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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-ISFSI
	)	
(Independent Spent Fuel Storage Installation)	)	

NRC STAFF'S PROPOSED FINDINGS IN REPLY TO THE STATE OF UTAH'S PROPOSED FINDINGS CONCERNING CONTENTION UTAH K/ CONFEDERATED TRIBES B (INADEQUATE CONSIDERATION OF CREDIBLE ACCIDENTS)

I. INTRODUCTION

Pursuant to 10 C.F.R. § 2.754 and the order of the Atomic Safety and Licensing Board (Licensing Board) of July 2, 2002, the staff of the Nuclear Regulatory Commission (Staff) submits its proposed findings of fact and conclusions of law in reply to the State of Utah's proposed findings, concerning Utah Contention K/Confederated Tribes Contention B (Inadequate Consideration of Credible Accidents). *See* Tr. 13,519.

II. BACKGROUND

The Commission has determined that the appropriate probability standard to apply to a Part 72 facility in defining what constitutes a credible aircraft accident is 10^{-6} per year. *Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), CLI-01-22, 54 NRC 255 (2001). In order to determine whether Private Fuel Storage, L.L.C. (PFS or the Applicant) has demonstrated that the 10^{-6} probability standard has been met with respect to its proposed Part 72 facility, the Licensing Board received evidence with respect to the following issues: 1) the hazard posed to the facility from F-16s transiting Skull Valley, including jettisoned ordnance; 2) air-to-air combat training on the Utah Test and Training Range (UTTR); 3) aircraft flying on the Moser Recovery Route

(MRR); 4) aircraft flying to and from Michael Army Airfield (MAAF) on IR-420; and 5) the cumulative hazard to the PFS facility from aircraft accidents and ordnance. *Private Fuel Storage, L.L.C.*, (Independent Spent Fuel Storage Installation), LBP-01-19, 53 NRC at 455-56. Following evidentiary hearings held with respect to these issues in Salt Lake City, Utah and Rockville, Maryland, the parties submitted their proposed findings of fact and conclusions of law related to this contention, in which they addressed the evidence adduced at hearing.[1]

Having considered the parties' proposed findings of fact and conclusions of law with respect to Contention Utah K/Confederated Tribes B, the testimony presented at the hearings and other evidence in the record, we find that the evidence supports a conclusion that the cumulative probability of a civilian or military aircraft crashing at or affecting the PFS facility (including jettisoned ordnance) is within the acceptance criterion of 10^{-6} per year. Therefore, reasonable assurance exists that civilian or military air crash accidents (including jettisoned ordnance) do not pose a significant hazard to the facility.

III. REPLY FINDINGS OF FACT

1. The State sets forth its findings with respect to Contention Utah K/Confederated Tribes B in "State of Utah's Proposed Findings of Fact and Conclusions of Law Regarding Contention Utah K/Confederated Tribes B," (State Findings) dated August 30, 2002. We address the State's Findings below.

Witness Qualifications

2. In setting forth the qualifications of its witnesses, the State sets forth in detail the qualifications of Lt. Col. Horstman, and asserts that, unlike the PFS witnesses, who are no longer

[1] *See* (1) "NRC Staff's Proposed Findings of Fact and Conclusions of Law Concerning Contention Utah K/Confederated Tribes B (Inadequate Consideration of Credible Accidents)," dated August 30, 2002 (Staff Findings); (2) "Applicant's Proposed Findings of Fact and Conclusions of Law on Contention Utah K/Confederated Tribes B," dated August 30, 2002 (Applicant Findings); and (3) "State of Utah's Proposed Findings of Fact and Conclusions of Law Regarding Contention Utah K/Confederated Tribes B," dated August 31, 2002 (State Findings).

engaged in aviation, Lt. Col. Horstman continues to fly as a commercial pilot piloting Boeing 747 jets. State Findings at 14, 15-16.

3. With respect to Lt. Col. Horstman's experience, we note that Lt. Col. Horstman is qualified as an expert witness on the subject of F-16 aircraft operations and training operations, including operations at Hill AFB. *See* Staff Findings at 16. We do not consider, however, that his experience as a pilot of commercial jets provides him with an advantage over the Applicant's experts in that commercial flights are no longer at issue with respect to this contention and the Applicant's witnesses have experience in flying numerous different types of military aircraft. Cole/Jefferson/Fly Post Tr. x, at 2, 4, 6.

4. The State asserts that Lt. Col. Horstman retired from the Air Force in 1999. State Findings at 14. We do not find that Lt. Col. Horstman's more recent retirement from the Air Force provides him with superior knowledge of Air Force operations or operations at Hill AFB. In this regard, Col. Fly retired from the Air Force in 1998 after serving as the commander of the 388th Fighter Wing at Hill AFB. *Id.* at 6. Lt. Col. Horstman was deputy commander of the operations group of the 388th Fighter Wing at Hill AFB under Col. Fly. Tr. 4277-78. Lt. Col. Horstman retired from the Air Force in the year following Col. Fly's retirement. *Id*. Therefore, both Col. Fly and Lt. Col. Horstman have familiarity with the operations at Hill AFB.

5. The State asserts that Dr. Resnikoff's experience includes analysis of dry cask disposal designs and storage installations and that he has "estimated the probability" of accidents regarding air, train and truck accident rates for the States of New York, Nevada and Utah. State Findings at 14-15. Contrary to the State's assertion, although Dr. Resnikoff has reviewed NRC reports regarding air, train and truck accident rates, he has not previously estimated the probability that an aircraft, train or truck would crash into a facility. Tr. 8805-06. Thus, Dr. Resnikoff does not have specialized knowledge pertaining to estimating the probability of an aircraft crash into a facility, and therefore his testimony should be weighted accordingly.

6. The State makes a number of assertions regarding the qualifications of the Applicant's and the Staff's witnesses. The State first asserts that Gen. Jefferson, Gen. Cole, and Col. Fly were retained by PFS through a consulting firm and were paid one thousand dollars per day for participating in the hearing. State Findings at 15-16. The fact, however, that a witness is a hired consultant does not undermine the value of the witness' testimony. *Metropolitan Edison Co.* (Three Mile Island Nuclear Station, Unit 1), ALAB-772, 19 NRC 1193, 1211 (1984), *rev'd on other grounds*, CLI-85-2, 21 NRC 282 (1985). Therefore, the fact that the Applicant's experts were paid for providing expertise to the Applicant does not impinge on the credibility of their testimony.

7. With respect to Gen. Jefferson, the State asserts that Gen. Jefferson has never flown an F-16 fighter aircraft, has never flown through Skull Valley, and has never ejected from any aircraft. Further, the State asserts that Gen. Jefferson has no prior experience using NUREG-0800 or using the DOE standard for aircraft crash analysis. State Findings at 15. Regarding Gen. Cole, the State asserts that Gen. Cole has never flown an F-16 fighter aircraft, has never flown through Skull Valley, and has never ejected from any aircraft. Further, the State asserts that Gen. Cole has not previously done a crash impact evaluation nor studied the issue of whether a F-16 pilot would be able to avoid a ground site. State Findings at 15-16. The State asserts that Col. Fly has never ejected from an F-16. *Id.* 16.

8. First, we note that neither the Applicant's military experts, nor Lt. Col. Horstman have ejected from any aircraft. Tr. 3216-17. Horstman, Tr. 8561. The evidence in the record, however, shows that Gen. Cole, Gen. Jefferson, and Col. Fly have jumped from aircraft, skydived, and have been involved in significant in-flight emergencies. Tr. 3216-17. Tr. 3608-25 (describing in-flight emergency experiences). In addition, we have heard live testimony from Col. Frank Bernard and Col. Michael Cosby, both of whom ejected from F-16s. As discussed, *infra*, these witnesses' testimony corroborates the Applicant's assertions regarding pilot's avoidance of people and objects on the ground. We give the testimony of Col. Bernard and Col. Cosby substantial weight.

Therefore, we do not consider the fact that the Applicant's witnesses have not ejected from an F-16 in any way diminishes the force of their testimony.

9. Second, we do not consider the fact that Gen. Jefferson and Gen. Cole have not flown an F-16 aircraft to impinge upon the weight of their testimony or the validity of the Applicant's aircraft crash report. In this regard, we note that the Applicant's expert witnesses, Gen. Jefferson, Gen. Cole, and Col. Fly have extensive Air Force experience. Collectively, they have nearly 90 years of Air Force flight experience. Tr. 3529. Cole/Jefferson/Fly Post Tr. x at 1-7. They have collectively 15,000 hours of total flying time and 1,500 hours of time in combat, air-to-ground, gunnery and ordnance delivery. *Id*. They have been chief pilots, operations officers, and commanders. Tr. 3529.

10. Further, the Applicant's aircraft crash report was a collaborative effort, in which each of the 3 witnesses, while jointly responsible for the assessment of the risk to the proposed facility due to aircraft crashes and ordnance impacts, provided input based on their individual perspectives. Cole/Jefferson/Fly Post Tr. x at 3, 5, and 7. With respect to direct F-16 flight experience, Col. Fly flew approximately 1,200 hours in the F-16 as a pilot and instructor. Cole/Jefferson/Fly Post Tr. x at 6. In addition, he served as a Commander of the 388th Fighter Wing at Hill AFB from 1997-1998 and has flown F-16s on the UTTR and through Skull Valley. *Id.* Col. Fly is well qualified as an expert witness on the subjects of Air Force F-16 aircraft operations, F-16 emergency procedures and flight operations in and around the UTTR, including operations at Hill AFB, which were the primary areas of his effort. *Id*. Therefore, the fact that Gen. Jefferson and Gen. Cole have not flown an F-16 does not impinge upon the weight of the Applicant's aircraft crash analysis or the panel's testimony.

11. Gen. Jefferson was responsible for the modeling and calculations used to determine the various factors associated with the assessment of the probability that a military aircraft would crash at the PFS facility or that ordnance jettisoned from a military aircraft would strike the facility.

Cole/Jefferson/Fly Post Tr. x, at 5. He reviewed the mishap reports for the F-16 for the 10 year period from 1989 through 1998. *Id*. Gen. Jefferson has been formally trained in statistics and probability theory and has 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, etc. *See* Tr. 3504-05; Cole/Jefferson/Fly Post Tr. x, at 5. As a pilot, he routinely reviewed accident reports germane to his aircraft type. As the Assistant Deputy for Operations of the Strategic Air Command, he reviewed accident reports for briefing to the commander and for corrective actions. Cole/Jefferson/Fly Post Tr. x, at 4. Since retiring from the Air Force, Gen. Jefferson has been a consultant in management, management training, and quantitative probabilistic analysis. He has provided risk management training for General Electric Corp. *Id*. We find Gen. Jefferson to be well qualified to address the modeling and calculations of the various probabilities and risk factors associated with the assessment. We also find Gen. Jefferson to be well qualified as an expert on the subjects of Air Force aircraft operations and weapons testing and training operations. *See* Staff Findings at 10-11.

12. Gen. Cole was jointly responsible for the Applicant's assessment of the risk to the facility with respect to overall aviation safety, data and information concerning military and civilian air traffic in the region of the PFS facility and aircraft accident rates. Cole/Jefferson/Fly Post Tr. x, at 3. He reviewed in depth the Air Force's mishap reports for the F-16 for the 10 year period from 1989 through 1998. *Id*. As a former Air Force Chief of Safety, Gen. Cole was responsible for accident prevention and investigation in all aspects of ground and air operations. He personally reviewed and approved every Air Force Accident Safety Investigation report for all types of aircraft. *Id*. We therefore find Gen. Cole to be well qualified to address overall aviation safety, accident rates and the data he collected concerning military air traffic in the region of the PFS facility. *See* Staff Findings at 10-11.

13. On the basis of the experience of Gen. Jefferson, Gen. Cole and Col. Fly, we find that the Applicant's panel of military experts embodies an impressive breadth and depth of experience in the areas of Air Force operations, aviation safety, Air Force training, F-16 operations, and ordnance testing and training. We consider that the panel's varied expertise and experience enable us to give their testimony substantial weight.

14. The State asserts that Mr. Vigeant is not a pilot, has never flown through Skull Valley and has not studied the extent to which a pilot can see under various cloud conditions and altitudes. State Findings at 16. Mr. Vigeant's testimony, however, was offered to describe the weather data that he provided to support the Applicant's analysis of the impact of weather on aviation operations in and around Skull Valley. Vigeant, Post Tr. x at 2. The effect of weather on pilots' actions is discussed in the prefiled testimony of Gen. Cole, Gen. Jefferson, and Col. Fly. *See* Cole/Jefferson/Fly Post Tr. x at 49-57. Therefore, Mr. Vigeant's lack of pilot experience is irrelevant.

15. The State asserts that the Staff's witnesses, Dr. Campe and Dr. Ghosh, have no pilot experience. State Findings at 17. Dr. Campe and Dr. Ghosh reviewed the Applicant's Safety Analysis Report pertaining to external hazards and participated in the Staff's preparation of the SER. Campe/Ghosh Post Tr. x, at 2. Dr. Campe reviewed aircraft crash hazards for nearly all of the nuclear power plants in the country and was the principal contributor for that portion of NUREG-0800 pertaining to aircraft hazards. Tr. 4090, 4122. Campe/Ghosh Post Tr. x, at 1-2. *See also* State Findings at 20, 37-38. Dr. Ghosh has experience with respect to probabilistic risk assessments and the design of surface and subsurface facilities. He is currently the technical lead for preclosure activities of the proposed high-level nuclear waste repository at Yucca Mountain and is involved with probabilistic risk assessment, identification of hazards and initiating events and repository design. *Id.* Dr. Ghosh was the principal author of the Center for Nuclear Waste Regulatory Analyses' conference paper, "Preliminary Aircraft Crash Hazard Assessment at

Proposed Yucca Mountain Repository." State Exh. 157. Ghosh, Tr. 4111. The Licensing Board finds Dr. Campe and Dr. Ghosh to be well qualified as expert witnesses on the subject of aircraft crash hazard assessments.

16. In addition, during the course of their review of the Applicant's aircraft crash analysis, the Staff witnesses met with personnel at Hill AFB as part of their confirmatory analysis. Tr. 4171. Tr. 4186-87. Tr. 8921. Tr. 8931-32. Thus, the Staff had access to Air Force pilots during the course of the Staff's evaluation of the Applicant's aircraft crash analysis. In this respect, Staff guidance recommends such communications with agencies responsible for aircraft operations. *See* PFS Exh. RRR (NUREG-0800) at 3.5.1.6-3 (in the review process, communications with agencies responsible for aircraft operations and the evaluation of aircraft operational data may be utilized). Therefore, we do not consider the fact that the Staff's witnesses are not themselves pilots in any way affects the weight we should give to their testimony or their review of the Applicant's analysis.

Changes in the Future

17. The State asserts that the military activity in the Sevier B and Sevier D MOA airspace "varies dramatically" from year to year. State Findings at 19. The number and type of missions flown as well as the number and type of bombs and other ordnance carried depend on Air Force tactics and training needs, national policy, budgets and the state of world conflict. *Id.* The State asserts that changes in military training cannot be anticipated and are "completely outside of the regulatory loop," unlike the "gradual evolution" of commercial air flights. *Id.*

18. The State asserts that no evidence is before the Board as to the nature of future training missions or weapon systems that will be active in Skull Valley after the F-16 is retired. Thus, the State argues, in the majority of the proposed 20-year license period, no evidence is available to calculate the risk to the PFS site from military aircraft crashes and weapons testing. *Id.*

19. First, we find no evidence to support the State's assertions that the military activity in the Sevier B and Sevier D MOA airspace "varies dramatically" from year to year. Rather, the evidence in the record shows that there has been little change in actual Air Force training requirements over the years. Fly, Tr. 13,086. In this respect, an air-to-ground unit is required to fly a set amount of sorties and drop a set amount of ordnance to maintain its designated operational capability. Tr. 13,082-86. Although the budget influences the Air Force's training capability, the evidence in the record suggests that the Air Force budget has decreased by approximately a third from 1986 to 1995 and that there are less aircraft and people. Tr. 13,087. In addition the Air Force is experiencing an overall downsizing in budget and Air Force structures, in conjunction with the use of more high-technology, precision-guided munitions. Tr. 13,088.

20. Second, the Staff's SER addresses the long-term trends in military aviation to project the estimated aircraft crash probability of the proposed facility. The Staff considered that, although it is difficult to predict the structure of the Air Force in the future, historic trends and current acquisition programs indicate a relatively small future force structure. NRC Exh. C (SER) at 15-99. In this regard, the Staff's SER noted that the Air Force is replacing older and less capable aircraft with modern, more advanced aircraft. *Id.* at 15-98. Significant resources are spent on research, improved design, manufacturing, and quality control so as to make the new aircraft safer to operate. *Id*. Thus, the crash rates of newer aircraft are expected to be decreasing relative to those of their predecessors. *See also* Cole/Jefferson/Fly, Post Tr. x at 32-33.

