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STRUCTURES TO RESIST THE EFFECTS OF ACCIDENTAL EXPLOSIONS

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
NOVEMBER 1990

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The blast effects of solid materials are best known. This is particularly true for high-explosive materials. The blast pressures, impulses, durations, and other blast effects of an explosion have been well established. These effects are contained in this chapter.

Unlike high-explosive materials, other solid, liquid, and gaseous explosive materials will exhibit a variation of their blast pressure output. An explosion of these materials is in many cases incomplete, and only a portion of the total mass of the explosive (effective charge weight) is involved in the detonation process. The remainder of the mass is usually consumed by deflagration resulting in a large amount of the material's chemical energy being dissipated as thermal energy which, in turn, may cause fires or thermal radiation damage.

2-9. TNT Equivalency

The major quantity of blast effects data presented in this manual pertains to the blast pressures output of bare spherical TNT explosive. These data can be extended to include other potentially mass-detonating materials (Class 1.1) by relating the explosive energy of the "effective charge weight" of those materials to that of an equivalent weight of TNT. In addition to the energy output, other factors may affect the equivalency of material compared to TNT. These factors include the material shape (flat, square, round, etc.), the number of explosive items, explosive confinement (casing, containers, etc.), and the pressure range being considered (close-in, intermediate or far ranges). These other factors will be discussed later in this manual.

For blast resistant design, the effects of the energy output on explosive material, of a specific shape, relative to that of TNT, of similar shape, can be expressed as function of the heat of detonation of the various materials as follows:

$$W_E = \frac{H^d_{EXP}}{H^d_{TNT}} W_{EXP} \qquad 2\text{-}1$$

where

W_E = effective charge weight

W_{EXP} = weight of the explosive in question

H^d_{EXP} = heat of detonation of explosive in question

H^d_{TNT} = heat of detonation of TNT

The heat of detonation of some of the more commonly used explosives are listed in Table 2-1.

The above equation for the effective charge weight is related primarily to the blast output associated with the shock effects of unconfined detonations (Section 2-13). The effective charge weight produced by the confinement effects

If the height of the triple point does not extend above the height of the structure, then the magnitude of the applied loads will vary with the height of the point being considered. Above the triple point, the pressure-time variation consists of an interaction of the incident and reflected incident wave pressures resulting in a pressure-time variation (Fig. 2-12b) different from that of the Mach incident wave pressures. The magnitude of pressures above the triple point is smaller than that of the Mach front. In most practical design situations, the location of the detonation will be far enough away from the structure so as not to produce this pressure variation. An exception may exist for multistory buildings even though these buildings are usually located at very low-pressure ranges where the triple point is high.

In determining the magnitude of the air blast loads acting on the surface of an above-ground protective structure, the peak incident blast pressures in the Mach wave acting on the ground surface immediately before the structure are calculated first. The peak incident pressure $P_{r\alpha}$ is determined for this point from Figure 2-9 using the scaled height of charge above the ground $H_c/W^{1/3}$ and the angle of incidence α.

A similar procedure is used with Figure 2-10 to determine the impulse $i_{r\alpha}$ of the blast wave acting on the ground surface immediately before the structure. An estimate of the other blast parameters may be obtained from Figures 2-7 and 2-8 by setting the values of $P_{r\alpha}$ and $i_{r\alpha}$ equal to the values of the peak incident pressure P_{so} and incident impulse i_s of the mach wave, respectively. The scaled distances corresponding to P_{so} and i_s are determined from Figure 2-7. The scaled distance corresponding to P_{so} is used to obtain values of Pr, P_{so}^-, $t_A/W^{1/3}$, U, $L_W/W^{1/3}$ and $L_W^-/W^{1/3}$ while the scaled distance corresponding to i_s is used to obtain values of i_r, i_s^-, i_r^-, $t_o/W^{1/3}$ and $t_o^-/W^{1/3}$.

2-13.3. Surface Burst

A charge located on or very near the ground surface is considered to be a surface burst. The initial wave of the explosion is reflected and reinforced by the ground surface to produce a reflected wave. Unlike the air burst, the reflected wave merges with the incident wave at the point of detonation to form a single wave, similar in nature to the mach wave of the air burst but essentially hemispherical in shape (Fig. 2-14).

The positive phase parameters of the surface burst environment for hemispherical TNT explosions are given in Figure 2-15 while the negative phase parameters are given in Figure 2-16. A comparison of these parameters with those of free-air explosions (Fig. 2-7 and 2-8) indicate that, at a given distance from a detonation of the same weight of explosive, all of the parameters of the surface burst environment are larger than those for the free-air environment.

As for the case of air bursts, protected structures subjected to the explosive output of a surface burst will usually be located in the pressure range where the plane wave (Fig. 2-14) concept can be applied. Therefore, for a surface burst, the blast loads acting on structure surface are calculated as described for an air burst except that the incident pressures and other positive phase parameters of the free-field shock environment are obtained from Figure 2-15, and theoretical negative phase blast parameters are shown in Figure 2-16.

As for the case of an air burst, the curves presented in Figures 2-15 and 2-16 which give the blast wave parameters as a function of scaled distance, extend only to a scaled distance $Z = 100$ ft/lb$^{1/3}$ (see section 2-13.1).

Blast parameters for explosives detonated on the ground surface other than hemispherical TNT are listed in Table 2-2. These explosives include both uncased and cased high explosives, propellants and propelling charges as well as pyrotechnic mixtures. The various shapes of the explosive materials are given in Figure 2-17. The blast parameters for the various explosives are illustrated in Figures 2-18 through 2-49. For each explosive material considered, the peak incident pressure P_{so} and scaled incident impulse $i_s/W^{1/3}$ is presented as a function of the scaled ground distance $Z_G = R_G/W^{1/3}$ from the point of detonation. The charge weight W is equal to the actual weight of the explosive material under consideration increased by the required factor of safety (20 percent).

An estimate of the blast parameters other than incident pressure and impulse, may be obtained from Figures 2-15 and 2-16. The scaled ground distance corresponding to the incident pressure P_{so} is used to obtain the values of P_r, P_{so}^-, P_r^-, $t_A/W^{1/3}$, U, $L_w/W^{1/3}$ and $L_w^-/W^{1/3}$. In addition, this scaled ground distance $Z_G = R_G/W^{1/3}$ is used to calculate the equivalent TNT design charge weight W for pressure using the actual ground distance R_G. The absolute values of the scaled blast parameters are obtained by multiplying the scaled values by the equivalent TNT design charge weight.

