure rate and increase the radar reliability.

- Directed technicians to work with the regional repair facility and identify a long term improvement. A redesign of the component involving a new memory chip was developed and an 18 month replacement plan initiated.

February 19, 2002

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
PRIVATE FUEL STORAGE L.L.C.	)	Docket No. 72-22
	)	
(Private Fuel Storage Facility)	)	ASLBP No. 97-732-02-ISFSI

APPLICANT'S EXHIBITS