21. The Staff stated that the FAA predicts that military air traffic will not increase appreciably, if at all, in the foreseeable future. Based upon the projections of the FAA, the number of military aircraft handled at FAA en route traffic control centers will remain constant at 4.2 million in 1998 through 2025. *Id.*

22. The Staff also considered that the Air Force has experienced an approximately one-third reduction in personnel, equipment, and funding since the end of the Cold War. In this respect, the

number of aircraft in the inventory of the Air Force has decreased from 7,640 in FY 1992 to 6,205 in FY 2000, with a corresponding decrease of flying hours from 2,790,000 to 2,036,000. Reduced budgets and increased fuel costs have resulted in constrained flying hours for training. Moreover, use of constantly improving flight simulators is enabling the pilots to advance flying proficiency with reduced actual flying hours. NRC Exh. C (SER) at 15-99.

23. Additionally, the Staff considered that the Joint Strike Fighter Aircraft is expected to replace the F-16 aircraft. The Air Force plans to procure a total of 1,763 Joint Strike Aircraft over the lifetime of the airplane, approximately 78 percent of the 2,230 F-16s that have been ordered. NRC Exh. C (SER) at 15-99. *See also* Cole/Jefferson/Fly Post Tr. x at 22-23.

24. The Staff concluded that military aircraft crash probabilities are expected to remain at or below the staff's projected cumulative value of 3.9×10^{-7} crashes per year for military aircraft in the future. NRC Exh. C (SER) at 15-99. The Staff considered that the aircraft crash hazard for the facility would remain valid for the foreseeable future, assuming the projected air traffic growth based on the long-term projections remains valid. The Staff noted, however, that "if the flight activities near the facility change significantly in the future, including the introduction of new types of aircraft whose crash statistics are not bounded by those of the aircraft considered herein, the above conclusions could be subject to change." *Id*. Therefore, the evidence in the record does not suggest that military activity will "vary dramatically" from year to year. Rather, the totality of evidence in the record shows that the Air Force is experiencing a general reduction in size in which newer model aircraft, which are safer to operate, are replacing older aircraft.

25. Further, we find no support for the State's assertion that changes in military training cannot be anticipated and are "completely outside of the regulatory loop," unlike the "gradual evolution" of commercial air flights. In this respect, as noted above, the Staff and the Applicant have considered the impact of future anticipated changes to military training. Second, there is no evidence in the record to demonstrate that military hazards are outside of the ambit of regulatory

consideration, while commercial flights, due to a purported "gradual evolution" are within the "regulatory loop."

26. The Staff, nevertheless, is aware that changes may take place in the future. *See* Staff Exh. C (SER) at 15-99 (noting that if flight activities near the facility change significantly in the future, the Staff's conclusions could change). Campe, Tr. 4194. Future changes must be brought to the attention of the Staff by the licensee if they have significant implications for public health and safety. *See* 10 C.F.R. § 72.11(b) (licensees must notify NRC of information "having a significant implication for public health and safety"). Should future changes result in an exceedance of the 10^{-6} annual probability of occurrence of an impact to the proposed ISFSI, the licensee may choose to demonstrate compliance with 10 C.F.R. Part 72 by performing a consequence analysis or by hardening its facility to withstand such events. *See* Campe, Tr. 4202-03. Therefore, the possibility of future changes does not render the Staff's assessment of military aviation hazards invalid.[2]

Value for Crash Rate

27. The State asserts that the value for the crash rate per mile of flight is 4.10×10^{-8}. State Findings at 27. This is a newly-derived number. The State's prior estimation of the crash rate was 3.39×10^{-8}. *See* Resnikoff, Post Tr. 8698 at 15. The State's post-hearing alteration of its calculation of the crash rate was not based on any information the State did not have before it when it derived the crash rate in Dr. Resnikoff's testimony. Thus, the State's post-hearing

[2] In support of its assertion, the State points to the NRC staff's notification of the Board and parties that the Air Force lowered the minimum altitude for flights in Sevier B MOA from 1,000 feet to 100 feet AGL at the location of the PFS facility. *See* State Findings at 19 n.7. According to the State, this change, allowing very low altitude flights, represents the "continuing change" in training activities by the Air Force. *Id*.

The Staff, however, notes that its August 12, 2002 letter from Mark S. Delligatti (NRC) to John D. Parkyn (PFS) requested information regarding the effect of the Air Force's altitude restriction change on the Applicant's analysis of the probability of military aircraft crashes. This letter demonstrates the Staff's readiness and ability to address future changes as part of its inspection program. *See id.* (Staff will review the information to determine whether PFS is still in compliance with applicable regulatory requirements).

alteration of its estimate, based on nothing new, "calls into serious question the thoroughness" and reliability of the analysis prepared by its expert, Dr. Resnikoff. *See, e.g., Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), LBP-01-19, 53 NRC 416, 440-41 (2001) (Licensing Board considers Lt. Col. Horstman's change in his analysis to be "troubling" and warns the State that further misstatements by the witness will impact on the credibility of his analysis).

28. The State presently asserts that using the average flight speed of 471.85 miles per hour, the ratio of 22.3 percent for destroyed F-16s occurring in normal flight and 47.18 percent of all flight miles occurring in the normal phase of flight, the crash rate per mile for normal flight based on lifetime F-16 mishap data from 1975 through 2001 is 4.10×10^{-8}. State Findings at 26. Therefore the State now believes that the value for C should be 4.10×10^{-8}. State Findings at 27.

29. The State's calculation differs from that of the Applicant in that the State's crash rate per mile of flight for normal flight is based on the F-16 data from 1975 through 2001, whereas the Applicant's crash rate per mile of flight for normal flight is based on F-16 data from 1989 through 1999. Further, the State applied a ratio that represents the percent of destroyed aircraft that occurred during normal flight, whereas the Applicant applied a ratio that represents the percent of the ACRAM Class A and Class B mishaps that occurred during normal flight.

30. The State first asserts that the Applicant, in deriving the crash rate per mile of flight, applied a ratio that represents the percent of the ACRAM Class A and Class B mishaps that occurred during normal flight and that the Applicant should have applied a ratio representing the percent of all destroyed aircraft that occurred during normal flight. *See* State Findings at 20-23, 25-27, 68-69. Of the ACRAM Class A and Class B mishaps from 1975 to 1993 (the years of the ACRAM report database), 15.09 percent occurred during normal flight. *Id.* at 22. Of the 121 F-16 destroyed aircraft during 1989 through 1998 (the years of the PFS experts' analysis), 22.3 percent occurred during normal flight. *Id.* The State argues that the Applicant should have used a value of 22.3 percent.

31. The State asserts that because of 1) the unknown distribution of Class A and B mishaps between the various phases of flight in the ACRAM study, and 2) the comparatively older data of the ACRAM study, the ratio indicating that 22.3 percent of all destroyed aircraft are destroyed in normal flight phase, when applied to the number of total destroyed F-16s, is the "best evidence" on which to base an estimate of F-16 mishaps occurring in the normal flight phase. State Findings at 26.

32. With respect to the unknown distribution of Class A and Class B mishaps in the ACRAM study, the State asserts that the ACRAM study does not indicate whether mishaps shown for each stage of flight - - normal, special in-flight, takeoff, and landing - - are Class A, Class B or some combination of the two. State Findings at 22. In this respect, the State asserts that during the years 1975 to 1993 on which the ACRAM data are based, a greater percentage of Class B mishaps occurred in flight phases other than the normal phase of flight, resulting in the lower 15.09 percent normal flight ratio for Class A and Class B mishaps and the higher 22.3 percent normal flight ratio for destroyed aircraft. State Findings at 22-23.

33. The State, however, has not presented any argument to show that the use of the ACRAM data does not provide a valid basis for deriving the percentage of Class A and Class B mishaps that take place in normal flight. The State does not explain how the non-delineated nature of the mishap distribution in the ACRAM report renders it invalid. Rather, the State considers that the ratio representing the percent of all destroyed aircraft that occurred during normal flight is the "better evidence."

34. We do not consider that the use of the destroyed aircraft, as presented by the State, is a preferable approach. The problem with the State's approach is that the State took some assumptions and estimates of the ACRAM analysis, which is based on Class A and Class B mishaps, (*e.g.*, 471.85 mph and 47.18% of flights flown in normal flight phase), and data for 1975 through 1993, and applied the data to other assumptions and estimates from the Applicant's expert

panel's analysis (*e.g.*, 22.3 percent of destroyed aircraft mishaps in normal flight phase), which spanned 1989 through 1998. Consequently, the analysis presented by the State likely violates characteristics in both studies in that it may contain an inconsistency between data and assumptions used in estimating the crash rate. As a result, the estimated crash rate in the normal flight phase for destroyed aircraft is unrealistically high, 4.10×10^{-8} crashes per mile. For comparison, the ACRAM study, which uses data for Class A and Class B mishaps from 1975 through 1993, estimates the normal in-flight crash rate to be 3.86×10^{-8} crashes per mile. The Applicant's approach therefore represents a more consistent use of data derived from the ACRAM study and the Air Force's Class A and Class B data obtained for later years.

35. Further, the crash rate determined by the ACRAM study should be the upper limit of the estimated crash rate in that the results are based in part on data for the first 4 years (1975 through 1978) during which time the aircraft were flying a small number of hours and were not flying in any operational unit of the Air Force. *See* Staff Findings at 26-27; Horstman, Tr. 8558. The crash rates in the early years were extremely high relative to the crash rates in the later years, which were decreasing. *See* State Exh. 154 (F-16 crash history); Staff Exh. C (SER) at 15-61; Campe/Ghosh Post Tr. x, at 14-15. Ghosh, Tr. 8900-01; Staff Exh. LL (F-16 linear regression analysis). Therefore, the crash rate for mishaps involving destroyed aircraft, which is a subset of Class A mishaps, should be smaller than that given by ACRAM. Consequently, the State's newly-derived crash rate of 4.10×10^{-8} crashes per mile, which exceeds the ACRAM study rate of 3.86×10^{-8}, is not consistent with the evidence adduced at the hearing.

36. The State criticized the Applicant's claim that its estimate of the crash rate is conservative because it is based on total Class A and Class B mishaps, which were higher in number than the number of destroyed F-16s during the 10 year period 1989 through 1998. State Findings at 68. The State asserts that the Applicant is not correct because the Applicant based its crash rate on ACRAM data, which provides only total mishap data without considering whether a mishap is a

Class A or Class B mishap. State Findings at 68. According to the State, the Applicant used the ratio from the ACRAM data showing 15.09 percent of mishaps from all flight phases occurred in normal flight, and the ratio is higher for the percentage of destroyed aircraft occurring in normal flight phase. *Id*.

37. The State asserts that the application of the percentage of mishaps occurring during normal flight cannot be applied to the subset of Class A and B mishaps. State Findings at 69. According to the State, no basis exists to conclude that the Applicant's crash rate is conservative by the fact that there were more total mishaps than destroyed aircraft during 1989 through 1998. State Findings at 69.

38. We find that the State's assertion regarding the Applicant's claim of conservatism with respect to the crash rate is not correct because the Applicant used the information pertaining to Class A and Class B mishaps of the ACRAM analysis to develop the crash rate for both Class A and Class B mishaps. The destroyed aircraft category, which is more appropriate for hardened structures, such as PFSF, is a subset of Class A mishaps. Consequently, the crash rate for the destroyed aircraft category is lower than both Class A, and Class A and Class B rates. This is evident from the ACRAM analysis as well as Air Force databases.[3] *See, e.g.*, State Exh. 50.

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[3] In addition, as stated previously, the State uses specific information from two different analyses to develop the crash rate. The ACRAM data use mishap information from 1975 through 1993 for both Class A and Class B mishaps and Tables 4.7 and 4.8 of the ACRAM analysis show that a total of 212 Class A and Class B mishaps took place over the 1975 through 1993 time period; out of which 18 mishaps took place during takeoff, 58 during landing, 32 during normal in-light, and 104 during special in-flight phases. For comparison, only 180 mishaps resulted in destroyed aircraft over the same time period. Therefore, 32 out of 212 or 15.09 percent of total Class A and Class B mishaps during 1975 through 1993 took place in normal in-flight phase.

The State is comparing this ratio, which has been used to develop the crash rate for Class A and Class B mishaps in the normal in-flight mode, with the ratio of 22 percent of destroyed aircraft category in normal in-flight mode developed using the information for the years from 1989 through 1998. PFS Exh. N at Tab H. The State uses the 22 percent ratio to estimate the crash rate in normal in-flight mode. As discussed, *supra*, the State's use of some information from the ACRAM analysis, applied to other assumptions and estimates derived from the Applicant's expert

(continued...)

39. The State asserts that not all F-16 flights through Skull Valley are low risk activities because of the speed, altitude and nature of the missions. The State asserts that low level flying 500 feet AGL and below is "very unforgiving due to the proximity with the ground, with little margin for pilot error." State Findings at 23-24. Low level flights and maneuvering operations in restricted airspace are classified as "special operations" flight phase and have a substantially higher crash rate than the normal flight phase. *Id.* at 24. Therefore, the State asserts that the use of only normal flight data to calculate the crash rate is not conservative.

40. We note first that the State, Applicant, and Staff are in accord that F-16s typically transit Skull Valley at altitudes from 3,000 to 4,000 feet AGL. *See* State Findings at 28, 31; Applicant Findings at 12, 36, 49, 77; Staff Findings at 78. Second, with respect to flights occurring at altitudes of 500 feet AGL and below, we note that there is no evidence in the record that flights take place less than 1,000 feet AGL in Skull Valley.[4] *See, e.g.* Horstman Post Tr. x at 9-10 (low level flights below 1,000 feet not conducted in Skull Valley). Third, according to the Air Combat Chief of Safety, "low level flying at 500 feet or above (except for obstacles and birds) is not generally considered high risk." *See* PFS Exh. N (Aircraft Crash Report) at Tab F. In this respect, an author of the ACRAM study who was responsible for analyzing the military crash data set forth in the study advised the Applicant that the term "special" operations describes the high stress, violent

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[3](...continued)
panel's analysis, likely violates characteristics of both studies and results in an unrealistic crash rate.

[4] The August 12, 2002 letter from the Staff and the August 23, 2002 letter from the Applicant regarding the lowest altitude at which F-16s are permitted to fly through Skull Valley on their way to the UTTR are not part of the record of this proceeding. The transcript of testimony and exhibits, together with all papers and requests filed in the proceedings, constitute the exclusive record for decision. *See* Administrative Procedure Act (APA), § 556 (e). A licensing board may not base a decision on factual material that has not been introduced into evidence. *Tennessee Valley Auth.* (Hartsville Nuclear Plant), ALAB-463, 7 NRC 341, 352 (1978) (no probative weight given to extra-record material). Therefore, the Licensing Board should not entertain arguments based on extra-record information.

maneuvers that occur in simulated air-to-air combat and air-to-ground weapons deliveries in restricted area ranges which significantly increase the potential for air crashes. *See* PFS Exh. N (Aircraft Crash Report) at 11-12.

Use of a 10-year Database

41. The State asserts that it is not reasonable or conservative to base the F-16 crash rate on data from the 10-year period from 1989 through 1998. The State asserts that the mishap data for the 10-year period produces the lowest 10-year average crash rate in the F-16 history and that the years 1995 through 2001 show an increasing trend in crash rate. According to the State, the most realistic estimate of future F-16 crash rates is obtained by using the entire F-16 crash history for all years available. State Findings at 24. We note that the State's claims in this regard have been sufficiently addressed in the Staff's and Applicant's Findings and need not be restated herein. *See* Staff Findings at 30-42; Applicant Findings at 56-62. *See also, e.g.,* State Exh. 154; Campe/Ghosh Post Tr. x, at 14-15; Staff Exh. C (SER) at 15-61; Staff Exh. LL; PFS Exh. Q; PFS Exh. UUU; PFS Exh. VVV; Tr. 3376-77; Tr. 3726; and Tr. 8751.

42. The State asserts that no objective basis is given by PFS as to why the years 1989 to 1998 were chosen as the basis for a crash rate, but rather the decision was "admittedly subjective." State Findings at 24. Rather, the exhibit and testimony cited by the State provides the rationale for selecting the 10-year data base. *See* PFS Exh. N (Aircraft Crash Report) at 11.

> PFS has used the 10-year average crash rate in its calculations. Use of the lifetime average for calculating future crash probability would be unduly conservative given the clear trend towards lower rates, as would be expected as discussed above, both for the F-16 crash data, and military aircraft crash data generally. The five-year average represents the most recent F-16 experience and might, for that reason, be considered more reliable as a future predictor. However, to be conservative and to avoid the possibility of statistical aberrations that might occur over shorter intervals of time, PFS has chosen to use the 10-year average crash rate in its probability calculations.

Id.