The scaled ground distance corresponding to the incident impulse requires a graphical solution. The point corresponding to the scaled incident impulse and scaled ground distance for the explosive material in question is plotted on Figure 2-15. A 45 degree line is drawn through this point. The point where the line intersects the scaled impulse curve corresponds to the scaled impulse and scaled ground distance for the equivalent TNT charge. This scaled ground distance is then used to obtain the values of $i_r/W^{1/3}$, $i_s^-/W^{1/3}$, $i_r^-/W^{1/3}$, $t_o/W^{1/3}$ and $t_o^-/W^{1/3}$. In addition, this scaled ground distance and the actual ground distance is used to calculate the equivalent TNT design charge weight for impulse. The absolute values of the scaled blast parameters are obtained by multiplying the scaled values by the equivalent TNT design charge weight.

It may be noted that the above data for explosives other than TNT is limited to surface bursts with container shapes indicated in Figure 2-17. This data should not be extrapolated for scaled distances less than those indicated on Figures 2-18 through 2-49. In addition, the blast pressure and impulse for propellants and, in particular, the pyrotechnic mixtures were obtained from tests which utilized booster charges to initiate the explosive material. Therefore, the blast parameters for both of these materials should be considered as upper limits.

2-13.4. Multiple Explosions

When two or more explosions of similar material occur several milliseconds apart, the blast wave of the initial explosion will propagate ahead of the waves resulting from the subsequent explosions, with the phasing of the propagation of these latter waves being governed by the initiation time and orientation of the individual explosives. If the time delay between explosions is not too large, the blast waves produced by the subsequent explosions will

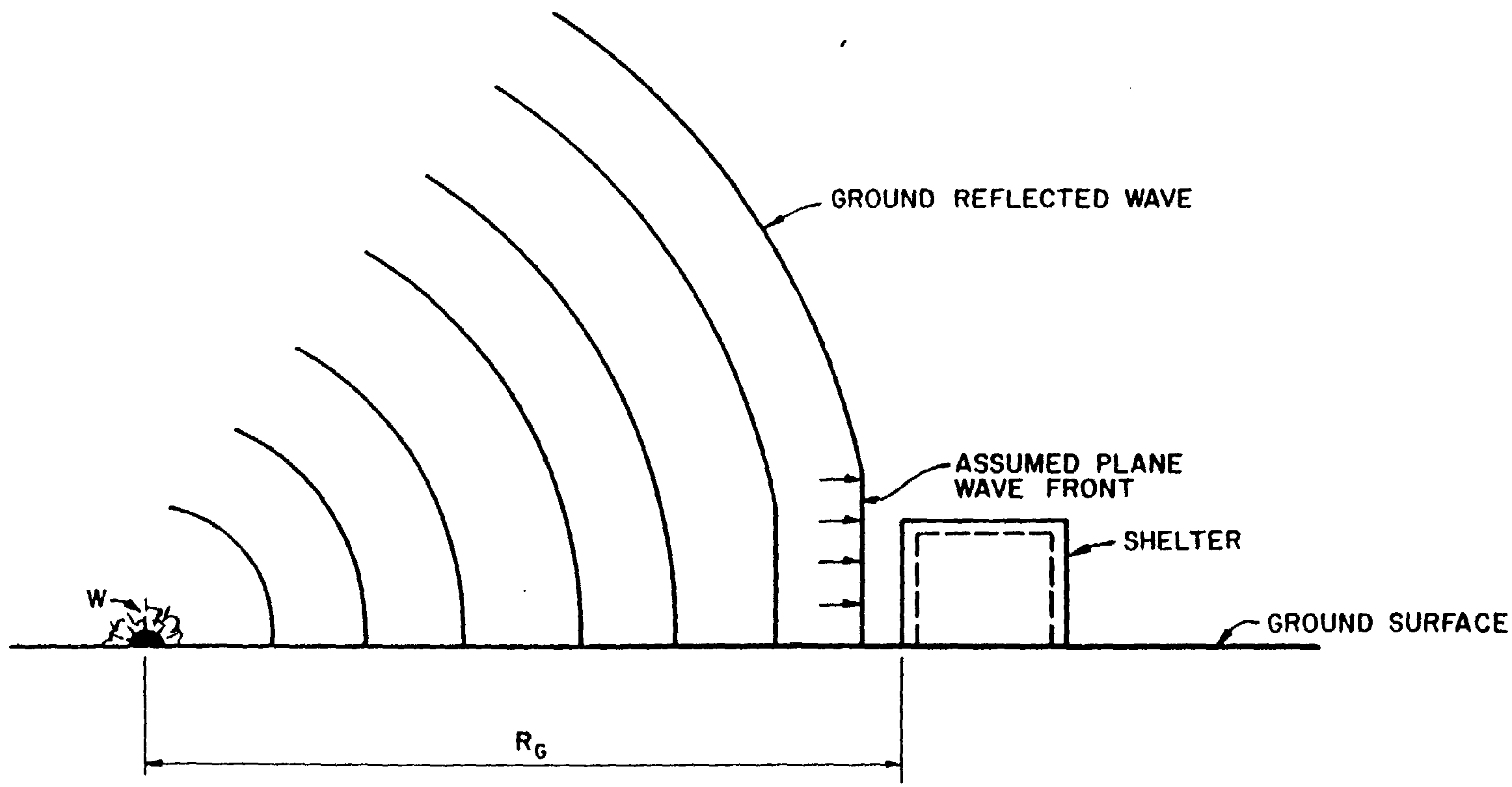
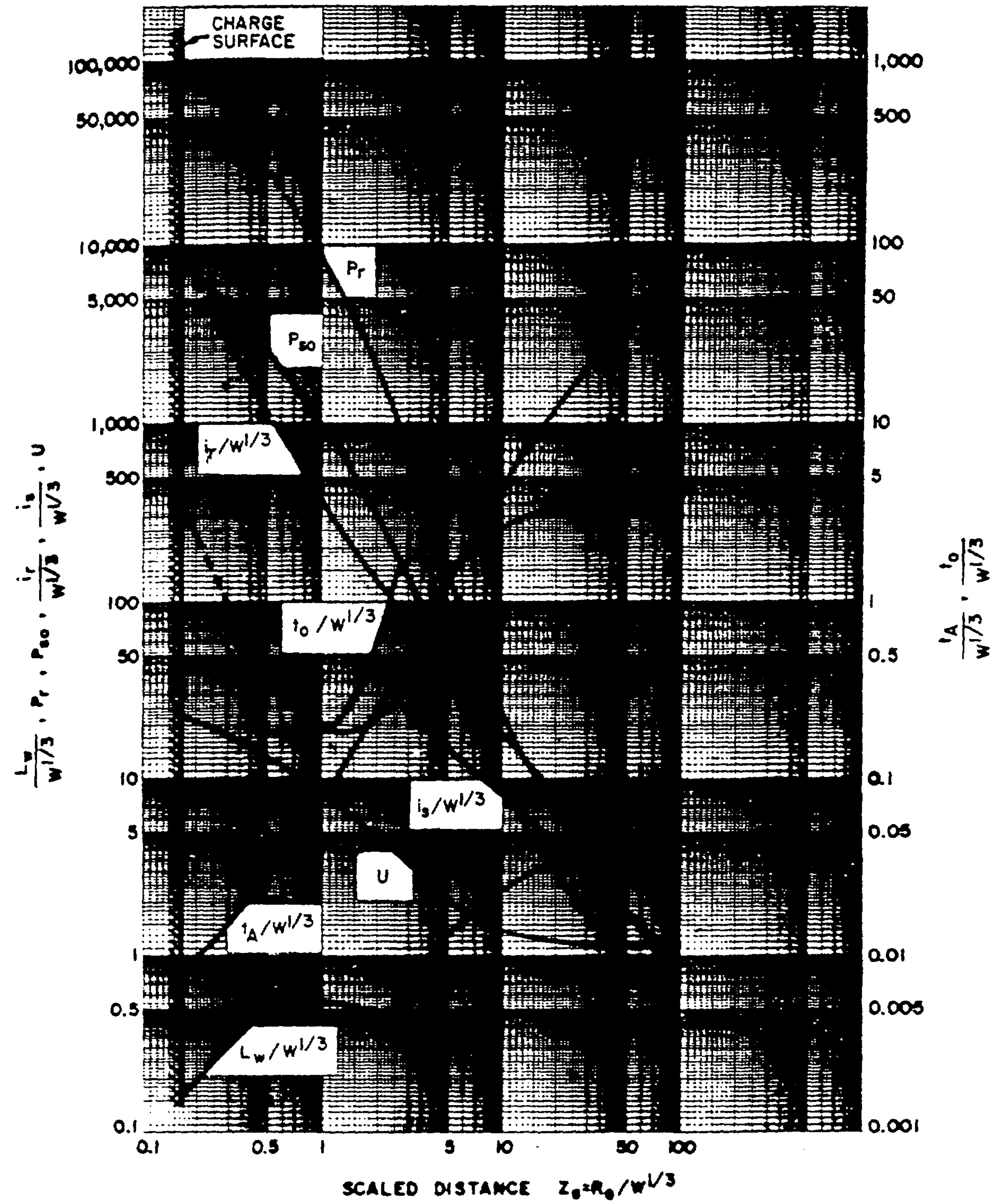