Gen. Jefferson testified that the Applicant selected the 10-year period as a proper database to use because of the recency of the data, as well as being a long enough average to not be unduly influenced by one year's experience. Tr. 3363. Thus, the use of the 10-year period from 1989 through 1998 is not without basis.

43. The State asserts that Dr. Campe testified that the years 1995 through 2001 "show an increasing trend and that it would be appropriate for PFS to base its crash rate on additional years." State Findings at 24. Dr. Campe's statements are taken out of context and twisted together to make it appear that Dr. Campe considers that the Applicant was in error not to use the data for the years up through 2001. First, while Dr. Campe stated that Dr. Resnikoff's analysis with respect to the 1995 through 2001 data shows an increasing trend, he did so in the context of showing that no other 6-year data set shows an increasing trend. *See* Campe, Tr. 8900 ("I would say that if one isolates oneself to that time period, then, indeed, this is what the linear regression would produce as a result.") He did not agree, however, that Dr. Resnikoff's selection of the 1995 through 2001 data is the appropriate period of time to use in order to do that analysis.[5] Tr. 8949. Second, while Dr. Campe stated that is would be appropriate to include later years in the crash rate, Dr. Campe testified that he meant that in a technical sense that there is nothing inappropriate with adding additional years, but that at the time an analysis is performed, the best available data is used. Tr. 8950. Thus, he would not require the Applicant to redo the analysis each year as soon as new data became available. Tr. 8951.

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[5] In this respect, we note that the Staff evaluated a broader range of data that did not depict an increasing crash rate in the latter years of the F-16 database. The Staff's witness, Dr. Ghosh, performed several linear regression analyses for F-16 Class A and Class B mishaps -- the same data category used by the State. Starting with 1979, Dr. Ghosh performed a linear regression analysis for each year, using a range from the test year up to 2001. Tr. 8900-01. *See* Staff Exh. LL (F-16 linear regression analysis). In the 21 tests performed, only 3 - - those for 1994, 1995, and 1996 - - show a positive correlation. All the other years show either no correlation or a negative correlation. *Id.*

44. The State asserts that the determination of the crash rate per mile of flight is limited by the fact that the only related evidence presented was based on F-16 fighter aircraft stationed at Hill AFB. No studies or estimates of the crash rate for the replacement aircraft have been made and no evidence exists as to the type of training missions that will be flown by the replacement aircraft. Therefore, the State considers that there is insufficient evidence to determine the crash rate per mile for flights transiting Skull Valley above or near the PFS site after 2010. State Findings at 27.

45. The State ignores the vast body of evidence adduced at the hearing regarding the beginning-of-life crash rates for the replacement fighter aircraft for the F-16. That evidence is set forth in the Staff's and the Applicant's Findings and will not be repeated at length here. The Applicant and the Staff clearly demonstrated that based on improvements to newer aircraft models, the decreasing introductory aircraft crash rates, and the overall decreasing aircraft crash rates, the replacement aircraft is expected to be safer than the F-16 during its introduction and throughout its total life cycle. *See* Staff Findings at 25-30; Applicant Findings at 59-62; Cole/Jefferson/Fly Post Tr. x, at 32; Tr. 8656; Tr. 3367-68; Tr. 3370; Campe/Ghosh Post Tr. x at 15. Therefore, the Applicant's crash rate is conservative with respect to flights of the replacement aircraft of the F-16 over Skull Valley during the licensed life of the PFS facility.

Value for Width

46. The State asserts that the width of the Sevier B MOA that is actually used by F-16 formations extends from one mile east of the western MOA boundary to 5 miles west of the eastern MOA boundary, or a width of approximately 6 miles. State Findings at 30. The State asserts that most of the flights through Skull Valley are in Sevier B MOA, and are concentrated in a narrow corridor of 5 miles or less in width above the PFS site. State Findings at 18, 29-30. Therefore, the State claims that the value for "W" in the NUREG-0800 equation should be 5 miles. *Id.*

47. The State asserts that "no evidence was presented" that F-16s transiting Skull Valley in Sevier B MOA fly further west than one mile west of the PFS site nor further east than 5 miles east

of the PFS site. State Findings at 31. First, the parties are in accord that F-16s do not fly further west than one mile of the PFS site. *See e.g.*, Horstman, Tr. 8572; Fly, Tr. 3415-16; Bernard, Tr. 3924; Cosby, Tr. 3924; Staff Exh. C (SER) at 15-63. The fact that pilots maintain distance from the western edge of the MOA was relied upon by the Staff and Applicant in their assertions that the natural shape of the MOA, the presence of the restricted airspace to the west of the MOA, and information obtained from Air Force personnel show that the predominant route of flight in Skull Valley is on the east side of the valley, away from the PFS facility. *See* Staff Findings at 49-58; Applicant Findings at 63-71.

48. The State, however, is mistaken in its assertion that no evidence was presented that F-16s fly no further east than 5 miles east of the PFS facility. The evidence suggests that the distance pilots maintain from the Stansbury Mountains on the eastern side of the MOA depends on the preferences of individual pilots. *See* Horstman, Tr. 8573. In this regard, Col. Fly stated that during his flights through Skull Valley, he would maintain a distance of "a couple thousand feet" from the mountains. Tr. 8648. Further, the Air Force has not established a minimum distance that pilots must maintain from the Stansbury Mountains. Tr. 4343. Therefore, we find that pilots can and do fly closer to the eastern boundary of the Sevier B MOA than the State asserts.

49. Finally, although the State's witness stated in his pre-filed testimony that he generally would maintain a distance of 2 miles from the Stansbury Mountains, which are 3 miles from the eastern boundary of the MOA, his testimony at the hearing was inconsistent in this regard. *Compare* Horstman Post Tr. x, at 6 (5 miles from the MOA boundary) *with* Tr. 8571 (a mile or two from the eastern edge of the MOA); *and* Tr. 8613-14 (2 or 3 miles from the eastern edge of the MOA); *and* Tr. 8572 (we tried to avoid the boundaries, east and west, by a mile or 2); *and* Tr. 8593-94 (1 or 2 miles from the crest of the Stansbury mountains - - *i.e*. "down the mountains <u>somewhat</u> would be as far east as I would ever go") (emphasis added).

50. The State asserts that the PFS statement that "the predominant route" for F-16s is 5 miles east of the PFS site is contrary to the evidence that F-16s fly in formations as wide as 4 miles, and that the basis for the statement is a "casual remark to General Cole of uncertain origin." State Findings at 30 n.12. Tr. 3398, 3402. First, the fact that F-16s fly 5 miles east of the site is not contrary to the evidence that F-16s fly in formation from 1.5 miles to 4 miles wide. The Sevier B MOA in Skull Valley has an effective width of 10 miles, of which 8 miles are east of the site. A formation flying 2 miles across in width may fly such that the centerline is 7 miles east of the site. A formation flying at a maximum width of 4 miles may fly such that the centerline is 6 miles east of the site. *See* Horstman Post Tr. x, at 6 (in a 2-ship formation, F-16s are spaced 1.5 to 2 miles apart; in a 4-ship formation, F-16s vary from "just over 1.5 to just under 4 miles" in horizontal width). Thus, evidence pertaining to the nature of formation flights does not contradict a finding that the predominant route of flight is 5 miles east of the site.

51. Second, the State's characterization of Gen, Cole's conference calls and meetings with Hill Air Force personnel as consisting of a "casual remark . . . of uncertain origin," is not accurate. In this respect, the transcript states as follows:

> Gen. Cole. On a conference call from the chief of safety for the Air Force's office with the Hill Air Force Base staff, on 20 November, we were given 3000 to 4000 by Larry Thompson and Jeff Harold, the chief of safety and his successor. I visited Hill Air Force Base on 15 December, '98 at a round table with Colonel Oholundt, vice commander at the time, and his staff and discussed a variety of issues. And that 3000 to 4000 was given to me again. And also that the eastern side of the valley is where they normally fly.
>
> Q. What exactly did they say with respect to flying or the flight path of the F-16?
>
> Gen. Cole: Generally they fly on the eastern side of the valley, fully understanding that because it is a MOA you can fly anywhere in it you wish. That came up on the conference call on 20 November, 1998. It also came up at the discussion on 15 December, 1998 when I visited Hill. I had a telephone conversation with Colonel Oholundt in July of 1999, and he reiterated that you

> could fly anywhere in the valley you wish but that, quote, the eastern side of the valley is the predominant route of choice.

Tr. 3396-97.

Further, Gen. Cole stated his belief that the distance of "approximately 5 miles east" was discussed with Col. Thompson during the November 20, 1998 conference call, who stated that 5 miles was an "approximate distance." Tr. 3398, 4302. The 5-mile distance was also discussed with Col. Oholundt during a telephone call of July 1999 and at a meeting at Hill AFB. Tr. 3404. During these discussions, Col. Oholundt told Gen. Cole, "We fly about 5 miles east, 3000 to 5000 feet AGL normally." *Id*.

52. In addition, the Applicant's prefiled testimony states that "[w]e have consistently been informed by Air Force ant 388th FW officials that the predominant route of flight through Skull Valley is approximately 5 miles east of the proposed PFSF." Cole/Jefferson/Fly Post Tr. x, at 44. The witnesses referenced the following meetings: November 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). *Id.* at n.44.

53. We do not consider the communications represented to be mere "casual remarks of uncertain origin." Therefore, contrary to the State's assertion, we find strong evidence to support a finding that the predominant route of flight of F-16 traffic in Skull Valley is 5 miles to the east of the proposed facility. Therefore, the Applicant's and Staff's consideration of a 10-mile width for the

factor, W, is conservative and acceptable in that the 10-mile width assumes a uniform distribution of flights across the corridor.[6]

54. The State asserts that the determination of the width of the airway to be used in calculating the probability of aircraft crashes at the PFS site is limited by the fact that the only related evidence presented was based on the type and flight patterns flown by F-16s stationed at Hill AFB. State Findings at 31. Gen. Cole testified that the F-16 would be replaced in 2010. Tr. 3371-72. No evidence was presented as to the type of training missions, flight altitudes or routes that will be flown by the replacement aircraft. State Findings at 31. Therefore, the State deems that there is insufficient evidence to determine the width of the airway for calculating crash probability after 2010. *Id.*

55. The State is incorrect that the only evidence pertaining to the width of the airway was based on the type and flight patterns flown by F-16s stationed at Hill AFB. Rather, the calculation for width was based primarily on the 12-mile width of the Sevier B and Sevier D MOAs at the latitude of the proposed facility. Campe/Ghosh Post Tr. x at 25. The Applicant and the Staff conservatively considered the effective width for flights in the Sevier B MOA as 10 miles on the basis that altitude flight restrictions and the rising terrain of the Stansbury Mountains will not permit flights across the full 12-mile width.[7] Campe/Ghosh Post Tr. x, at 25-26. Moreover, should changes in the future impact the value for W, the Staff will be able to exercise is regulatory oversight regarding the effect of such changes. *See* supra at 11.

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[6] The use of a 10-mile width is conservative because F-16s transiting Skull Valley typically fly on the eastern side of the MOA, away from the PFS facility site. *See* Campe/Ghosh Post Tr. x, at 25. Use of an even distribution of flights across the corridor, as opposed to modeling the flights as taking place away from the PFS facility, increases the risk to the site and therefore is conservative. *See* Jefferson, Tr. 3443.

[7] We note that even without the minimum altitude flight restriction of 1,000 feet AGL, the use of a 10-mile width would remain conservative in that aircraft would be permitted to fly closer to the mountains than the 10-miles assumed by the Applicant.

Value for Number of Flights

56. The State considers that the best evidence of the number of F-16 flights transiting Skull Valley in the past is the total number of flights shown on the usage reports for Sevier B and D MOAs. Further, the State asserts that the Applicant should have used the data from 2000 instead of the 1999 and 2000 average. In 2000 the total number of flights in Sevier B and D MOAs was 5,997, and, in April of 2001, 12 additional F-16s were stationed at Hill AFB, which the State estimated to result in a 17.4 percent increase in flights, for a total of 7,040 flights. State Findings at 32-33. The State notes that the Staff used the data from 2000 for Sevier B and D MOAs, increased to account for the 12 additional F-16s stationed at Hill AFB. *Id*.

57. The Staff, however, reduced the value it obtained for N to account for those aircraft in formation flights that do not pose a threat to the PFS facility. Campe/Ghosh Post Tr. x, at 10-11. The Staff reasoned that only one of the ships in a 2-ship formation could fly directly over the PFS site and be in a position to strike the PFS facility. *Id.*

58. We note that there is approximately a 9,000 foot lateral separation between the leader and the wingman in a 2-ship formation. *See* Horstman Post Tr. x at 6 (1.5 to 2 miles line abreast); Cole/Jefferson/Fly Post Tr. x, at 45 (6,000 to 12,000 foot separation). Consequently, at least one of the aircraft in a two-ship formation will not be in a position from which it can strike the PFS facility in the event of a crash. Campe/Ghosh Post Tr. x, at 11. *See* Cole/Jefferson/Fly Post Tr. x at 45 (the easternmost aircraft in formation would rarely, if ever, fly over the site). *See also* State Exh. 48 (depiction of F-16s in formation on cross section of MOA). If an offset aircraft were to experience a catastrophic failure such that the aircraft was no longer controllable, the aircraft would not deviate significantly from its original flight path. *See* PFS Exh. N (Aircraft Crash Report) at 38 (if the aircraft went into a deep stall, it would be in a vertical descent with little to no horizontal velocity; if the aircraft suffered structural damage, it would go into a dive and impact the ground within a few miles). If the aircraft remained controllable, the flight continuation would not pose any significant

hazard to the PFS facility in that the absence of the PFS facility along the flight path would preclude the need for avoidance actions in the event that the pilot decided to eject. *See* PFS Exh. N (Aircraft Crash Report) at 21 (F-16's flight control computer is designed to maintain the aircraft on the flight path set by the pilot, even after ejection).[8]

59. The State asserts that Gen. Jefferson used a value for the number of flights based on the average Sevier B flights in 1999 and 2000, increased by 17.4 percent to represent the additional F-16s stationed at Hill AFB. State Findings at 33. The State asserts that it is not realistic or conservative to exclude flight counts for the Sevier D MOA as a basis in estimating the future number of flights in Skull Valley. State Findings at 34. The State notes that Gen. Jefferson testified that there is no way to determine whether all or a portion of the reported flights were in Skull Valley, and that it would be more conservative to include the Sevier D flight counts in estimating the number of future Skull Valley flights. *Id.*

60. We do know, however, that based on information obtained from the Air Force, up to 10 percent of flights in the Sevier B MOA do not transit Skull Valley. NRC Exh. C (SER) at 15-19. The Sevier B MOA flight count is therefore an overcount due to the flights that are flying in the southern part of the Sevier B MOA that do not transit Skull Valley. Tr. 3356. The extent of the offset is unknown. Nevertheless, the Applicant's approach is acceptable in that the value obtained for N is bounded by that obtained by the Staff, which we have found to be acceptable. *See also* Staff Findings at 44-45.

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[8] In its findings, the State for the first time asserts that in view of the evidence that an F-16 performing emergency procedures no longer stays in a formation but performs various maneuvers and turns toward an emergency landing field, the number of flights cannot be reduced on this reasoning. State Findings at 33 n.13. Had the State wished to challenge the Staff's assertion in this regard, it should have raised its argument in either its direct testimony or on cross-examination so that the Staff would have had notice and opportunity to present evidence on the record regarding the State's newly-raised argument. Consequently, the State's argument should be disregarded.

61. The State argues that the Applicant's use of the average number of flights from 1999 and 2000 is not conservative. The higher number of flights in 2000 was not used as a basis due to "past history and the current war on terrorism." *Id.* Gen. Jefferson stated that to his knowledge no F-16 fighter aircraft from Hill AFB were involved in the war on terrorism in Afghanistan. *Id.* at 33-34. The State asserts that Gen. Jefferson stated that there was no statistical basis for using the average 1999 and 2000 flights, that the number of future flights would depend on national budgets and policy and that neither he nor the commanders at Hill AFB would know the number of future flights. State Findings at 34.

62. The Applicant basis its claim that the number of flights in 2000 was abnormally high on several grounds. The Applicant states that the number of flights at Hill AFB in 2000 was at the "maximum or near-maximum" possible level and that the commander would not be able to sustain that many flights. Cole/Jefferson/Fly Post Tr. x, at 19. Further, the Applicant asserts that the U.S. military did not participate in an international conflict during 2000 and, therefore, the number of flights flown at Hill AFB in 2000 would be higher than in years in which the military is engaged in international conflicts.