Figure 2-14 Surface burst blast environment



P_{so} = PEAK POSITIVE INCIDENT PRESSURE, psi
P_r = PEAK POSITIVE NORMAL REFLECTED PRESSURE, psi
$i_s/W^{1/3}$ = SCALED UNIT POSITIVE INCIDENT IMPULSE, psi-ms/lb$^{1/3}$
$i_r/W^{1/3}$ = SCALED UNIT POSITIVE NORMAL REFLECTED IMPULSE, psi-ms/lb$^{1/3}$
$t_A/W^{1/3}$ = SCALED TIME OF ARRIVAL OF BLAST WAVE, ms/lb$^{1/3}$
$t_o/W^{1/3}$ = SCALED POSITIVE DURATION OF POSITIVE PHASE, ms/lb$^{1/3}$
U = SHOCK FRONT VELOCITY, ft/ms
W = CHARGE WEIGHT, lbs
$L_w/W^{1/3}$ = SCALED WAVE LENGTH OF POSITIVE PHASE, ft/lb$^{1/3}$

Figure 2-15 Positive phase shock wave parameters for a hemispherical TNT explosion on the surface at sea level

Table 2-1 Heat of Detonation and Heat of Combustion

Explosive Name	Explosive Symbol	Heat of Detonation (ft-lb/lb)	Heat of Combustion (ft-lb/lb)
Baratol	-	1.04 E+06	
Boracitol	-	5.59 E+06	
	BTF	2.37 E+06	
Composition B	Comp B	2.15 E+06	3.91 E+06
Composition C-4	Comp C-4	2.22 E+06	
Cyclotol 75/25	-	2.20 E+06	3.68 E+06
	DATB/DATNB	1.76 E+06	4.08 E+06
	DIPAM	1.89 E+06	
	DNPA	1.48 E+06	
	EDNP	1.72 E+06	
	FEFO	2.03 E+06	
	HMX	2.27 E+06	3.31 E+06
	HNAB	2.06 E+06	
	HNS	1.99 E+06	
	LX-01	2.41 E+06	
	LX-02-1	1.99 E+06	
	LX-04	1.99 E+06	
	LX-07	2.08 E+06	
	LX-08	2.77 E+06	
	LX-09-0	2.24 E+06	
	LX-10-0	2.17 E+06	
	LX-11	1.72 E+06	
	LX-14	2.20 E+06	
	NG	2.22 E+06	2.26 E+06
	NQ	1.49 E+06	2.79 E+06
Octol 70/30	-	2.20 E+06	3.81 E+06
	PBX-9007	2.18 E+06	
	PBX-9010	2.06 E+06	
	PBX-9011	2.14 E+06	
	PBX-9205	2.04 E+06	
	PBX-9404	2.18 E+06	
	PBX-9407	2.24 E+06	3.31 E+06
	PBX-9501	2.22 E+06	
Pentolite 50/50	-	2.14 E+06	
	PETN	2.31 E+06	2.70 E+06
	RDX	2.27 E+06	3.20 E+06
	TETRYL	2.11 E+06	4.08 E+06
	TNETB	2.34 E+06	
	TNT	1.97 E+06	5.05 E+06

REPORT TO NUCLEAR REGULATORY COMMISSION

REVISED ADDENDUM TO AIRCRAFT CRASH IMPACT HAZARD AT THE PRIVATE FUEL STORAGE FACILITY

July 20, 2001

AS AMENDED PER LICENSING BOARD ORDERS
PFS HEARING EXHIBIT O

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REVISED ADDENDUM TO AIRCRAFT CRASH IMPACT HAZARD AT THE PRIVATE FUEL STORAGE FACILITY

Private Fuel Storage, L.L.C. (PFS) is filing this Revised Addendum to the "Aircraft Crash Impact Hazard at the Private Fuel Storage Facility," Rev 4 (Aug. 10, 2000) ("Report"), to reflect additional information and analysis with respect to the aircraft crash hazard at the Private Fuel Storage Facility (PFSF or Facility). This Revised Addendum both replaces and supplements the January 19, 2001 Addendum to the Report.[1] It replaces the January 2001 Addendum by including all the relevant additional information that had been set forth in that earlier Addendum and it supplements the January 2001 Addendum by including additional information subsequently received and provided by PFS in response to the NRC's requests for additional information (RAIs) of March 9, 2001 regarding aircraft hazards at the PFSF.[2] PFS's responses to the NRC's RAIs are attached as Tabs to this Revised Addendum and are summarized and referred to as appropriate in this Revised Addendum. The PFS responses are:

- March 30, 2001 Letter from John L. Donnell, PFS Project Director, to Mark S. Delligatti, NRC Senior Project Manager, Partial Response to Requests for Additional Information (March 30 Response), answering those RAIs for which PFS had the necessary information to provide a response (Tab FF).
- May 15, 2001 Letter from John L. Donnell, PFS Project Director, to Mark S. Delligatti, NRC Senior Project Manager, Clarification to PFS March 30 Partial Response[3] (May 15 Clarification) (Tab GG).
- May 31, 2001 Letter from John L. Donnell, PFS Project Director, to Mark S. Delligatti, NRC Senior Project Manager, Remaining RAI Responses and Clarification (May 31 Response) (Tab HH).

In addition, PFS provides responses directly in this Revised Addendum to requests for clarification communicated by the NRC Staff in a July 5, 2001 teleconference between PFS and the NRC Staff. Tab II identifies the specific requests for clarification communicated by the NRC

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[1] Addendum to Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Jan. 19, 2001) (January 2001 Addendum).

[2] March 9, 2001 Letter from Mark S. Delligatti, NRC Senior Project Manager, to John L. Donnell, PFS Project Director, Requests for Additional Information.

[3] These clarifications were requested by the NRC in a teleconference with PFS on April 25, 2001. <u>See</u> Tab GG.

Staff in that teleconference and identifies where in the Revised Addendum PFS addresses each request for clarification.

The Revised Addendum is organized to follow the sections of the Report for which additional information, clarification and analysis has been provided (either in the earlier January 2001 Addendum or in response to the NRC's March 9, 2001 RAIs and subsequent requests for clarification).

I. F-16s TRANSITING SKULL VALLEY (SUPPLEMENTING SECTION III OF THE REPORT)

A. Additional Data on Number of F-16 Sorties and F-16 Aircraft

PFS received new information in December 2000 regarding additional F-16 fighter aircraft to be based at Hill Air Force Base (AFB) and the number of sorties the F-16s at Hill flew through Skull Valley in Fiscal Years 1999 and 2000, which it provided in its January 2001 Addendum to the Report.[4] The information for F-16 sorties flown through Skull Valley was based on Freedom of Information Act (FOIA) Responses providing the Sevier B MOA usage reports (under which Skull Valley lies) for Fiscal Years 1999 and 2000.[5] PFS subsequently obtained additional information in response to FOIA requests which it provided in its May 31 Response. Both the information provided in the January 2001 Addendum and that subsequently obtained by PFS are set forth and summarized below.

1. Increased F-16 Sorties From Hill AFB[6]

PFS had previously obtained from the Air Force, and provided as part of its Report (at page 5), the number of F-16 sorties through Skull Valley for Fiscal Year (FY) 1998, which was 3,871.[7] Based on these previous communications with the Air Force, PFS had used the total

[4] January 2001 Addendum page1, note 1.

[5] 388th Range Squadron, Airspace Manager, Annual Military Operating Area Usage Reports for Sevier B MOA, dated November 12, 1999 and November 8, 2000. These Usage Reports were received by Brig. Gen. James L. Cole, Jr., USAF (Ret.), on December 19, 2000 in response to the FOIA request. Thus, PFS obtained the Fiscal Year 2000 report six weeks after it was first published.

[6] This section of the Revised Addendum is taken virtually verbatim from the PFS May 31 Response, pages 1-3, Tab HH.

[7] That number was provided to Brig. Gen. Cole, USAF (Ret.), in a series of conversations with Col. Charlie Bergman, Deputy Chief of Safety, USAF, and Lt. Col. Dan Phillips, Office of the Chief of Safety, in late 1998 and the first part of 1999. Subsequently, in response to a follow-up Freedom of Information Act (FOIA) request made in the summer of 1999 for the documentary support of the 3,871 number, Hill AFB referenced as support for this

Footnote continued on next page

number of flight operations from the MOA usage reports for Sevier B, under which Skull Valley lies, to determine the number of F-16 sorties transiting Skull Valley in FY 1999 and FY 2000 for the revised calculations in its January 2001 Addendum.

In its most recent FOIA inquiries, PFS specifically requested how many of the total number of flight operations for Sevier B for FY99 and FY00 represented F-16s transiting Skull Valley en route to the UTTR.[8] Also, to follow-up on claims made by Lieutenant Colonel Horstman, USAF (Ret), that F-16s transiting Skull Valley may fly above Sevier B airspace,[9] PFS at the same time requested the MOA usage reports for Sevier D (which lies above Sevier B) for FY99 and FY00 as well as how many of the total number of flights from the MOA usage reports for Sevier D represented F-16s transiting Skull Valley en route to the UTTR.[10] In its responses, however, Hill AFB stated that it was not possible to determine the exact number of the F-16s transiting Skull Valley because no records are kept for Skull Valley transitions as a subset of Sevier B and D MOA usage, but it did indicate that a majority of the flights are F-16s.[11]

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number, and as being applicable for Skull Valley, the Military Operating Area (MOA) usage report for Sevier A instead of Sevier B under which Skull Valley lies. 388th FW Wing Response to FOIA Request of July 24, 1999. (Sevier A is to the south and west of Sevier B and is also part of the route taken by those F-16s transiting Skull Valley on their way to the South UTTR). Although there is a slight difference in the number of operations for FY98 shown on the MOA usage report for Sevier A (3,871) and the report for Sevier B (3,878), PFS has used 3,871 as the applicable number (both for Skull Valley and Sevier B) because of the small differences between the two numbers and because PFS had previously been provided the 3,871 number directly in responses to its requests for F-16 flights transiting Skull Valley. Further, in subsequent years (FY99 and FY00) PFS has used the Sevier B MOA usage reports since Skull Valley lies under Sevier B and not Sevier A. (In FY99, the flight operations shown on the Sevier A and Sevier B MOA usage reports are identical and for FY00 there is a difference of one flight operation between the two MOAs.)