63. With respect to the maximum or near-maximum number of flights flown in 2000, the Applicant asserts that in 2000, the 388th Fighter Wing significantly increased its sortie count and achieved the highest flight rate per aircraft of any F-16 wing. Cole/Jefferson/Fly Post Tr. x, at 19. The flights flown per aircraft were at a maximum, and the 388th Fighter Wing Commander said that they were "pushing to the limit." Tr. 3353-54; Cole/Jefferson/Fly Post Tr. x, at 19. Gen. Jefferson expects that the 388th Fighter Wing will not be able to sustain the high flight rate per aircraft level experienced in 2000 due to the wear and tear on the F-16s, parts, and people. Tr. 3354. Therefore, the Applicant's expert panel testified that they do not expect the number of flights to continue indefinitely at the maximum or near-maximum rate achieved per aircraft by the 388th Fighter Wing in 2000. Cole/Jefferson/Fly Post Tr. x, at 19.

64. With respect to the fact that during 2000, the U.S. military was not involved in a major international crisis, the Applicant's expert panel testified that the number of Skull Valley flights in years involving international conflicts would be less than the number of flights flown in 2000. Cole/Jefferson/Fly Post Tr. x, at 19-20. Further, even if the 388th Fighter Wing or 419th Reserve Fighter Wing were not deployed overseas for such a crisis, some of their aircraft may be temporarily deployed to other bases in the U.S. to replace aircraft sent overseas. *Id*. Therefore, we agree with the Applicant that, based on past history and the current state of the world, it is reasonable to expect periodic unscheduled future deployments and an associated lower flight count at Hill AFB. *Id.* at 20. We find that the Applicant has demonstrated that the 2000 sortie count was abnormally high due to the fact that aircraft at the 388th Fighter Wing were flying at near maximum levels. We further consider that years in which the U.S. military is involved in international conflict will further reduce the number of flights flown at Hill AFB.

65. We additionally note that the 2001 F-16 flight information for the Sevier B and D MOAs provides a useful benchmark for determining the reasonableness of the Applicant's estimates. The PFS prediction of 5,000 flights in Skull Valley (unadjusted for the additional 12 F-16s stationed at Hill AFB) compares favorably to the actual 2001Sevier B MOA flights of 5,046. Tr. 13,019. In 2001, the additional F-16s were stationed at Hill AFB for half of the year. An increase in the Applicant's estimate by 8.7 percent (17.4 percent for a full year divided by 2), would result in 5,435 Sevier B MOA flights. Tr. 13,019-20. The result obtained is 8 percent higher than the actual Sevier B MOA flight count of 5,046 for 2001. Tr. 13,020. Therefore, based on the data obtained for flights in 2001, the Applicant's estimate of the number of flights is conservative.

66. The State asserts that the determination of the annual number of flights through Skull Valley over or near PFS is limited by the fact that the only related evidence presented was based on the number and type of training flights flown by F-16s stationed at Hill AFB. State Findings at 34. No evidence was presented as to the number of aircraft to be stationed at Hill AFB following the

retirement of the F-16, nor the type and number of training missions that will be flown by the replacement aircraft. Therefore, the State considers that there is insufficient evidence to determine the number of flights transiting Skull Valley above or near the PFS site after 2010. State Findings at 35.

67. The State is incorrect that the only evidence presented with respect to the number of flights was based on the number and type of training flights flown by F-16s stationed at Hill AFB. Gen. Jefferson testified that the average from 1999 and 2000 is a reasonable number in that the number of aircraft in the foreseeable future is not likely to increase. Tr. 3791-92. The number of aircraft in the Air Force inventory has gone from 9,000 down to 6,000 over an 8 or 10-year period, which is a 30 percent decrease. The number of people in the Air Force has decreased in the same period. The proposed replacement for the F-16, the F-35, buy for the Air Force is 1,763 - - less than that originally proposed - - 2,230 aircraft. Tr. 3792.

68. The evidence in the record shows that, due to the general downsizing of the Air Force, among other things, the number of flights that annually transit Skull Valley is not likely to increase during the licensed life of the PFS facility. *See* Staff Findings at 47-48 ("Projections and Trends"). *See also* supra at 9. Further, the State's witness testified that he is not aware of any Air Force plans to expand Hill AFB, to station more F-16s at Hill AFB, or to increase the number of flights to be flown through Skull Valley. Tr. 8566-67. Therefore, the Applicant's consideration of the number of flights than annually transit Skull Valley is conservative.[9]

The Avoidance Factor

69. The State asserts that the R factor devised by the PFS witnesses has never been used prior to the PFS application and that the NUREG-0800 does not make reference to the concept of pilot

[9] With respect to the State's claim that no evidence exists as to the type of training missions of the replacement aircraft of the F-16, the State has not shown that the type of training missions of the replacement aircraft is in any way relevant to the value for the number of annual flights through Skull Valley.

avoidance of ground sites. *Id.* We do not consider the fact that the R factor has not been used prior to the PFS application or the fact that the NUREG-0800 is silent with respect to its use demonstrates that it is unrealistic or unreasonable. NUREG-0800, as a guidance document, does not set forth legally binding requirements. *PFS*, CLI-01-22, 54 NRC at 264. NUREG-0800 does not prohibit the use of an R factor as the Applicant has done. *See* PFS Exh. RRR (NUREG-0800) at 3 (4-factor formula is only "one way" of calculating the probability of an aircraft crash). Further, Gen. Cole, Gen. Jefferson, Col. Fly and Lt. Col. Horstman all testified that Air Force pilots would steer and avoid the PFS facility if they had time and ability to control the aircraft. Tr. 3376-78; Tr. 4229. Therefore, we consider a modification to the NUREG-0800 formula to account for pilot avoidance to be acceptable.

70. The State asserts that the decision to modify the NUREG-0800 formula by adding the R factor was made by the Applicant's 3 retired Air Force witnesses, none of whom testified as to having any previous experience using NUREG-0800. State Findings at 37. The State asserts that Dr. Campe stated he has never seen a significant departure from the NUREG-0800 4-factor formula used for aircraft crash assessment in "any previous application." State Findings at 38. The State also asserts that Dr. Campe testified that neither NUREG-0800 or any DOE document dealing with aircraft crash probability makes reference to a pilot's ability to avoid a ground site. *Id.*

71. With respect to Dr. Campe's statement that he has not seen any significant departure from the 4-factor NUREG-0800 formula, contrary to the State's assertion, Dr. Campe did not distinguish in his statement between the PFS application and "previous application[s]." Tr. 4125-26. Dr. Campe does not consider the use of the R factor as proposed by the Applicant in the PFS application to be a significant departure from the NUREG-0800 formula. Tr. 4183-85 (the value R is, in effect, a part of the calculation of the crash rate, C, in the formula). Tr. 8906-07 ("I view the R factor as a modification of the factor C in the formula, which is the crash rate"). Further, Dr. Campe reviewed the Applicant's use of the R factor as part of the NUREG-0800 formula and

found it to be acceptable. *See* Campe/Ghosh Post Tr. x, at 15-25; Staff Exh. C (SER) at 15-63 through 15-68. Therefore, the testimony of Dr. Campe does not support the State's assertion that the Applicant's use of the R factor in NUREG-0800 is inappropriate.

72. The State asserts that Dr. Ghosh did not use a factor based on a pilot's ability to avoid a ground site in the aircraft crash analysis for Yucca Mountain, nor does he know of any authorities that support calculation of crash probability using the theory that a pilot would be able to avoid a ground site in the event of a crash. State Findings at 38. First, Dr. Ghosh did not use a factor based on a pilot's ability to avoid a ground site in his analysis for Yucca Mountain because the paper was a review of DOE's preliminary analysis. The DOE used the NUREG methodology without the inclusion of an R factor, and Dr. Ghosh did not suggest that DOE include one. Tr. 4179-81. Second, Dr. Ghosh did know of an authority that supports the consideration of pilot avoidance. In this regard, Dr. Ghosh made reference to the United Kingdom study, although he did not rely on it for his review of the Applicant's calculations. Tr. 4115.

73. The State asserts that the Applicant has made a subjective determination that the probability of aircraft crashes can be reduced by 85.5 percent based on the expectation that an Air Force pilot will not allow a crashing aircraft to impact the PFS facility. The State asserts that such a determination is unreliable and should be stricken as inadmissible under 10 C.F.R. § 2.743. *See Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993). State Findings at 70. First, we note that the Licensing Board previously denied the State's motion to exclude this testimony. Tr. 3013. Therefore, the State's argument that the analysis is inadmissible should be rejected. Further, the adequacy of the Applicant's consideration of pilot avoidance has been thoroughly demonstrated in the evidence adduced at the hearings, as summarized in the Staff's and Applicant's Findings.

PFS Review of Accident Reports

74. The State asserts that even though PFS reviewed 126 Class A mishap reports, five were eliminated from consideration on the basis that only crashes involving destroyed aircraft would be considered, for a total of 121. State Findings at 42. One of the crash reports eliminated was the F-16 flight of December 19, 1991 that disappeared after take off and was never heard from. The State asserts that Col. Fly testified that it was "probably" destroyed although it was not considered in the 121 crashes reviewed. *Id.*

75. Regarding the December 19, 1991 accident, this accident was not considered because, although it probably was destroyed, the Applicant's expert panel had no idea about the flight parameters upon which to make a determination and therefore, removed it from the database of accidents considered. Tr. 13,113-36 through 13,113-37. The only information that could be gleaned from the mishap report is that the aircraft made a normal takeoff and right hand turn. *See* PFS Exh. 210 at 3. The airframe post-mishap analysis was not available because "neither the impact area nor the aircraft has been found." *Id.* at 6. There was no cause of the accident reported. We find that due to the unusual disappearance of this aircraft, the Applicant's witnesses were correct to exclude it from the database of accidents. For example, the mishap report provides no information as to whether the aircraft experienced engine failure or a bird strike or whether the pilot was flying in an environment that was representative of a Skull Valley-type event.

76. We find that the consideration of those accidents representing destroyed aircraft is acceptable because the crashes that represent destroyed aircraft are relevant to the calculation of the hazard to a hardened reinforced concrete structure, such as the Canister Transfer Building and spent fuel storage casks. *See* PFS Exh. N (Tab H) at 4. *See also* PFS Exh. N (Tab C) ACRAM report) at 4-5 (destroyed aircraft is best considered for hardened facilities). Several of the reports pertained to Class A mishaps in which no aircraft were destroyed. These incidents were properly excluded from consideration because they do not represent potential crash impact hazards

to the PFS facility. *See* PFS Exh. N (Tab H) at 4. A Class A mishap is defined as one in which results in total property damage at or above $1 million, a destroyed aircraft, or a fatality. Campe/Ghosh Post Tr. x at 12. Therefore, it is reasonable for the Applicant to have excluded those accidents that would not pose a hazard to the PFS facility.

77. The State asserts that Gen. Jefferson testified that in 42 percent of the 121 crashes reviewed, the pilot did not have control of the aircraft such that the pilot could avoid the PFS site. State Findings at 42. Of the crash reports found to be relevant to Skull Valley, 59 were determined by the Applicant to represent crashes in which the aircraft remained controllable with sufficient time to avoid a fixed site on the ground. *Id*. The State asserts that of the 59 crash reports, 5 reports show the pilot ejected during an uncontrolled spin or the aircraft was otherwise uncontrollable. Also, 11 reports show the F-16 was on fire when the pilot ejected. State Findings at 42-43.

78. We do not consider that the 5 accidents identified by the State show that the pilot ejected during an uncontrolled spin or that the aircraft was uncontrollable. These accident reports are examined in the Staff and Applicant's Findings. *See* Staff Findings at 94-95 (September 3, 1990 mishap); 93-94 (January 13, 1991 mishap); 88-89 (March 19, 1991); 91, 111 (December 17, 1992 mishap); 86-87 (February 19, 1993 mishap). *See* Applicant Findings at 125, 139-142.

79. The September 3, 1990 accident report shows that the pilot made several emergency maneuvers, such as zooming the aircraft, indicating that the pilot had control of the aircraft. PFS Exh. 113 at 2. The accident report states that "[t]he flight controls were functioning properly through the pilot's ejection." *Id.* at 3. It was not until after ejection that the aircraft became uncontrollable. *Id.* at 2.

80. The March 19, 1991 accident report states that the mishap pilot turned to an emergency airbase following indication of an emergency. PFS Exh. 124 at 3. Approximately 4 to 5 minutes after the first indication of a problem, the mishap aircraft lost electrical power and became uncontrollable. *Id*. at 3-4. The pilot maintained control of the aircraft for at least 4 minutes after

the first indications of a problem, which would have provided the pilot with sufficient time to establish and maintain positional and situational awareness with respect to the PFS facility had the accident occurred in Skull Valley.

81. The December 17, 1992 accident report states that during the emergency the pilot "turned 20 degrees right to avoid a hunting lodge off his nose" and to head directly toward the nearest landing field. PFS Exh. 145 at 5. Following ejection, the aircraft became uncontrollable and turned upside down before impacting the ground. *Id.* at 8.

82. The February 19, 1993 accident report shows that following a noise from the aircraft, the pilot began to climb to the maximum height available below a cloud deck. PFS Exh. 147 at 3. He radioed that he had a problem and 26 seconds later the mishap aircraft began an uncommanded climb. *Id*. at 4. The pilot was able to maintain control of the aircraft for approximately 26 seconds prior to the onset of the uncontrolled climb. Had this engine failure occurred in Skull Valley, the pilot would have had positional awareness and would have taken action to avoid the PFS facility in the 26 seconds while taking other actions. *See* Cole/Jefferson/Fly Post Tr. x at 82.

83. The January 13, 1991 accident report shows that the pilot set the throttle in accordance with emergency procedures and continued a climb. PFS Exh. 118 at 3-4. Twenty-eight seconds after the electrical generator failed during the climb the hydraulics system failed and the aircraft then became uncontrolled. *Id.* at 4. Throughout the majority of the accident, up to the final 10 seconds, the pilot was in control of the aircraft.

84. We therefore find that the accident reports for these 5 accidents demonstrate that the aircraft were controllable.

85. Further, we do not consider that the fact that an aircraft was on fire renders an aircraft uncontrollable such that a pilot would not have the ability to avoid the PFS facility. We find adequate evidence in the record to support a conclusion that an engine fire would not necessarily require a pilot to eject. Tr. 13,023. The F-16 does not have a history of catching on fire and

exploding immediately, even with respect to severe fires. Tr. 13,024. A fire in the engine may result in some damage; however, in such a case, the aircraft may still be flyable and the pilot may still be able to land. Tr. 13,023-24. *See also* Bernard, Tr. at 3890 (during the mishap flight, there was a fire in the F-16 engine, but the aircraft was still controllable). Moreover, in several of the 11 accidents in which a fire was reported, the accident report demonstrates that the pilot took into consideration and avoided objects on the ground. *See, e.g.* Staff Findings at 91-92 (avoided a hunting lodge); 113 (turned away from populated areas).

86. The State asserts that the determination that in 90 percent of the potential accidents a pilot would have sufficient time and control of the aircraft to direct the aircraft away from a fixed ground site in Skull Valley is inconsistent with the evidence that engine failure is the most likely cause of a crash where the pilot retains control and the evidence that only 36 percent of F-16 Class A accidents are engine failures according to the manufacturer, Lockheed Martin. State Findings at 43. The State's argument, however, is flawed in that the Lockheed Martin information pertained to all Class A accidents over time. *See* State Exh. 56. It did not pertain to those accidents in which the F-16 was destroyed or those accidents representing events that could have occurred in Skull Valley. Tr. 13,024-25 (the Lockheed Martin statistic captures those accidents that have no bearing with respect to accidents in Skull Valley). The Applicant reviewed separately each accident report for destroyed F-16s that could have reasonably occurred in Skull Valley to derive its estimate of 90 percent of the accidents in which a pilot had control of the aircraft.

87. The State asserts that the 90 percent value used to represent the percentage of F-16 crashes that could occur in Skull Valley in which the pilot retained control of the aircraft with sufficient time to avoid the PFS site is neither realistic nor conservative and was determined by selecting data in a subjective manner. State Findings at 43. There is no evidence in the record that the data was selected in a subjective manner. The Applicant reviewed all of the available accident reports involving destroyed F-16s from the period from 1989 through 1999 in order to

arrive at the 90 percent value. Cole/Jefferson/Fly Post Tr. x at 17. The Applicant's expert panel first reviewed each report individually and then discussed them collectively. PFS Exh. N (Aircraft Crash Report) at 17-17b. The experts' individual reviews yielded nearly identical results. PFS Exh. N, Tab H at 6-7. In addition, Lt. Col. Horstman had no disagreements with the Applicant experts' classification of the accident reports during his first deposition. Tr. 4,323-25. Further, a review of those accident reports with which the State currently disagrees with the Applicant's classification shows that the Applicant's analysis of the accident reports appears reasonable. *See* Staff's Findings at 67-72, 81-95.