[8] FOIA Request from James L. Cole, Jr., Brig. Gen. USAF (Ret.), to Mary Maynard, FOIA Manager Hill AFB (February 13, 2001) (Feb. 13 FOIA Request).

[9] E.g., Declaration of Lt. Colonel Hugh L. Horstman, Air Force (Retired) in Support of the State of Utah's Response to PFS's Motion for Summary Disposition of Contention Utah K and Confederated Tribes B (Jan. 30, 2001) ¶ 16.

[10] Feb. 13 FOIA Request. PFS also made the same request for Sevier D for FY98. FOIA Request from James L. Cole, Jr., Brig. Gen. USAF (Ret.), to Mary Maynard, FOIA Manager Hill AFB (February 12, 2001) (Feb. 12 FOIA Request).

[11] In its response to PFS's February 13 FOIA Request (which had requested the number of F-16s transiting Skull Valley en route to the UTTR included in the total flight numbers for Sevier B and Sevier D for FY99 and FY00), Hill AFB responded as follows:

> No records are kept for Skull Valley transitions as a subset of the Sevier B and D MOA usage or as an entry or departure route to/from the range. Therefore, there is no way to determine the exact number of F-16s that transited Skull Valley.

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Thus, the Air Force's recent responses for FY99 and FY00 flight information are less precise than those previously provided PFS for FY98 in which it identified a specific number of flights transiting Skull Valley (3,871). Further, the Air Force has now indicated that, in addition to F-16 Skull Valley flights going through Sevier B, the majority of flights going through Sevier D are also F-16s. As reflected in the following Table, however, the number of total flights identified in the MOA usage reports for Sevier D are small compared to Sevier B and constitute on average for FY98, FY99, and FY00 only approximately 5.7% of the flight operations identified in the Sevier B MOA usage reports.

	Sevier B	Sevier D
FY98	3,871	215
FY99	4,250	336
FY00	5,757	240

Further, as reflected in the Air Force FOIA responses, not all flight operations identified in the Sevier B and D MOA usage reports are F-16s transiting Skull Valley. Both Sevier B and Sevier D (which overlies Sevier B) are 145 miles long, extending more than 100 miles south of Skull Valley,[12] and various flight operations in these MOAs take place in the southern part of Seviers B and D far from Skull Valley. For example, cruise missiles and the chase aircraft that follow them as safety observers fly in the southern portions of the Sevier B MOA but do not overfly Skull Valley.[13]

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March 28, 2001, FOIA Response from Hill AFB, Mary Maynard, FOIA Manager Hill AFB Utah. In its response to PFS's February 12 FOIA Request (which had requested information on the number of F-16s transiting Skull Valley en route to the UTTR included in the total numbers for the Sevier D MOA usage reports), Hill AFB responded as follows:

> Sevier D Military Operations are not broken out by aircraft type, but the majority of operations for each year would have been for F-16 aircraft. . . . .No records are kept for Skull Valley transitions as a subset of the Sevier B and D MOA usage or as an entry or departure route to/from the range.

March 28, 2001 FOIA Response from Hill AFB, Mary Maynard, FOIA Manager, Hill AFB Utah.

[12] See Salt Lake City Sectional Aeronautical Chart, National Oceanic and Atomspheric Administration (NOAA); Las Vegas Sectional Aeronautical Chart, NOAA.

[13] See Risk Assessment of Cruise Missile Accidents Impacting Private Fuel Storage LLC Independent Spent Fuel Storage Installation, Rev. 1 (Jan. 25, 2001), pages 26-27.

Therefore, PFS continues to believe, as before, that the best estimate for the number of F-16 flights transiting Skull Valley in FY99 and FY00 (for which the Air Force did not provide a specific number as it had previously done for FY98) are the number of flight operations identified in the Sevier B MOA usage reports. This corresponds to the source of the Skull Valley F-16 number provided by the Air Force for FY98, discussed in note 7, supra, and takes into account that flight operations other than F-16s transiting Skull Valley occur in the large southern expanse of Seviers B and D.[14]

2. Increased F-16 Aircraft Stationed at Hill AFB

The number of F-16 aircraft assigned to the 388th Fighter Wing (Chargeable Aircraft) at Hill AFB has increased from that previously authorized for the Wing during each of the past three fiscal years (FY98, FY99, and FY00). For those 3 years, the number of F-16 aircraft assigned to the 388th FW at Hill AFB was stable at 54.[15] However, an additional 12 F-16 aircraft were officially assigned to the Wing in the third quarter (April) of FY01,[16] at which time the Wing would have received additional funding for them. PFS had been advised that, as before, the 419th Fighter Wing (Reserve) had 15 authorized F-16s at Hill AFB,[17] and therefore used this number in the calculations in its January 2001 Addendum and its May 31 Response.[18]

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[14] PFS has, however, performed a sensitivity analysis showing that the cumulative hazard remains well below the regulatory limit of 1 E-6 even assuming the number of F-16 flights through Skull Valley were equal to the sum of the flight operations for the Sevier B and D MOAs. See Section VII infra.

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

[16] Id. Of those aircraft, 6 were physically present at Hill AFB by the end of the third quarter (June) of FY 00. Telephone conversation between Col. Ronald Fly, USAF (Ret.) and 388th FW Public Affairs Office, January 12, 2001. However, the 388th FW's flying hour program and the additional pilots, maintenance personnel, funding and other resources necessary to support an increase in the flying hour program would not be made available until the aircraft were formally assigned to the wing (chargeable aircraft). See March 30 Response to RAI 1(c) (Tab FF).

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

[18] The number of aircraft assigned to the 419th FW was used to adjust the number of F-16 sorties projected for future years to account for the increase in the assigned aircraft to the 388th FW. In an FOIA response received in June 2001, after the PFS May 31 Response, however, the Air Force informed PFS that the average number aircraft assigned to the 419th FW were as follows: FY98 (15.9); FY99 (18); FY00 (18); FY01 (17.8). June 11, 2001 FOIA Response from Hill AFB, Mary Maynard, FOIA Manager, Hill AFB, Utah. For conservatism, PFS has not revised its calculations for this new information, which would slightly decrease the proportional increase in F-16s stationed at Hill AFB calculated in the text above (from 17.4% to 16.7%), and therefore slightly decrease the number of F-16 sorties projected for future years from 5870 to 5835. (Using the average number of 419th FW aircraft assigned in FY 99 and FY 00 of 18, plus the 366th FW aircraft assigned number of 54 gives a base case number of 72 F-16s; if 12 more are added to this base, the increase is 16.7%, less than the 17.4% used in the text above.)