95 Percent

88. The State asserts that the component value of 95 percent used by PFS is a purely subjective determination made collectively by PFS witnesses. State Findings at 43. The State asserts that the determination of 95 percent was made without performing any calculation or statistics, and was made prior to reviewing the F-16 accident reports. *Id.*

89. We find that the Applicant's determination that in 95 percent of those accidents leaving a pilot with time and opportunity to direct a crashing F-16 away from the PFS facility in control of the aircraft, the pilot would avoid the PFS facility is reasonable and, contrary to the State's assertion, is not based on a purely subjective determination.[10] All witnesses from whom we have heard,

[10] The State cites to the statements made by Gen. Jefferson at Tr. 8882 in support of its assertion that the Applicant's determination was "purely subjective." State Findings at 43. The expert witness' expert opinion was based on 3 principal considerations: 1) Air Force training; 2) the amount of time available in an emergency; and, 3) the visibility of the PFS facility in Skull Valley. Tr. 8882. In addition, the accident reports support the Applicant's witness' determination regarding pilot avoidance. *Id.* Therefore, the State's assertion that the determination was "purely subjective," as that term is commonly understood, does not withstand scrutiny. *See* Black's Law Dictionary, 7th *ed*. (*Subjective*, *adj*. 1. Based on an individual's perceptions, feelings, or intentions, as opposed to "externally verifiable phenomena"); *see also Daubert v. Merrell Dow Pharmaceuticals, Inc*., 509 U.S. 579, 590 (1993) (linking subjective belief with "unsupported speculation"). The Applicant's consideration of pilot avoidance is based on externally verifiable phenomena, and is, therefore, not mere subjective belief. *See also* Tr. 4198 (ability of Air Force pilots to avoid ground objects is not a mere theory but something real).

including Lt. Col. Horstman, testified that a pilot would intentionally avoid the PFS facility if the pilot had time and ability to avoid the facility. Further, the basis upon which the Applicant made its determination - - the Air Force training, the time available to avoid, the small effort required to avoid, the sparsely-populated terrain in the vicinity of the facility site, and the familiarity of the pilots with the PFS facility's location - - is supported by reliable evidence. *See, e.g.* Staff Findings at 96-102; Applicant Findings at 91-97. Further, the F-16 accident reports contain descriptions of pilots avoiding people and objects on the ground and support the Applicant's determination with respect to pilot avoidance. *See* PFS Exh. N at 23; PFS Exh. 100A. In no report do we find that a pilot with time and opportunity to avoid a ground site failed to do so. Therefore, the Applicant could have reasonably set the determination at 100 percent, but, as a measure of conservatism, chose to set the value at 95 percent avoidance. *See* PFS Exh. N at 23; Cole/Jefferson/Fly Post Tr. x at 17.

90. Finally, the State ignores the Staff's sensitivity analysis regarding the use of the 95 percent value. The Staff performed a sensitivity analysis with respect to the probability that a pilot with adequate control of the aircraft and sufficient time to direct the aircraft away from a ground site would be able to avoid the proposed facility. *See* Campe/Ghosh Post Tr. x, at 21. The Staff's sensitivity analysis showed that a 20 times decrease in the likelihood of avoiding the PFS facility increases the overall crash probability by approximately a factor of 2.5. Consequently, the overall crash probability for an F-16 transiting Skull Valley is not highly sensitive to the assumed likelihood of a 95 percent avoidance factor. As a conservatism, however, the Staff used a value of 90 percent for the avoidance factor. *See* NRC Exh. C (SER) at 15-57 through 15-58.

91. The State asserts that the 95 percent component represents the percentage of time that a pilot will be successful, during an engine failure emergency, in performing emergency procedures including attempting to restart the engine, in specifically locating the PFS site which will be 3.22 miles or more away at the time of ejection, in directing the aircraft away from the PFS site while also directing the aircraft away from any populated areas, and in ejecting at or above the minimum

altitude of 2,000 feet AGL. State Findings at 43-44. The State overstates the obstacles facing a pilot with respect to avoiding the PFS facility.

92. First, the ability of a pilot to avoid the PFS facility is not hindered by the pilot's attempts to start the engine of the aircraft. In this regard, we have heard evidence that Air Force pilots are well-trained to perform simultaneously many different tasks during an in-flight emergency. *See* Cosby, Tr. 3994-95 (pilots are very good at multitasking). Tr. 4001 (average pilot is able to handle three or four tasks simultaneously). *See also* Jefferson, Tr. 13,697 (pilots can keep track of their surroundings at the same time that they try to restart a failed engine). *See* Cole Tr. 13,698 (multitasking is something pilots are trained to do). *See* Fly, Tr. 13,699 (same). Even after all attempts at restarting are concluded, a pilot may still be able to direct a gliding F-16 away from a ground site. *See* PFS Exh. 205 at 2 (while continuing efforts to restart his engine, the mishap pilot delayed jettisoning his fuel tanks due to his proximity to populated areas). *See also* Joint Exh. 7 at 2 (after 6 unsuccessful attempts at restart, the mishap pilot directed the F-16 toward an uninhabited wooded area).

93. According to the State, an F-16 pilot will eject at a distance of at least 3.22 miles and possibly as far away as 5 miles from where the F-16 will impact. The pilot would have to know if the impact area is a populated area. State Findings at 45-46. The State asserts that the PFS site only covers 0.13 square miles and consists mostly of open space and concrete casks and does not appear to be a populated area. *Id.* at 46. We consider, however, that in Skull Valley, the PFS facility will be the largest structure in the area. Tr. 3600. In addition, the PFS facility will be well lit at night. Cole/Jefferson/Fly Post Tr. x at 66 & nn.80-81. Skull Valley itself is sparsely populated, and near the proposed facility, on the Skull Valley Band Reservation there are 2 tribal homes located approximately 2 miles southeast of the proposed site, additional residences about 3.5 miles east-southeast of the site, and off the Reservation, 2 private farm residences located approximately 2.75 and 4 miles northeast of the site. *See* Staff Exh. C (SER) at 2-4. A considerable amount of

open desert space exists around the PFS facility to which a pilot could direct a crashing F-16 prior to ejecting. PFS Exh. N at 22. Therefore, we find that the absence of other built-up areas in Skull Valley would assist the pilot of a crashing F-16 to locate an adequate crash impact site.

94. Moreover, we find that Air Force pilots will be generally aware of the existence and location of the PFS facility in Skull Valley. A new pilot to a base would have local area orientation that would include a discussion of the local flying area and hazards in the area. Tr. 3783. Also, the PFS facility would be listed in the Area Planning Guide of the U.S. Department of Defense so that military flight planners and pilots would be aware of the location of the facility. Ghosh/Campe Post Tr. x, at 21. Tr. 13,114. The Area Planning Guide provides guidance to planners of military training routes regarding location and avoidance of radioactive waste facilities and is updated every 56 days. *Id*. Finally, if pilots at Hill AFB determine to use the PFS facility regularly as a primary visual reference point, the facility will be known to those pilots. Cole/Jefferson/Fly Post Tr. x, at 42. In that event, pilots would be able to see or at least be aware of the location of the PFS facility in Skull Valley. *Id.*

95. Further, avoidance does not require that the pilot be able to direct the aircraft to any particular location in the desert or specifically locate the PFS site. In this regard, we note that the evidence suggests that it would be easier to turn a crashing F-16 away from a point target, such as the PFS facility, than an area target, such as a city, in that the turn with respect to a point target requires less maneuvering. Tr. 13,471. In addition, the evidence in the record suggests that a pilot would be able to recognize the PFS facility from 5 miles away. *See* Fly, Tr. 13,674-75. The facility will have significant vertical development and would cover 99 acres. It will be brightly illuminated at night. Cole/Jefferson/Fly Post Tr. x, at 66 & nn.80-81. Thus, the PFS facility will be prominently visible in Skull Valley. Further, a pilot would not need to be able to find the exact location of the PFS facility in order to avoid it. Pilots would be aware of the relative position of the PFS facility

during an emergency due to the pilot's positional awareness maintained during the flight prior to an emergency or prior to a decision to eject. Cole/Jefferson/Fly Post Tr. X at 53.

96. The State asserts that the decision to turn away from a populated area requires the pilot to assess the impact area of where the F-16 is pointed and alternative impact areas to turn towards. State Findings at 46. Thus, a pilot in Skull Valley would not direct an F-16 toward the Goshute Indian Village in an effort to avoid the PFS facility. *Id.* The State's assertion is contrary to the evidence found in the record. The concern of impacting one facility in favor of another is not present in Skull Valley because the density is so low that a significant amount of space - - often miles - - exists between structures. Tr. 13,706-07. In fact, if a pilot were to eject in Skull Valley in the vicinity of the facility, there is mostly desert and the pilot would not have to choose between hitting the PFS facility and hitting the Goshute Indian Village. The pilot would simply turn to the open desert. Tr. 13,707.

97. In addition, a pilot would be aware of the location where the aircraft would impact the ground. Fly, Tr. 3552-54 (pilot in an emergency will be assessing the terrain and where aircraft is headed); Bernard, Tr. 3896-97 (pilot would spend time directing plane away from populated areas and objects on the ground); Cosby, Tr. 3989-91(once aircraft is controllable, pilots assess their surroundings - - including the "bailout direction" to guide the aircraft in the event of an emergency); Horstman, Tr. 4514 (During an emergency, "I'm going to try to locate the PFS site, I'm going to try to locate roads, I'm going to try to locate houses and farms and anything else."); Fly, Tr. 13,684 (in a flame out landing pilot would be able to see where the aircraft was going to hit as well as the area short of it); Fly, Tr. 13,643 (In emergency a pilot would be able to see the flight path marker, which shows where the aircraft is headed - - therefore, pilot would see impact point).

98. In addition, avoidance of the PFS facility does not require ejection at or above the minimum recommended ejection altitude. The accident reports and the testimony of Col. Cosby demonstrate that pilots successfully avoid objects on the ground although ejection may be delayed below the

minimum recommended ejection altitude in order to do so. *See* Joint Exh. 9 at 16 (pilot commended for delaying ejection in order to avoid ground sites); PFS Exh. 205 at 17 (same). *See* Cosby, Tr. 3980-81. *See also* Staff Findings at 104-105; Applicant Findings at 134. *See also* Horstman, Tr. 13,463 (Air Force pilots would descend below 2,000 feet AGL to avoid any populated areas).

Air Force Training

99. The State asserts that the Air Force does not teach pilots to look for specific sites on the ground in an emergency and that there is no Air Force training or guidance to avoid a house, a facility, or other specific ground site and pilots do not have the tools for such a task. State Findings at 45. The State's assertion is contrary to the evidence adduced at the hearing. Both Col. Cosby and Col. Bernard, who ejected from F-16s, testified regarding their Air Force training. Col. Cosby testified that the Air Force trains pilots to handle emergencies, try to land the aircraft, and, if not possible, try to point the aircraft to uninhabited areas away from buildings and people. Tr. 4006. Col. Bernard testified that Air Force pilots are trained to point their aircraft away from populated areas. Tr. 3898. In addition, the Air Force F-16 flight manual instructs pilots to "direct the aircraft away from populated areas" if time permits. *See* State Exh. 150 (Tech. Order 1F-16C-1).

100. Further, the Air Force teaches pilots to develop and maintain general positional and situational awareness, which relates directly to a pilot's success in avoiding structures on the ground during an emergency. *See, e.g.*, Cole, Tr. 3591-93, 3593-96; Jefferson, Tr. 3596-98; Cole, Tr. 3103-05; Horstman, Tr. 13,334-35. Thus a pilot will generally know where the aircraft is headed at the time of an incident. Tr. 8606.

101. The State asserts that directing the aircraft away from a populated area refers to a large geographic area, not a specific site or targets on the ground. State Findings at 45. We find, however, that regardless of what is defined as a "populated area," pilots will direct their aircraft away from any populated areas. Therefore, we find that pilots would attempt to avoid the PFS

facility, regardless of whether it is deemed a "populated area," as set forth in the F-16 flight manual. Based on the totality of evidence in the record regarding pilot training, we find that Air Force pilots are extraordinarily well trained. They are trained to maintain situational and positional awareness, to handle successfully all aspects of emergencies, including ejection, and to avoid populated areas on the ground.

102. The State asserts that Air Force training does not include practicing engine failure emergencies where the F-16 engine is failed for training purposes. State Findings at 47. Further the Air Force does not practice ejections from an aircraft. *Id*. According to the State, until a pilot actually ejects from an aircraft during an emergency, the pilot has never fully experienced that sensation nor made decisions relating to where the aircraft will impact. *Id*.

103. No evidence exists in the record, however, that not experiencing the sensation of an ejection has a negative effect on a pilot's ability to implement avoidance measures. Rather, we note that the average Air Force pilot is not likely to have had to face ejection. Tr. 3217. Yet, the ability to react successfully and engage in avoidance maneuvers would apply to pilots who represent average Air Force pilots who are not highly experienced. Cosby, Tr. 4000-01.

104. Further, we note, however, that the evidence in the record strongly demonstrates that the Air Force adequately trains and prepares pilots to be able to respond successfully to emergencies and, therefore, the experience of actual ejection would provide only marginal additional training. Lt. Col. Horstman testified that throughout a pilot's Air Force career, a pilot will receive egress training annually, which addresses how to escape from an aircraft, how to use the ejection system, and the procedures and mechanisms for doing so. Tr. 13,132. F-16 pilots receive numerous emergency and training simulation exercises, as well as egress training and monthly "safety days," during which pilots review other training topics for safety. Tr. 13,133. They train in the F-16 flight simulator, in which they are presented with emergencies, such as an engine failure, and they are required to perform all the necessary steps, including pulling the ejection handle. Tr. 3334-35. An

advantage of simulator training is that a procedure can be repeated many times so that the training and learning process can be measured and proficiency determined. The purpose of the training is to prepare pilots so that when faced with an emergency situation, they will be able to respond. *See* Cosby, Tr. 3988-89 (training prepares pilots to respond successfully to emergency).

105. The success of the training is evidenced in the accident reports in which pilots are able to eject and avoid objects on the ground. Col. Cosby, who ejected from an F-16, testified that Air Force pilots are trained to handle emergencies and go through a very straightforward set of procedures that they practice monthly that address engine failures and ejections. Tr. 4027. The ability of a pilot to avoid a ground site comes from pilot training and instruction. Tr. 4000.

Emergency Stress and Pilot Error

106. The State asserts that a pilot's primary concern upon realizing the aircraft is about to crash is for the pilot's survival, which is dependent on ejection. State Findings at 47. The State, in support of its assertion, referred to the testimony of Col. Bernard who stated that a pilot has a period of divided attention during an emergency that "completely becomes focused on what you need for your survival." State Findings at 47-48.[11] The State asserts that there is an incentive for a pilot to restart the engine and avoid ejection. State Findings at 48.

107. Col. Bernard stated that the ability of a pilot to focus on matters other than survival depends on the situation, but in a controllable airplane in a heavily populated area a pilot would spend time directing the aircraft away from populated areas or things that the pilot wanted to avoid. Tr. 3897-98. He stated that as the emergency progresses, a pilot will divide attention between what is happening to the airplane, keeping track of the mock air battle, and then gradually, the attention

[11] The State also based its assertion on: the Chief of Safety's 1996 ALSAFECOM 02-1996, statements made by Lockheed Martin, the ejection experiences of Col. Bernard and Col. Cosby, and Lt. Col. Horstman's discussions with 4 pilots who ejected. These matters have been adequately addressed in the Staff's and Applicant's Findings. *See* Staff Findings at 144-54; Applicant Findings at 98-111.

of the pilot becomes focused on the need for survival. Tr. 3898. This is fully consistent with Col. Fly's description of the actions a pilot takes during an emergency - - if the engine does not restart, then the pilot will "start thinking about ejection." Tr. 3554-55.

108. Thus, prior to the action of ejection, a pilot facing an emergency will have engaged in specific procedures. These procedures, which are reinforced throughout pilots' careers are: maintain control of the aircraft; analyze the situation and take appropriate actions; and land as soon as conditions permit. PFS Exh. N (Aircraft Crash Report) at 19. *See also* Cosby, Tr. 3898-99 (first thing we do is control the airplane, then we assess our surroundings). The assessment of the surroundings includes situational and positional awareness. Tr. 3990. Pilots are thus aware prior to the decision to eject in a controllable situation where the aircraft is heading and where a suitable landing field or crash site is. Tr. 3990-91. Therefore, a pilot will have considered avoidance, if necessary, prior to the time of actual ejection, whereupon the pilot's focus will be on his survival.

109. The State asserts that a pilot in an emergency commonly focuses on the task of restarting a failed engine to the exclusion of performing other emergency procedures, including assessing where the aircraft will impact. State Findings at 48. The State asserts that Col. Cosby ejected from an F-16 during a training mission and that he spent too much time and attention trying to restart the failed engine. *Id.* The time Col. Cosby spent trying to restart his mishap airplane, however, did not interfere with his ability to see where he was situationally. Tr. 4019. We note that Col. Cosby successfully maneuvered the mishap aircraft away from a large apartment housing complex and an aircraft on a taxiway. PFS Exh. 79 at 2-3. In the words of Lt. Col. Horstman, Col. Cosby did "an absolutely magnificent job of avoiding things." Tr. 13,379.

110. The State makes much of Col. Bernard's testimony that it was error on his part to use all his time trying to solve his failed engine problem, which drove him to eject at only 170 feet AGL. State Findings at 49. Although Col. Bernard ejected too low, his ejection had no relevance to an ability to avoid a ground site. Col. Bernard, did not consider where the aircraft would impact - - not

because he was spending too much time trying to restart the engine - - but, rather, because there were no cultural features in that part of Canada to avoid. Tr. 3894-95 (he knew he was 30 to 40 miles from the nearest settlement). Therefore, the time Col. Bernard spent in attempting to restart the engine simply had no bearing on his consideration of avoidance.

111. Lt. Col. Horstman interviewed active duty Air Force pilot Maj. Tom Smith, who ejected from an F-16 on January 13, 1995. State Findings at 50. According to Lt. Col. Horstman, Maj. Smith said he did not have time to think about where his jettisoned stores would impact or where the F-16 would impact. Lt. Col. Horstman also interviewed three other pilots, and each of the pilots said their thoughts were focused on their own survival and did not consider where the aircraft would impact. State Findings at 51.

112. Col. Fly testified that he spoke recently with Maj. Smith, who took strong objection to the characterization of what was in the State's testimony. Tr. 3223. Maj. Smith said that he was concerned about where his aircraft would land, but, because he was above cloud cover, he could not see the ground and had no familiarity with the terrain beneath him. *Id*. He knew, however, that he was not near major population centers. Tr. 3223-24. The other three pilots were not in control of their aircraft, and, therefore, their inability to consider where their aircraft would crash is not relevant. *See* Staff Findings at 151-54; Applicant Findings at 102-104.

Weather Conditions in Skull Valley

113. The State asserts that no evidence suggests that a pilot unable to see the ground due to the presence of clouds will be motivated or trained to search for the PFS site in an emergency. State Findings at 51. The State also asserts that no evidence suggests that a pilot would turn away from the PFS site at the risk of impacting a "populated area" hidden by clouds. *Id*. First, as discussed previously, we find that the evidence in the record supports a finding that Air Force pilots will be aware of the existence of the PFS facility in Skull Valley and would steer and avoid the PFS facility if they have time and opportunity to control the aircraft. Tr. 3776-78. Tr. 3783. Tr. 13,114.

Thus, a pilot unable to see the ground will nonetheless be motivated and trained to avoid ground sites, including the PFS site, in the event of an emergency. Further, with respect to the risk of impacting a "populated area," we find that the record also supports a finding that there is a considerable amount of open space around the PFS facility to which a pilot could direct a crashing F-16 prior to ejecting. PFS Exh. N at 22. Col. Fly noted that the concern of impacting one facility in favor of another is not present in Skull Valley because the density is so low that a significant amount of space - - often miles - - exists between structures. Tr. 13,706-07. Tr. 13,116.

114. The State asserts that navigation instruments cannot be relied upon to locate the PFS facility and that the Heads Up Display would not facilitate looking for the PFS facility unless the PFS location was selected as a steer point. State Findings at 51. The evidence in the record, however, indicates that a pilot in an emergency would be able to use the navigational aids to maintain positional awareness. Cole/Jefferson/Fly Post Tr. x at 57. The instruments would allow a pilot to select a ground track to fly toward, which, even if the PFS facility were not visible, would provide the pilot with a general idea of its location. Tr. 3602. *See also* Staff Findings at 134-37. Further, pilots will use both onboard navigational systems and visual references, such as the Stansbury and Cedar Mountains, during an emergency. Tr. 3288. Tr. 3289-90. Tr. 3601. PFS Exh. O, Tab FF at 28. Further, Lt. Col. Horstman testified that even in weather conditions where the PFS facility was not selected as a steer point, a pilot would have a general idea of the location of the PFS facility. Tr. 13,457.

115. The State asserts that weather conditions limiting visibility will prevent the pilot from being able to avoid the PFS site. State Findings at 52. The State's assertion, however, is contrary to the evidence in the record that weather conditions are "generally excellent" around the vicinity of the UTTR for Visual Flight Rules (VFR) flight conditions in that the annual percentage of occurrence of "no ceiling" at or below 5,000 feet AGL, combined with a visibility of greater than or equal to 7 miles is 91.5 percent. *See* Vigeant Post Tr. x, at 4; PFS Exh. O, Tab FF (ceiling versus

visibility chart) at 29-32. *See also* PFS Exh. W (The Air Force describes the UTTR as having "excellent" weather and visibility).

116. The State asserts that the cloud cover for Skull Valley represents a ceiling at 5,000 feet 12 percent of the time. State Findings at 52. Thus, the State asserts that a pilot "will not be able to see the facility" at least 12 percent of the time and may not be able to see the facility up to 21 percent of the time. First, the argument that a pilot will not be able to see though a ceiling is based on a legal fiction that a pilot will not be able to see through cloud coverage of greater than 4/8 of the sky. In this regard, Lt. Col. Horstman asserts that a cloud ceiling would obstruct the pilot's view because of the way the FAA defines cloud ceiling as obstructing the visibility of objects on the ground. *See* Horstman, Tr. 8421 (by definition, a cloud ceiling obstructs visibility of the objects on the ground, by the FAA). Thus, the assertion that a pilot cannot see through greater than 4/8 cloud cover may have relevance with respect to FAA regulatory matters, but has no practical relation to what can be seen in Skull Valley. Further, the State's argument ignores the fact that a ceiling is composed of clouds at various layers. In many instances in which clouds are present in layers, a pilot may be able to fly between the cloud layers and, under those circumstances, a pilot is in a better position to be able to see objects on the ground than if the pilot were flying above multiple layers of scattered clouds. Tr. 13,064. Therefore, the weather data supports a finding that a pilot would be able to see the PFS facility or other nearby ground references most of the time.

117. The State asserts that a pilot's view of the facility "will be obstructed" when cloud coverage is 50 percent or greater. State Findings at 52. Again, the State refers to the prefiled testimony of Lt. Col. Horstman, who claims that "[a] cloud ceiling is defined as 50 percent cloud cover and would obstruct the pilot's view of the PFS facility." Horstman Post Tr. x, at 21. We find that the evidence in the record supports a finding that even with 75 percent cloud coverage, a pilot would be able to maintain general positional awareness throughout Skull Valley. *See* Fly, Tr. 13,041. Tr. 13,048.

118. The State asserts that there is a high probability that a pilot's view of the facility will be obstructed when the sky is 25 percent cloud covered. State Findings at 52. According to the State, because clouds have vertical development and because a pilot's view of the ground is at an angle, a sky that is 25 percent cloud covered may completely block the pilot's view of the ground. *Id.* The State's witness agreed, however, that a pilot would have general situational awareness under conditions of 25 percent cloud coverage. Tr. 8417. A pilot would be able to see portions of Skull Valley Road and would be able to see portions of a rail line to the proposed facility. *Id*. Thus, Lt. Col. Horstman agreed that generally speaking, a pilot would have an idea of the location of the PFS site if flying above 25 percent cloud cover. Tr. 8418.

119. The State asserts that clouds are generally dense enough that they cannot be seen through and that even transparent clouds cannot be seen through by a pilot viewing the ground at an angle. State Findings at 52-3. All three of the Applicant's military expert witnesses, however, stated that they, as pilots, are able to see through transparent clouds. Fly, Tr. 13,077 (that's why they're called "transparent"); Jefferson, Tr. 13,078 (agrees, adding that a transparent cloud is very thin and you can see down, although some restriction may exist based on slant range); Cole, Tr. 13,078 (agrees, adding that looking straight down through a cloud is probably a little easier than looking at an angle). In the event that transparent clouds do obscure the ground from an angle, a pilot will still be able to maintain positional awareness. *Id.*

120. The State asserts that clouds above the pilot will prevent a pilot from zooming the aircraft in an emergency. The inability to zoom will require the pilot to stay at an altitude with less time for emergency procedures including avoiding populated areas. State Findings at 53. We find that although a pilot will not zoom an aircraft into clouds, the record supports our finding that a pilot will be able to zoom an aircraft up to a point under the clouds. *See* Staff Findings at 131-32; Applicant Findings at 115 n. 105. Thus, if the clouds were at 3500 feet AGL, a pilot flying at 2500 AGL at 425 knots would zoom to 3400 feet and would have sufficient time to avoid the PFS facility. Tr. 8423,

8426. Further, even if a cloud prevented a pilot from zooming, a pilot may nonetheless have time to avoid the PFS facility. In this regard, if cloud cover is present at 3500 feet, a pilot flying at 3000 feet would have 15 seconds to glide from 420 knots to an ejection speed of 200 or 225 knots without zooming. Tr. 8403-04.

121. We find that the totality of the evidence regarding weather impacts in Skull Valley shows that the Sevier B MOA has no ceiling with at least 7 miles of visibility 91.5 percent of the time. Therefore, pilots can fly through the Sevier B MOA under VFR conditions approximately 334 days per year. Campe/Ghosh Post Tr. x at 22. The Sevier D MOA, which extends up to approximately 13,750 feet AGL, has at least 7 miles of visibility 74 percent of the time. Consequently, VFR flight is possible in the Sevier D MOA approximately 270 days per year. Thus, the weather in Skull Valley is predominantly favorable for VFR flight operations.

122. Moreover, even the presence of a cloud ceiling in Skull Valley would not necessarily preclude a pilot from seeing or avoiding the PFS facility. Cole/Jefferson/Fly Post Tr. x, at 51-53. A pilot in an emergency would be able to maintain positional awareness by reference to easily recognizable features in Skull Valley, such as the portions of the Stansbury and Cedar Mountains that rise above the clouds and the portion of the ground that remains visible. Cole/Jefferson/Fly Post Tr. x, at 52. The mountains provide an approximate relationship to the location of the PFS facility in Skull Valley. Tr. 3600-01.

Visual Obstruction Due to the Nose of the Aircraft

123. The State asserts that during failed engine emergency procedures, an F-16 pilot's ability to see ground sites in the path of the aircraft is substantially impaired. State Findings at 55. The State further asserts that the pilot would not be able to see the ground during the zoom portion of the procedures and would not be able to see the impact location at the time of ejection. *Id*.

124. The State asserts that if the pilot had been flying at an altitude of 4,000 feet AGL, the zoom would take the F-16 to approximately 7,000 to 8,000 feet AGL. State Findings at 54. The State

asserts that during the glide descent at 6 degrees, the pilot's view will be obscured in front of the aircraft for a distance of approximately 5,500 feet for every 1,000 feet of altitude. *Id*. As the aircraft continues on this glide path the pilot will not be able to see ground terrain closer than 22,000 feet (4.16 miles) in front of the aircraft at an altitude of 4,000 AGL, nor closer than 13,750 feet in front of the aircraft at an altitude of 2,500 feet AGL. *Id.*

125. We find, however, that during an engine failure in which a pilot zooms, the pilot will have knowledge of his general position such that the pilot would be aware of objects under the aircraft and in the flight path during the zoom process. *See, e.g.*, Joint Exh. 1 at 2 (during the zoom, the pilot made corrections to his flight path to avoid populated areas). A pilot will also have positional awareness during the resulting glide to engage in avoidance measures. *Id.* (during the resulting glide, the pilot made corrections to his flight path to avoid populated areas). Tr. 13,642-44.

126. The State ignores that even with portions of the flight obstructed by the nose of the aircraft, the pilot would be able to maintain positional awareness due to the presence of navigation aids, such as the flight path marker and the steer point symbology. In this regard, during an emergency, the flight path marker would be visible. Tr. 13,643. The flight path marker shows where the aircraft is headed. *Id*. In addition, the INS would be available to the pilot to assist in maintaining positional awareness in the event that the nose of the aircraft obscures an object that had been programmed as a steer point. Further, even if an F-16 pilot cannot see a ground object directly out of the front of the aircraft due to an obstruction caused by the nose of the aircraft, a pilot would be able to look out of the side or turn to look down. In this regard, the F-16 pilot sits fairly high in the aircraft, allowing for excellent visibility. Tr. 3570. *See* State Exh. 144. Therefore, a pilot would retain situational awareness by being able to see the ground even if the nose of the aircraft causes temporary obstruction of a ground object.

Significance of Mishap Reports

127. The State asserts that PFS already concluded that 95 percent of pilots would be able to avoid the PFS site prior to reviewing the accident reports. State Findings at 55. The timing of the review of the accident reports, however, has no bearing on the validity of the Applicant's estimation of the probability that a pilot, with the time and opportunity to direct a crashing F-16 away from the PFS facility, would avoid the facility. The Applicant based its determination of a 95 percent probability on factors other than the data from the accident reports, such as the time available to the pilot, pilot training, etc. *See* PFS Exh. N (Aircraft Crash Report) at 18-24. The accident reports provided supporting data that showed examples of pilot avoidance and showed that in no case did a pilot attempt to avoid a facility on the ground but failed to do so. Thus, the timing of the review of the accident reports has no bearing on the Applicant's determination of a 95 percent probability of avoidance.

128. The State asserts that PFS Exh. 100A was prepared to justify the 95 percent component of the R factor and that PFS admits that mishaps shown in Applicant Exh. 100A do not statistically support a 95 percent success rate for a pilot to avoid a ground site. State Findings at 56. We find that the State misconstrues the purpose for which PFS Exh. 100A was prepared. PFS Exh. 100A was prepared to document instances in the accident reports that show pilots making conscious decisions to avoid objects on the ground prior to ejecting. It was not offered to provide a mathematic or statistical analysis for the Applicant's 95 percent avoidance factor. Tr. 13,101-103. Rather, the exhibit demonstrates clear instances in which pilots took actions to avoid ground sites and serves to support the Applicant's assertion regarding pilot avoidance. *See* PFS Exh. 101A at Items 1-16, 49. The examples found in the accident reports are actual accounts of pilots facing the stress of in-flight emergencies that resulted in the destruction of their aircraft in which the pilots made adjustments to their flight paths prior to ejection so as to minimize damage to objects and people on the ground. These reports complement the Applicant's expert panel's testimony, the

Applicant's aircraft crash report, and the testimony of Col. Bernard and Col. Cosby. These reports show that avoidance of objects on the ground is a principal action a pilot takes during an emergency, such as zooming and attempting engine restart. The examples of pilot avoidance in the accident reports provide strong weight to the Applicant's derivation of the 95 percent factor.

129. The State asserts that Lt. Col. Horstman reviewed the same crashes and that in no case did a pilot identify a specific ground site from the minimum ejection altitude of 2,000 feet and take some maneuver to avoid it. State Findings at 56. The State asserts that the pilot task contemplated by the PFS avoidance factor, the identification of a ground site from a distance of 3.22 miles or more, and turning away from that site did not happen a single time during the ten year period reviewed by PFS. *Id.*

130. We find that the State's assertion regarding the pilot's decision to eject below the recommended minimum ejection altitude has no bearing on the showing of avoidance in the accident reports. We find that the record supports a finding that pilots are commended for deciding to descend below 2,000 feet AGL if, to do so, a pilot would avoid objects and people on the ground.

131. The State asserts that in 50 percent of the crashes, the pilot ejected below the published minimum altitude of 2,000 feet AGL, and that this, in turn, indicates that the pilot did not have time to perform emergency procedures including the contingent procedure pertaining to avoiding populated areas. State Findings at 56. The State's assertion, however, is not logical because in many of the circumstances in which the pilot descended below 2,000 feet AGL, the pilot was able to avoid objects on the ground. Further, there is no evidence in the record to suggest that a pilot who delays ejection below 2,000 feet AGL does not have time to avoid a ground site.

132. The State asserts that in PFS Exh. 100A, PFS notes in several crashes the pilot turned toward an emergency air field and suggests that it represents evidence of a pilot avoiding a ground site. State Findings at 57. The State asserts that a turn toward an emergency air field is not an

effort to avoid a ground site but rather a standard emergency procedure that indicates the pilot intends to "fly the aircraft and land it." *Id*.

133. Again, the State misconstrues the purpose for which the accident reports demonstrating pilot maneuvering, such as turning toward an emergency air field, were offered. These accident reports are described by the Applicant as demonstrating that, based on pilot maneuvering, the pilot had situational awareness, which would contribute to successful avoidance. Staff Findings at 102. Thus, these accident reports demonstrate that the pilot was aware of his or her relative location. Jefferson, Tr. 8678-79. Tr. 13,102. Therefore, an accident report's description of a pilot's actions to "fly the aircraft and land it" shows that the pilot had situational awareness.