It would be reasonable to assume a proportional increase in the number of F-16 sorties through Skull Valley resulting from the 12 additional aircraft assigned to the 388th FW.[19] The total number of authorized F-16 aircraft at the base would therefore increase from 69 (54 + 15) to 81 (66 + 15), which is a 17.4% increase.

B. Evaluation of Additional Data in Projecting F-16s Transiting Skull Valley

The change in the number of F-16 flights through Skull Valley from FY98 to FY99 to FY00 represents certain changes in Air Force operations plus normal fluctuations in the number of sorties flown annually as well. The Air Force began a new policy for overseas and other deployments of Air Force units away from their home bases through adoption of the Air Expeditionary Force (AEF) concept, initially implemented in October 1999 (FY00). Under the AEF concept, portions of various Air Force wings are assigned to an AEF on a regular basis for overseas or other deployment as needed. Under the AEF concept, units are on call for deployment for 90 days over a 15-month period. The purpose is to make more equal and regular the on-going deployment of Air Force units from their home base of operations. This would provide a more stable and predictable operating cycle, and control and reduce the amount of time spent away from the home base of operations.

There were major Air Force deployments of aircraft overseas in FY98 to both Bosnia and the Persian Gulf and in FY99 to Kosovo. These deployments tapered off towards the end of FY99, and FY00 saw the beginning of the regular AEF deployments. The 388th Fighter Wing had part of one squadron (out of three) deployed in October, November and half of December 1999 (FY00).

Further, since at least April of 2000, the 388th Fighter Wing has significantly increased its sortie count from its available aircraft, and has achieved the highest sortie rate per aircraft of any F-16 wing.[20] Since the 388th Fighter Wing is doing what it can to maximize its sortie rate now, it has little leeway to increase the rate even more and PFS would therefore not expect further increases. Past history has shown, moreover, that fluctuation in sortie rates do occur as a

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[19] PFS's responses to RAI nos. 1(b) and 1(c) explain why it is reasonable to assume a proportional increase in sorties based on the increase in assigned aircraft. March 30 Response at pp. 1-2 (Tab FF).

[20] Hilltop Times, Sept. 7, 2000 (Colonel John Weida, 388th FW Commander) and Hilltop Times, October 19, 2000 (Colonel John Weida, 388th FW Commander), which can be found at www.hilltoptimes.com/archives.

result of various operating constraints and training needs as well as changes in operating priorities or emphasis. Thus, PFS would not expect the number of sorties to continue indefinitely at the maximum or near-maximum rate currently being achieved by the 388th Fighter Wing.

Also, during FY 00, United States military forces were not involved in an international crisis. The number of UTTR sorties in future years, in which there was such a crisis, would therefore be expected to be lower than those in FY00. Even if the 388th Fighter Wing were not deployed overseas for such a crisis, some of its aircraft might be temporarily deployed to other locations and units in the United States to replace aircraft that were sent overseas. Based on past history, it is reasonable to expect periodic unforeseen future deployments and an associated lower sortie count at Hill.

Based on the above considerations, PFS believes that in accounting for the recent increases in sorties, an appropriate and reasonable number of F-16 sorties to assume on an annual basis transiting Skull Valley would be an average of the FY99 and FY00 numbers, or approximately 5,000.[21] Further, as discussed above, in addition to the higher number of sorties flown through Skull Valley by F-16s currently at Hill AFB, the total number of authorized aircraft at the base will increase by 17.4%. Therefore, to capture the effect of the higher numbers of sorties in FY99 and FY00 and the effect of more aircraft being based at Hill AFB in the future, the annual number of sorties would increase by 17.4%, from 5,000 to 5,870. As discussed below, PFS believes that this average will be a reasonable, conservative approximation of future traffic density when the PFSF is operating, particularly 20 or more years in the future, when the Facility would be approximately at full capacity.

C. Forecasts of Future Traffic Density

Future traffic density of military aircraft operating in the vicinity of the PFSF will be determined, for the most part, by the future structure of the U.S. Air Force and tempo of U.S. Air Force operations. Over the projected life of the PFSF, U.S. Air Force structure and tempo of operations are likely to be sized and shaped by several significant factors, which in turn will be

[21] PFS has also noted that F-16s flew similar numbers of sorties on the UTTR in both FY99 and FY00 further reflecting that use of an average of those two years for Skull Valley sorties is appropriate. See May 31 Response pp. 7-8 (Tab HH).

reflected in the volume and scope of air operations at Hill AFB and on the UTTR. The factors that will likely determine future USAF force structure and operations, and in turn the volume and scope of operations at Hill AFB and on the UTTR, include the assessment of worldwide threats, the funds available for defense spending, technological advances in aircraft capability and weapons lethality and accuracy, and improvements in training and flight simulation. Historically, these factors have been interrelated in a synergistic manner in determining the size of the USAF force structure and the volume and scope of USAF operations. The long term trend in the USAF has been for fewer, more modern aircraft to replace older, less capable ones. The PFSF expects this general trend to continue as the existing USAF aircraft inventory is replaced with more modern, capable and reliable aircraft over the proposed PFSF's life span.

Throughout the 20th century, the United States has reacted vigorously to increase its armed forces to combat significant and specific threats, but such increases have been followed by periods of substantial force reductions. U.S. entry into World War I in 1917 was marked by a significant force structure buildup and expansion across the board with the end of the war producing an equally significant force structure reduction and contraction that lasted for two decades. During this time, funding was limited and the U.S. armed forces force structure was at bare bones minimum with very low operations tempo. U.S. entry into World War II in 1941 was marked by a similar large buildup with the end of the war in 1945 producing a similar reduction and contraction of force structure, with U.S. armed forces again operating at a very low operations tempo with limited funding. This continued into the 1950s until the emergence of the Soviet Union as a significant threat and also the outbreak of the Korean War.

The advent of the "Cold War" signaled a significant force structure buildup and expansion to counter the threat. This force structure buildup and expansion was, however, significantly different than those that had previously occurred following the events of 1917 and 1941. The proportionate number of aircraft involved for the U.S. Air Force was significantly less for two very important reasons. First, the technology, payload capacity, and range of the jet powered fighters and bombers were significantly greater than that of their reciprocating engine powered predecessors of World War II. Fewer aircraft with improved technology and better weaponry represented a much greater combat capability than the much larger numbers of aircraft in previous years. Secondly, the lethality and accuracy of weapons had increased tremendously.

Consequently, fewer aircraft and sorties were required to accomplish specific missions and destroy a specific number of targets.