134. The State asserts that a reference to a pilot turning away from a populated area or towards a sparsely populated area is consistent with Air Force training but represents a pilot avoiding a large area, such as a city, and not a specific ground site. State Findings at 57. The State asserts that the crash report of July 11, 1996 shows that the pilot turned towards what he perceived to be a less congested area, although the impact destroyed 2 houses, killed a child, and injured an adult. State Findings at 57. The State asserts that the crash report of August 31, 1992 shows that the pilot turned toward what appeared to be an uninhabited area, and yet the aircraft impacted 150 yards from 2 inhabited dwellings. *Id.*

135. First, neither the State nor Lt. Col. Horstman has provided any support for the assertion that a reference in an accident report to a pilot turning from a populated area or toward a sparsely populated area represents only large areas such as cities. Further, even with respect to those reports that refer to pilot avoidance of cities, the State agrees that it would be easier to turn away from a point target, such as the PFS facility, than an area target, such as a city, in that the turn with respect to a point target requires less maneuvering. Tr. 13,471. In addition, we note that a pilot would be able to recognize the PFS facility from 5 miles away. *See* Fly, Tr. 13,674.

136. With respect to the July 11, 1996 accident report, we find that although the mishap pilot struck a house, killing a person, the pilot turned from an area where he saw houses everywhere below him to an area where there were few, if any, houses. Joint Exh. 10 at 5. Therefore, although the pilot impacted a house in another area, he was able to avoid the more congested area. In this regard, the pilot's avoidance maneuver is similar to the choice a pilot would make between crashing into the PFS facility or crashing in the open desert of Skull Valley. *See also* Tr. 13,706-07 (the concern of impacting one facility in favor of another is not present in Skull Valley because of the sparsely-populated terrain).

137. With respect to the August 31, 1992 accident report, we find that the mishap pilot attempted to avoid a populated area "dead ahead" and successfully diverted the aircraft into a wooded area, containing primarily trees and underbrush. PFS Exh. 140. The State notes that the aircraft impacted 150 yards from two inhabited dwelling structures. *See* PFS Exh. 140 at 4. First, we do not consider a distance of 150 yards - - 1 and a half football fields - - to be a near miss. Second, we agree with the Applicant that avoidance is avoidance, whether by 100 feet or by 1,000 feet. Applicant Findings at 138.

Air Force Outside of Regulatory Loop

138. The State asserts, based upon the testimony of Gen. Jefferson, that the PFS determination that 95 percent of pilots will avoid the PFS site is based on "the current Air Force Training, missions and Air Force equipment and policies."[12] State Findings at 57. The State asserts that the training conducted in Skull Valley is dependent on the combat needs of the nation and world conflict. State Findings at 58. According to the State, the capabilities of the pilots and equipment will depend on

[12] Gen. Jefferson, however, did not state that the PFS estimate was based on "current" Air Force training or "missions and Air Force equipment and policies." Tr. 8882. Rather, Gen. Jefferson agreed with Judge Lam's understanding that the Applicant's expert witnesses based their estimation on 3 considerations: the well-trained Air Force pilot, the visibility of the PFS facility in Skull Valley, and the sufficient time available during an emergency to take action. Tr. 8882.

decisions made by the Air Force. State Findings at 58. The State asserts that the "lack of actuarial data and total reliance on human factors" under control of the Air Force for the safety of the PFS site amounts to "delegating an essential element of safety outside the regulatory loop." *Id*. Further, the State asserts that reducing the probability of aircraft crashes on the expectation that an Air Force pilot will not allow a crashing aircraft to impact the PFS facility constitutes the delegation of an essential element of safety to an unlicensed and uncontrolled third party outside the "regulatory loop." State Findings at 70.

139. The Staff has not impermissibly delegated an element of safety to the Air Force or to Air Force pilots. Rather, the Staff took into account the practice of the Air Force to train its pilots well to develop and maintain positional and situational awareness and to avoid objects on the ground. *See* Tr. 4150-51 (consideration of the Air Force pilots' performance is based on historical data). Consideration of the Air Force's training practice in assessing the threat posed by Air Force activities to the proposed facility is no different from assessing other man-made facilities and activities in the vicinity of the proposed site that may endanger the facility.[13] *See* 10 C.F.R. § 72.94. Certainly these man-made facilities are managed and owned by third parties that do not fall within the NRC's enforcement jurisdiction. Yet, the Commission requires that the Staff assess their potential impact on the ISFSI and, in doing so, sets forth a rule of reason, providing that in assessing external man-induced events the "current state of knowledge about such events" is employed. 10 C.F.R. § 72.94(c).

140. Further, it is doubtful that the Air Force will change tactics to such an extent that pilots are no longer trained to develop and maintain positional and situational awareness or to avoid objects on the ground. There is no evidence in the record to suggest that pilots will change their overall

[13] In addition, the Staff will base a licensing decision on other types of factors involving third parties, such as the character and distribution of population and the present and projected uses of land and water in the region. 10 C.F.R. § 72.98 (c) (1) and (2).

attitude of professionalism and safety or will no longer keep track of their surroundings in flight. In fact, military pilots have a long history of avoiding people and objects on the ground. *See* PFS Exh. WWW (In 1956, pilot of F-86 avoided populated area); PFS Exh. XXX (In 1961, pilot avoided a farm); PFS Exh. YYY (In 1961, pilot avoided grade school, and in 1966 pilot avoided houses); PFS Exh. ZZZ (several years ago, pilot avoided parade ground).

Moser Recovery Route

141. The State asserts that the Applicant's basis for the conclusion that less than 5 percent of flights returning to Hill AFB use the MRR is "faint and unconvincing." State Findings at 60. Rather, the State asserts that night vision goggle training will increase and stated that of the total training flights in MOAs, approximately one third will be night sorties. *Id*. at 59. Therefore, the State asserts that a realistic number of flights using the MMR is 33 percent of the flights returning to Hill AFB from the UTTR South Area. *Id.*

142. To support its assertion regarding night vision goggle training, the State relies on an Air Force Memorandum, which states that night vision goggle training will increase and that of the total sorties flown in MOAs, approximately one third will be night sorties. State Exh. 64 (Air Force Memorandum, dated July 2001) at 4. We do not consider that the State has demonstrated on the basis of the Air Force Memorandum that any expected increase in night vision goggle training on the Sevier B and D MOAs will likely cause an increase on the MRR. The mere availability of the MRR as a night route does not render the MRR a preferable route. We find no evidence in the record that the use of the MRR has increased due to night vision goggle training, rather, as we note below, there are impediments to using the MRR that exist even if night vision goggle training becomes more frequent in the Sevier B and D MOAs.

143. We find that the Applicant's assertion that less then 5 percent of flights use the MRR is supported on the grounds that: 1) the MRR is only used under specific wind conditions; 2) the MRR is not favored by pilots due to conflicts with Salt Lake City International Airport traffic; and 3) most

importantly, Air Force personnel have confirmed that the MRR is rarely used. These bases are not "faint and unconvincing," as is argued by the State.

144. The Applicant's witnesses testified that the MRR is only used at night under specific wind conditions which require the use of Runway 32 at Hill AFB. Cole/Jefferson/Fly Post Tr. x, at 97. *See also* PFS Exh. 218 (March 23, 1998 accident report) at 1-3 (due to strong winds, mishap pilot was directed to fly to Runway 32 via MRR). In this regard, the MRR is used when the wind conditions dictate a northern approach and landing. Cole Tr. 3460, 3465. The wind conditions dictate a northern approach and landing when the wind is coming from the north. Under such conditions, an aircraft would be flying into the wind and would be able to land without excessive tail wind. Tr. 3461. At Dugway, however, the prevailing wind direction is from the south. *See* Vigeant, Tr. 3473. At Salt Lake City, the prevailing wind is from the southeast. *See* Vigeant, Tr. 3473-74. Therefore, there is a south or southeast prevailing wind direction at both Salt Lake City and Dugway. Tr. 3474. We therefore find that the prevailing wind conditions do not favor a northern approach and landing from the MRR.

145. The Applicant's witnesses testified that pilots are not inclined to use the MRR due to conflicts with Salt Lake City International Airport air traffic flow and the active use of the runways. Cole, Tr. 3461. Fly, Tr. 3462-63. In fact, when Col. Fly was stationed at Hill AFB, Salt Lake City International Airport preferred that pilots use the takeoffs and landings toward the south due to the possible conflicts and traffic sequencing concerns. Tr. 3463. We therefore find that the MRR is not a preferred flight route due to conflicts with Salt Lake City air traffic.

146. The Applicant's witnesses communicated with Air Force personnel and air traffic controllers regarding the use of the MRR. In August 1999, Gen. Cole spoke to Col. Ron Oholundt, the Vice Commander of the 388th Fighter Wing to ascertain how often the MRR is used. Col. Oholundt said "not very often." Tr. 3456. When asked if the use of the MRR was less than 15 percent of the traffic volume, he agreed. Tr. 3456-57. Gen. Cole then spoke with an air traffic controller at the

Salt Lake City Center and the controller stated that the MRR was used "very rarely." He stated that it was less than 5 percent. Tr. 3457. Gen. Cole reconfirmed with the air traffic controller in March, 2002 the use of the MRR. The air traffic controller verified that the MRR is used the same or less than when Gen. Cole spoke to him previously. Tr. 3458. He said, "It is significantly less than five percent." Tr. 3458.

147. Col. Fly, likewise, communicated with Air Force personnel regarding the use of the MRR. He spoke to Col. Coutts, the 3rd Operations Group Commander. Tr. 3799. Col. Coutts stated that 5 percent would be "about right." Tr. 3800. Col. Coutts also informed Col. Fly that they have a strong preference not to use the MRR. *Id.* Therefore, we find that Air Force personnel and air traffic controllers have informed the Applicant that less than 5 percent of the traffic uses the MRR.

148. Further, the March 23, 1998 accident report regarding a mishap that took place on the threshold of runway 32 at Hill AFB following a flight along the MRR supports the Applicant's assertion regarding the minimal use of the MRR. The accident report states that 5 of the pilots interviewed with respect to the mishap had flown a night approach to runway 32, and 4 agreed that it was difficult. PFS Exh. 218 at 3. *See also id.* at 13 (a properly flown TACAN to runway 32 at night was still challenging to an experienced pilot). According to the accident report, "[t]he approach is rarely done; only one of the five had done it more than once." *Id.* (emphasis added).

149. Moreover, the introduction of night vision goggle training at Hill AFB, the Staff asserted that the use of the MRR has not significantly increased, such that the Applicant's estimate of 5 percent of returning F-16s using the MRR understates its use. Campe/Ghosh Post Tr. x, at 39. Personnel at Hill AFB stated that the introduction of night vision goggle training did not appreciably change the traffic density through the MRR. Thus, pilots do not use the MRR more frequently due to the introduction of night vision goggle training. *Id.*

150. Therefore, on the basis of the complications associated with the use of the MRR, which make it undesirable as an air corridor, and the discussions the Applicant and the Staff had with Air

Force personnel, we find that less than 5 percent of flights returning from the UTTR South to Hill AFB, and not 33 percent, use the MRR annually.

Probability of Impacts Due to Jettisoned Ordnance

151. The State's estimation of the probability of impacts due to jettisoned ordnance in its Findings is new. Previously, the State considered the fraction of the number of flights carrying ordnance on the UTTR South area to be 11.8 percent, based on the 1998 data.[14] Resnikoff Post Tr. 8698, at 19. State Exh. 79. The State asserted that use of the 1998 percentage is more conservative than the 2000 percentage. *Id.* The State now asserts that the fraction of the number of flights carrying ordnance should be 21.2 percent or 15.1 percent, depending if one wants to be conservative or merely realistic. *See* State Findings at 64-65.

152. In support of its new value for the percentage of flights carrying ordnance (and consequently, its new value for the probability of jettisoned ordnance impacts), the State presently asserts that based on the ordnance carried by the 419th Fighter Wing, in addition to the ordnance carried by the 388th Fighter Wing, the percentage of sorties carrying ordnance should be increased. State Findings at 63. The State additionally applies the percentage of flights carrying ordnance in 1998 (the year representing the greatest number of ordnance flights) to the number of overall flights in 2000 (the year representing the greatest number of overall flights), to arrive at the number of flights carrying ordnance. *Id*. at 64.

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[14] Dr. Resnikoff's prefiled testimony stated:

> To determine the number of F-16 sorties that carry inert or live ordnance, I started with 7,040 as the number of F-16 flights transiting Skull Valley that I used to calculate the probability of a n aircraft crash from F-16s transiting Skull Valley en route to the UTTR South range. I then multiplied that number of sorties by the percentage (11.8 percent) of F-16s that carried jettisonable ordnance in FY 98. *See* Horstman Tsmy A. 77, *Crash Report* at 82.

Resnikoff Post Tr. 8698 at 19 (emphasis added).

153. The State asserts that the Applicant did not account for the flights carrying ordnance by the 419th Fighter Wing in its initial Aircraft Crash Report. State Findings at 63 n. 27. The Applicant, however, considered the contribution from the 419th Fighter Wing and the 388th Fighter Wing in its revised analysis. *See* PFS Exh O at 30; PFS Exh. O (Tab HH) at 14-15. *See also* Staff Exh. C (SER) at 15-85 and Table 15-9. The Applicant considered that if the average fraction of sorties carrying jettisonable ordnance on the South UTTR for 1999 and 2000 is increased proportionally to account for the 419th Fighter Wing, the fraction is increased by 1.278. *Id*. at 14. Using this fraction, and holding the other factors used in its analysis constant, the Applicant estimated that the probability of striking the PFS facility with jettisoned ordnance results in a decrease from the hazard calculated for jettisoned ordnance.[15] *Id*. Therefore, the Applicant did consider the contribution of the ordnance carried by the 419th Fighter Wing in its analysis.

154. The State asserts that the number of flights that carry ordnance "varies dramatically" and is dependent on training tactics, national policy and world conflict. Therefore, the State claims that the Applicant should use the number of ordnance in the highest year, 1998, rather than the number of ordnance carried in 2000. The State asserts that current training needs require more sorties to carry ordnance than carried in 2000 and that the Applicant does not know the reason for the decline in the number of sorties carrying ordnance from 1998 to 2000. State Findings at 63. Therefore, according to the State, it is neither realistic nor conservative to assume that future flights will carry less ordnance than flights in 1998. State Findings at 63.

155. The evidence in the record, however, shows that - - contrary to the State's assertion - - ordnance training requirements do not vary significantly from year to year in response to world

[15] The Applicant took the average number of flights through Skull Valley in 1999 and 2000, adjusted to account for additional F-16s stationed at Hill AFB in 2001. PFS Exh. O (Tab HH) at 14-15. The Applicant additionally conducted 2 sensitivity analyses addressing: 1) FY 2000 flights through Skull Valley, increased to account for additional F-16s stationed at Hill AFB in 2001 and; 2) FY 2000 flights through the Sevier B and Sevier D MOAs in 2000, increased to account for additional F-16s stationed at Hill AFB in 2001. *Id*.

events. The Applicant's witnesses testified that the Air Force has minimum training requirements for ordnance and that each fighter squadron has a training program to support its designated operational capability (DOC). *See* Fly, Tr. 13,082. The 388th Fighter Wing's DOC is air-to-ground bombing. Tr. 13,084. Therefore, each pilot has annual air-to-ground training requirements that must be fulfilled to support the Wing's DOC. *Id.*

156. Col. Fly testified that he has seen little change over the years in actual training requirements to fulfill DOCs. Tr. 13,086. A fighter wing with an air-to-ground bombing DOC would need to conduct ordnance training to fulfill its DOC, regardless of the state of the world. In this respect, the Air Force is required to maintain readiness to fight a full spectrum of war, including air-to-ground bombing, regardless of military action in a given year. *Id.*

157. Gen. Cole explained that budgetary impacts affect the requirements regarding ordnance training. Tr. 13,087. The total Air Force budget has decreased significantly from 1986 to 1995, and less ordnance training is presently conducted. Tr. 13,087. The Air Force is buying fewer bombs due to the decrease in the Air Force budget and also due to the availability of high-technology, precision-guided munitions that do not require as many training flights for pilots to develop proficiency. Tr. 13,088. Precision-guided munitions are not routinely dropped from an aircraft during training exercises due to high cost of the ordnance. Instruments keep track of the scoring. Tr. 13,085. Further, Col. Clark of the Air Force Safety Agency, which monitors ordnance expenditures, does not expect the ordnance expenditure rate to increase. *Id*.

158. We find that the evidence in the record shows that the 388th Fighter Wing's ordnance training requirements are not likely to increase in the future due to the fact that the Wing must maintain an established level of air-to-ground ordnance training, regardless of the state of the world. Further, we find that the Air Force's expenditures for munitions are not likely to increase. Therefore, the Applicant's consideration of the percentage of flights that carry ordnance in 1999 and 2000 is acceptable.