The collapse of the Soviet Union and the end of the Cold War precipitated yet another significant force structure reduction and contraction. The significant threat of the Soviet Union and the challenges of a bi-polar world no longer existed. The U.S. armed forces in general and the U.S. Air Force in particular experienced an approximately one-third reduction in force structure, including personnel, equipment, and funding since the end of the Cold War in the late 1980s. The U.S. Air Force is now smaller than it was before the Japanese attack on Pearl Harbor in 1941. However, the USAF's present day capabilities make this smaller force orders of magnitude more capable than its Pearl Harbor predecessor. To further illustrate this recent reduction and contraction in the size of the USAF force structure and operations, the Air Force aircraft inventory decreased from 7,640 in FY92 to 6,205 in FY00; flying hours decreased from 2,790,000 in FY92 to 2,036,000 in FY00.[22]

Although this recent force structure reduction and contraction was driven by a decreased threat and calls for a "peace dividend," the capability and lethality of the U.S. Air Force had experienced another quantum increase. Better conventional weapons have significantly increased the combat capability of the U.S. Air Force. Precision Guided Munitions (PGMs) provide tremendous accuracy and require far fewer aircraft and sorties to accomplish specific missions. Three comparisons of WWII and the Persian Gulf War capabilities drive home the dramatic quantitative effects of the qualitative improvements in aerial warfare.

1. In some cases, a single airplane with one Precision Guided Munition (PGM) in the Gulf War in 1991 achieved the same result as a 1000-plane raid with over 9,000 bombs in World War II.[23]

2. During the first day of the Gulf War, more targets were hit by coalition forces than by the entire 8th Air Force in Europe during 1942 and 1943.[24]

[22] 2001 AIR FORCE ALMANAC.

[23] *Effects-Based Operations: Change in the Nature of Warfare*, pg. 9, by Brigadier General David A. Deptula, Aerospace Education Foundation; based upon a HQ USAF/XOXW briefing chart, Fall 1990.

[24] Id. at pg. 2; from *Mighty Eight War Diary* by Roger A Freeman, (London, Jane's Publishing Co., 1981). 8th Air Force was the USAF bomber force based in England in Europe during WWII.

3. During the first night of the Gulf War, 13 F-117 stealth fighters flew against 22 separate targets.[25] By contrast, "[i]n times past it was necessary to send dozens, sometimes hundreds, of airplanes to ensure that a critical target was struck."[26]

Smaller force structure and reduced defense spending have forced other efficiencies on the U.S. Air Force as well. Decreased budgets and rising fuel costs have constrained flying hours for training. New and improved technology simulators have been leveraged to increase pilot proficiency without a proportionate increase in flight time. The constantly improving technology and capabilities of modern simulators with visual displays have enabled much more training to be accomplished without actually flying a real aircraft. This reduces fuel costs and also risks. Maneuvers that are difficult to do in an aircraft can be practiced in simulators with no risk. Pilots can now build experience and confidence in simulators and consequently be much more proficient, confident, and less error prone when they actually get to the real aircraft. This results in decreased requirements for flying hours and sorties as well as less risk when the actual flying is done.

The current national security environment indicates no major superpower requiring a continuing large force structure to defend against. In addition, any future needs for increased force capability are likely to be satisfied by smaller force structures due to continued improvements in aircraft capability, technology, and weapons accuracy and lethality. Both the

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[25] Id. at pg. 1 based upon the transcript of an interview by Major Greg Biscone and BGen Deptula, October 11, 1993 and Colonel Terry A. Burke, Commander, 4300 Provisional Bombardment Wing, narrative from the recommendation of the Distinguished Flying Cross.

[26] *Evolution of the Aerospace Force*, pg. 2, by John T. Carroll, Editor in Chief, Air Force Magazine, June 2001. Mr. Carroll goes on to state as follows:

> By contrast, in the air campaign in the Balkans in 1999, the B-2, carrying the latest "smart bombs", hit an average of 15 separate aim points per sortie. A few years from now, a single bomber will take on 80 different targets per sortie. Aircraft of the future will be able to do even better.
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> * * * * * * * * *
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> In the 1950s, more than 40 percent of all Air Force officers were pilots. Today, pilots account for only 17 percent of the officer force. Pilot and aircraft totals have diminished.
>
> One reason is that airpower keeps getting better. As recently as the Vietnam War, the F-4D Phantom had to expend, on average, 200 tons of gravity bombs to drop a bridge span. Current aircraft can do it with four tons of ordnance, and they can do in all kinds of weather. As aircraft become more capable, they grow fewer in number.

current USAF force structure and future estimates indicate a continuation of the trend towards fewer aircraft of increased technological capability and lethality.

The Joint Strike Fighter (JSF), a stealth-type aircraft currently in research and development, is the planned replacement for the F-16. The total planned USAF buy over the life of the airplane is 1,763 aircraft.[27] This is only 78% of the 2,230 F-16s ordered by the USAF.

Similarly, the new F-22 fighter will replace the F-15[28] in the air superiority mission. Based upon current procurement plans, 339 F-22s will be bought over the life span of the airplane. This represents only approximately 39% of the 874 F-15s purchased originally by the USAF.

The same trend exists in the USAF bomber forces. The B-1 is a long range, multi-role bomber capable of carrying several different ordnance loads to include 84-MK82 500 lb. bombs. The B-1 became operational in 1986 and 104 were produced.[29] The U.S. Air Force recently announced that it would decrease its B-1 force by about a third, so that the B-1 force inventory will be reduced from its current inventory of 93 to only 60 aircraft.[30] The B-2 is a stealthy long-range multi-role bomber that can deliver both conventional and nuclear munitions anywhere in the world. The B-2 became operational in 1997, and only 21 were produced.[31] In contrast, 744 of the previous generation B-52 bombers were produced from 1955 through 1962 .

Although it is difficult to predict exactly what the USAF force structure will be 20-40 years into the future, current acquisition programs and historic trends both clearly indicate that the future force structure will be smaller. It is equally difficult to predict how the reduced forces will be deployed and stationed within the US and overseas. Over time, the USAF has both closed bases and reduced force structure at existing bases as the total aircraft inventory has declined. It is reasonable to expect the same pattern in the future. Further complicating the

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

[28] The F-22 is designed to replace the F-15A-D models which are air-superiority variants. The F-15E, although it looks similar, has significant structural and electronic systems differences from the A-D models. The F-15E is optimized for the long range, ground attack mission. The number of F-15s purchased (874) referred to in the text above is for the F-15A-D models only.

[29] 2001 AIR FORCE ALMANAC, p. 132.