159. The State asserts that the Air Force does not keep records of the routing where aircraft with ordnance actually flew and therefore, it is conservative to assume that all sorties with ordnance transit Skull Valley, or 21.2 percent of 4,086 flights in 1998. State Findings at 64. The State, however, applies the fraction of ordnance data from 1998 to the sortie count from 2000. The State provides no basis for combining the sorties count from one year and the fraction of flights carrying ordnance from another. Therefore, we reject the State's estimate of the percentage of flights carrying ordnance.

160. In determining the percentage of aircraft that carry ordnance, the Applicant relied on data obtained from the Air Force regarding ordnance carried by F-16s from 1999 through 2000. The Applicant determined the fraction of flights on the UTTR South area that carried ordnance in 1999 and 2000 to be 2.556 percent. *See* PFS Exh. O, Tab HH a 14. The Applicant applied this fraction to the number of flights that transit Skull Valley during these years, updated to account for additional F-16s stationed at Hill AFB. Therefore, the Applicant estimated the value for N in the above equation to be 2.556 percent of 5,870 flights, or 150. *Id*. at 102-03.

161. The Staff estimated the fraction of the number of flights carrying ordnance in 2000, adjusted to account for the number of additional flights due to the 12 additional F-16 aircraft to be stationed at Hill AFB, to be 2.3 percent of 7041 flights, or 161, which is close to the figure obtained by the Applicant. *See* Staff Exh. C (SER) at 15-85 through 15-87.[16] We find the Staff's value derived for the fraction of the number of flights carrying ordnance on the UTTR South area in 2000 to be acceptable and, further, does not suffer from the ill effects of mixing apples and oranges, as does the State's value.

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[16] The Staff considered that "[i]n FY 2000, a total of 164 sorties to the UTTR South area out of 7059 sorties carried jettisonable ordnance, taking into account both the 388th and 419th Fighter Wings. Hence, the portion of the sorties that carried jettisonable ordnance in FY2000, f_o, is equal to 164/7059, or 0.023." Staff Exh. C (SER) at 15-85 through 15-86.

162. The State asserts that the Applicant modified the NUREG-0800 formula to account for an additional factor, *e* - - the percentage of crashes that leave the pilot in control of the aircraft. State Findings at 65. The State criticizes the Applicant's use of the additional factor, *e*, which assumes that a pilot would jettison ordnance in only 90 percent of crashes. *Id*. In the other 10 percent of crashes the pilot would eject quickly without time to jettison ordnance. The State asserts that no evidence is offered in support of that assumption. *Id.* at 66. The State also asserts that emergency procedures indicate that jettisoning of stores precedes attempts to restart the engine and thus a pilot may jettison stores and not crash. *Id.* Thus, according to the State, jettisoned ordnance may occur more frequently than F-16 crashes. *Id.*

163. We believe, contrary to the State's assertion, that the evidence in the record supports a finding that consideration of the value for *e* is acceptable in calculating the hazard posed to the facility by jettisoned ordnance. In this regard, we note that *e* is the same as R1, the estimate of the percentage of crashes that leave the pilot in control of an aircraft. This factor, R1, is addressed in conjunction with our discussion pertaining to the hazard posed by F-16s transiting Skull Valley. The value for *e* is thus the same as R1 - - 90 percent.[17] Staff Findings at 95.

164. The Applicant conservatively assumed that in all crashes leaving a pilot in control of the aircraft, the pilot would jettison stores. The evidence in the record supports the assumption that a pilot in control of an aircraft, after experiencing an in-flight emergency, would jettison ordnance, whereas a pilot not in control of an aircraft would not jettison ordnance. Cole/Jefferson/Fly Post Tr. x, at 103. *See also* Horstman Post Tr. x, at 28 (after zooming a pilot will jettison all stores); State Findings at 62 (after a pilot zooms, the pilot will release the bombs and fuel tanks).

[17] The Applicant considered the remaining 10 percent of crashes to be those in which the F-16 would not be in control and would result in an impact to the proposed facility. Therefore, by neglecting *e*, in the estimate of the threat to the facility posed by jettisoned ordnance, the State overcounts those accidents in which the pilot is out of control and does not jettison ordnance. Those accidents are addressed as part of the crash probability of F-16s transiting Skull Valley in which all accidents involving out of control aircraft are assumed to impact the proposed facility.

Moreover, we find that the analytical assumption that a pilot in control of a crashing F-16 would always jettison the ordnance without regard to its impact location is, in fact, conservative. In this regard, we note that accident reports and testimony in the record demonstrate that pilots consider where the jettisoned stores will impact and take measures to mitigate damage to people and objects on the ground. *See* Joint Exh. 3 at 3-4 (pilot could see ground and determined it was safe to jettison tanks); PFS Exh. 205 at 2 (pilot delays jettisoning tanks due to proximity to populated areas). *See also* Jefferson, Tr. 3623 (Gen. Jefferson dropped tanks after looking down to make sure nothing was below).

165. The State's assertion that jettisoned ordnance may occur more frequently than F-16 crashes has no merit because jettisoned ordnance having the potential to cause damage to the PFS facility are classified as either Class A or Class B mishaps. These ordnance impacts are therefore included in the crash rate for F-16 aircraft. In this regard, Class A and Class B mishaps are categorized in terms of monetary damage both to the aircraft and to ground sites. For example, the Air Force defines a Class A mishap as one that results in total property damage at or above $1 million, a destroyed aircraft, or a fatality. A Class B mishap results in total property damage between $200,000 and $1 million. Campe/Ghosh Post Tr. x, at 12. Therefore, jettisoned ordnance is considered as a Class A or Class B mishap if it results in damage exceeding $200,000. *See* PFS Exh. 211 (April 14, 1992 accident report) at 1 (mishap pilot jettisoned fuel tanks into a lake and landed uneventfully). Cole, Tr. 13,004-05 (the accident was a Class A mishap). It is not unreasonable to assume that any jettisoned ordnance that impacts the PFS facility would be classified similarly to that of the April 14, 1992 mishap. Therefore, the crash rate accounts for those mishaps in which ordnance is jettisoned although the aircraft safely recovers.

166. The State estimated the area to be 0.12519 square miles, assuming a skid distance of ordnance similar to that of an F-16 aircraft. State Findings at 65. Resnikoff Post Tr. 8698, at 20.

Dr. Resnikoff, however, recognized that the skid distance of ordnance may be different from that of an aircraft due to the differences in the configuration of an F-16 and ordnance. Tr. 8803-04.

167. The Applicant asserts that ordnance does not skid. Cole/Jefferson/Fly Post Tr. x, at 107. Gen. Jefferson testified that ordnance will come down fairly steeply and much more close to vertical than an F-16, because, unlike an F-16, ordnance has no aerodynamic capability. Tr. 8868; Tr. 8689. Thus, Gen. Jefferson had no basis for postulating that ordnance could skid. Moreover, the Joint Munitions Effects Manual Trajectory Model prepared at Eglin AFB, discusses the effects of the impact angle on the estimated probability. *See* Staff Exh. C (SER) at 15-87. The analysis shows that the estimated probability would not significantly increase due to the impact angle of ordnance. *Id.* The State does not address any of the above evidence in its Findings with respect to its estimation of the effective area. *See* State Findings at 64-65.

168. Based on the above, we find that ordnance jettisoned from an F-16 is unlikely to skid. Therefore, we find that the Applicant's consideration of the area is acceptable.

Probability of Crashes from Air-to-Air Combat Training Over the UTTR

169. The State asserts that the Applicant considered pilot avoidance to reduce the probability of crashes from combat training on the reasoning that the pilot would steer the aircraft away from the PFS facility. According to the State, it is not realistic or conservative to allow a reduction in crash probability based on a pilot's ability to avoid the PFS site. State Findings at 66.

170. In its evaluation of the risk posed by air-to-air combat training in the UTTR South area to the PFS facility, the Applicant assumed that aircraft experiencing an engine failure would not glide beyond 5 miles from the location where the emergency occurred. Staff Exh. C (SER) at 15-77. Using a 5-mile glide distance, the Applicant estimated that the likelihood that a disabled aircraft within the training zone of the UTTR South area reaching and crashing onto the PFS facility would be negligibly small. Cole/Jefferson/Fly Post Tr. x, at 91-94.

171. As part of its evaluation, the Applicant assessed accident reports involving F-16 crashes that occurred during special in-flight operations, such as air-to-air combat training. *Id*. at 91. Most crashes in which a pilot did not have control of the aircraft took place toward the center of the restricted ranges. These aircraft did not travel more than 5 miles before impacting the ground. *Id*. Therefore, crashes resulting from air-to-air combat training within the UTTR South and involving loss of aircraft control would not pose a hazard to the PFS facility.

172. The Applicant considered that crashes also can occur that leave a pilot in control of an aircraft. A pilot under these conditions would likely have the ability to see and avoid the PFS facility in that air-to-air combat training in the UTTR South only occurs when the weather is sufficient to support VFR flights. Staff Exh. C (SER) at 15-78. If a pilot were in control of an aircraft, a distance of 5 miles would provide sufficient time for the pilot to steer the aircraft away from the PFS facility. *Id.* A pilot experiencing an in-flight emergency while training on the UTTR South would not likely glide the aircraft across the Cedar Mountains toward Skull Valley. Rather, the UTTR South provides a relatively safe area for landing a disabled aircraft - - Michael Army Airfield. *See* PFS Exh. P (map). *See also* Cole/Jefferson/Fly Post Tr. x, at 93-94.

173. The Staff agreed with the Applicant that a cut-off radius of 5 miles is reasonable. Campe/Ghosh Post Tr. x, at 37. The State's military expert, Lt. Col. Horstman, stated in his December 2000 deposition that "if an airplane has a problem [in the UTTR], it's not going to make it to Skull Valley, it's going to go to Michaels or it's going to crash before it gets there, it's that simple." PFS Exh. O (Aircraft Crash Addendum) Tab BB, at 218. The State's nonmilitary witness, Dr. Resnikoff, estimated the hazard posed to the PFS facility assuming that aircraft would fly 10 miles before impacting the ground. Tr. 8794. He did so on the basis of the Applicant's prior calculations, in which the Applicant applied a 10-mile glide distance. Tr. 8798-99. The Applicant, however, applied a more realistic distance of 5 miles in its revised analysis. PFS Exh. O (Aircraft Crash Addendum) at 17-20. Dr. Resnikoff agreed that if the possible distance an aircraft

experiencing an emergency in the UTTR South would fly is 5 miles, and not 10 miles, the hazard to the facility would be effectively reduced to zero. Tr. 8800.

174. We find, based on the above considerations of the Staff, Applicant, and statement of Lt. Col. Horstman, that a pilot experiencing an in-flight emergency while conducting air-to-air training on the UTTR South would not fly to the PFS facility. Therefore, we find that the annual probability that an aircraft conducting air-to-air training on the UTTR South area would impact the PFS facility is less than 1×10^{-8}.

Cumulative Probability of Aircraft and Ordnance Striking the PFS Facility

175. The State in its Findings, has altered its calculated annual crash probabilities from the figures Dr. Resnikoff derived in testimony for the hearing. In this respect, the State has increased the probability of impact of F-16s transiting Skull Valley estimated by Dr. Resnikoff from 6.39×10^{-6} to 7.72×10^{-6}. *Compare* Resnikoff Post Tr. 8698, at 21 *with* State Findings at 67. The State has also disregarded Dr. Resnikoff's calculated probability of impact of aircraft on the Moser Recovery Route, increasing the probability from 1.36×10^{-6} to 1.64×10^{-6}. *Id.* The State additionally increased the probability of jettisoned ordnance estimated by Dr. Resnikoff from 7.06×10^{-7} to 1.53×10^{-6}. *Id.*

176. The State has increased its overall cumulative hazard estimate. *Id*. In this respect, the State would have us now find that "a cumulative annual impact probability for crash hazards to the PFS site from aircraft and ordnance of less than 1.12×10^{-5} is neither realistic nor conservative." State Findings at 67-68. Thus, the State effectively disparages Dr. Resnikoff's prior estimate of 8.99×10^{-6} as being neither realistic nor conservative.

177. We find that the State's post-hearing alteration of its calculations was not based on any information the State did not rely upon when it prepared its pre-filed testimony in February, 2002. Thus, the State's post-hearing alteration of its calculations calls into serious question the thoroughness, and thus the reliability, of Dr. Resnikoff's analysis and the State's demonstration of

purported deficiencies in the Applicant's aircraft crash analysis and Staff's SER. *See, e.g.*, *Private Fuel Storage, L.L.C.* (Independent Spent Fuel Storage Installation), LBP-01-19, 53 NRC 416, 440-41 (2001) (Licensing Board finds Lt. Col. Horstman's change of analysis to be "troubling" and warns the State that further misstatements of the witness will impact on the credibility of the analysis).[18] Consequently, the Licensing Board does not accept the State's changes in its aircraft crash probability.

Respectfully submitted,

/RA/
Catherine L. Marco
Counsel for NRC Staff

Dated this 7th day of October, 2002
at Rockville, Maryland

[18] We find that any <u>further</u> changes to the State's analyses, such as may be set forth in its reply findings, shall be disregarded in that the Commission's regulations do not provide for responses to reply findings absent leave and that fundamental fairness dictates that each side be given an opportunity to be heard. 10 C.F.R. § 2.754. *See also Private Fuel Storage, L.L.C* (Independent Spent Fuel Storage Installation), LBP-02-08, 55 NRC 171, 201 (2002) (licensing board must bear in mind the ancient axiom - - "hear the other side.").

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-ISFSI
	)	
(Independent Spent Fuel Storage Installation)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF'S PROPOSED FINDINGS IN REPLY TO THE STATE OF UTAH'S PROPOSED FINDINGS CONCERNING CONTENTION UTAH K/ CONFEDERATED TRIBES B (INADEQUATE CONSIDERATION OF CREDIBLE ACCIDENTS)" in the above captioned proceeding have been served on the following through deposit in the NRC's internal mail system, with copies by electronic mail, as indicated by an asterisk, or by deposit in the U.S. Postal Service, as indicated by double asterisk, with copies by electronic mail this 7th day of October, 2002:

Michael C. Farrar, Esq., Chairman*
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(E-mail copy to **MCF@NRC.GOV)**

Dr. Jerry R. Kline*
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(E-mail copy to **JRK2@NRC.GOV)**

Dr. Peter S. Lam*
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(E-mail copy to **PSL@NRC.GOV)**

Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Office of the Secretary*
ATTN: Rulemakings and Adjudications Staff
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(E-mail copies to SECY@NRC.GOV and HEARINGDOCKET@NRC.GOV)

Office of the Commission Appellate Adjudication
Mail Stop: 16-C-1 OWFN
U.S. Nuclear Regulatory Commission
Washington, DC 20555

James M. Cutchin, V*
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(E-mail to **JMC3@NRC.GOV)**

Jay E. Silberg, Esq.**
Ernest Blake, Esq.
Paul A. Gaukler, Esq.
Sean Barnett, Esq.
Shaw Pittman
2300 N Street, N.W
Washington, DC 20037-8007
(E-mail copy to jay_silberg,
paul_gaukler, sean_barnett, and
ernest_blake@shawpittman.com)

Tim Vollmann, Esq.**
3301-R Coors Road N.W.
Suite 302
Albuquerque, NM 87120
(E-mail copy to **tvollmann@hotmail.com**)

Leon Bear, Chairman
Skull Valley Band of Goshute Indians
3359 South Main
Box 808
Salt Lake City, Utah 84115

Denise Chancellor, Esq.**
Fred G. Nelson, Esq.
Laura Lockhart, Esq.
Utah Attorney General's Office
160 East 300 South, 5th Floor
P.O. Box 140873
Salt Lake City, UT 84114-0873
(E-mail copies to dchancellor, fnelson,
llockhart, and jbraxton@utah.gov, and
attygen@xmission.com

Connie Nakahara, Esq.**
Utah Dep't of Environmental Quality
168 North 1950 West
P. O. Box 144810
Salt Lake City, UT 84114-4810
(E-mail copy to **cnakahara@utah.gov)**

Diane Curran, Esq.**
Harmon, Curran, Spielberg & Eisenberg
1726 M Street, N.W., Suite 600
Washington, D.C. 20036
(E-mail copy to
dcurran@harmoncurran.com)

John Paul Kennedy, Sr., Esq.**
David W. Tufts, Esq.
Durham, Jones & Pinegar
111 East Broadway, Suite 900
Salt Lake City, UT 84105
(E-mail copy to **dtufts@djplaw.com)**

Joro Walker, Esq.**
Land and Water Fund of the Rockies
1473 South 1100 East, Suite F
Salt Lake City, UT 84105
(E-mail copy to utah@lawfund.org

Paul C. EchoHawk, Esq.
EchoHawk Law Offices
151 North 4th Avenue, Suite A
P.O. Box 6119
Pocatello, Idaho 83205-6119
(E-Mail copies to: paul, larry and
mark@echohawk.com)

/RA/

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Catherine L. Marco
Counsel for NRC Staff