[30] Wall Street Journal, (July 13, 2001), "Stop Reviewing. Start Reforming.", by Ken Adelman.

[31] 2001 AIR FORCE ALMANAC, p. 132.

future force structure basing decisions is the political aspect of the basing process. Elected representatives have historically resisted closings or drawdowns at bases in or near their districts and states. The practical effect has been to be keep more bases open with lower force levels at the bases than is generally considered optimum by the military.

It is PFS's belief that the USAF will continue to operate fighter aircraft from Hill AFB for the foreseeable future, even as current day aircraft are replaced by newer ones such as the JSF or F-22. The training and testing opportunities available on the UTTR represent excellent capabilities that are difficult to replicate elsewhere.[32] However, it is reasonable to assume that the significant USAF wide reduction in total fighter aircraft will affect Hill AFB, just as previous force structure reductions have resulted in fewer aircraft at Hill AFB.[33]

PFS believes that the high operations tempo and sortie count for the 388th FW at Hill AFB in FY00 represents a near maximum rate that would be difficult to exceed for sustained periods. During that year, the 388th FW commander publicly stated that the 388th FW aircraft utilization rate (average number of times per month each airplane is flown) exceeded that of any other F-16 wing for at least the last six months of FY00. In light of the current acknowledged high tempo of operations of the 388th FW combined with the known, future reductions in total fighter aircraft in the USAF inventory, use of the average of FY99 and FY00 flight activity is a reasonable, conservative approximation for the expected flight activity over the expected life span of the proposed PFSF. It also gives weight to the Aerospace Expeditionary Force (AEF) concept which was implemented in FY00. The AEF was developed by the USAF to decrease the amount of time spent deployed by aircrews and support personnel. The AEF is on a 15 month schedule and does not align with the FY flying hour program. Due to the relative newness of the AEF, it is difficult to completely assess its effectiveness. Further, not including the lower FY98 flying data tends to provide an upward, conservative bias to the average data.

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[32] Although the weather is normally excellent for fighter operations at Hill AFB and on the UTTR, the runway is periodically closed during the winter due to snow and ice. After particularly heavy storms, it may take a few days to clear the accumulated ice and snow from the parking aprons, taxiways and runways. This situation argues against placing too large a percentage of the future fighters at Hill AFB. In times of crisis, it would be unacceptable to have a significant portion of the fighter force trapped at any one location by inclement weather.

[33] The 388FW previously had 4 assigned F-16 squadrons. The 16th Fighter Squadron was deactivated several years ago as part of a reduction. If the JSF were to replace the F-16s at Hill AFB at a rate proportionate to the respective aircraft buys, the total fighter aircraft assigned to the base would drop from 81 to 63. This would be the functional equivalent of deactivating a18-fighter squadron, such as the 421st Fighter Squadron of the 388th FW.

As an upper sensitivity bound, PFS calculated the risk posed by tactical aircraft based solely on the FY00 sortie data, even though PFS believes that it is highly unlikely for this level of flight activity to be sustained over the life span of the PFSF.[34] Given that the PFSF will not reach full capacity until 20 years into its operational life, the USAF should have completed its planned F-22 acquisition and be well into delivery of the JSF before the PFSF is at full capacity. The calculated aircraft crash probability for the PFSF using the average of the FY99 and FY00 sortie count for Skull Valley is based upon the Facility being at full capacity and does not assume any Air Force downsizing or modernization. Thus, the USAF long-term modernization program that is expected to result in a significant downsizing and a likely reduction in total annual sorties will in all likelihood result in PFS's base case probability being conservative. Nevertheless, PFS has used the FY00 data as a conservative upper bound for a sensitivity analysis.

D. Other Additional Information

1. RAI Responses

In response to the NRC's RAIs, PFS supplied information pertaining to other issues related to the aircraft crash hazard posed to the PFSF by F-16s transiting Skull Valley. This information supplements that set forth in the Report and does not alter any of the Report's calculations or results beyond that conservatively calculate by PFS. The topics PFS addressed in the RAI responses are noted individually below:

- The operational width of Skull Valley, for the purpose of calculating the aircraft crash hazard to the PFSF, may conservatively be taken to be 10 miles, as in the PFS Report. March 30 RAI Question 8; May 15 Clarification 6. Further, the basic airspace configuration of Skull Valley creates a "neck" or "gap" in the southern part of the MOA on the eastern side of Skull Valley that has the effect of funneling F-16 traffic along the eastern side of the Valley away from the PFSF. Id.; see also March 30 RAI Questions 3(b) and 4(e); May 15 Clarification 7.
- The hypothetical potential for the use of the PFSF as a "turning point" by F-16s transiting Skull Valley would not increase the probability that an accident would occur at the PFSF. March 30 RAI Question 3; May 15 Clarification 7.

[34] See note 36 infra and Section VII infra.

- The hypothetical potential for the use of the PFSF to calibrate sensors by F-16s transiting Skull Valley would not increase the probability that an accident would occur at the PFSF. March 30 RAI Questions 4 and 5.
- The airspace in Skull Valley is not suitable for the conduct of high risk maneuvers that could increase the probability of an accident at the PFSF. March 30 RAI Question 6(b).
- The potential for a pilot's "G-suit" to fail during a G-awareness maneuver would not increase the likelihood of an accident in Skull Valley. March 30 RAI Question 6c; see also May 15 Clarification 8.
- The potential for cloud cover or bad weather in Skull Valley or flying at night would not increase the probability that an accident would occur at the PFSF. March 30 RAI Question 9; May 15 Clarifications 1, 3, and 4.
- The hypothetical potential for bird strikes by F-16s transiting Skull Valley would not increase the probability of an accident at the PFSF. March 30 RAI Question 10.
- The F-16 would remain aerodynamically stable after the pilot ejected from the aircraft. May 15 Clarification 2.

2. Consideration of Sevier D F-16 Crash Data

In Tab H to the Report, F-16 aircraft crashes were examined in three different groupings, (1) all accidents which could have occurred in Skull Valley, regardless of phase of flight ("Skull Valley Type Events" category), (2) a smaller set of all accidents in the Normal Flight phase, which is the mode of flight for transiting Skull Valley, which were generally applicable to flight in Skull Valley regardless of altitude, speed, etc. ("Normal In-flight" category), and (3) a yet smaller subset of all "Normal Flight Phase" accidents which occurred in approximately the same conditions of flight (altitude, weather, speed, etc.) as would be encountered in a Sevier B transit of Skull Valley ("Sevier B Flight Conditions" category).

In the July 5, 2001 teleconference, the NRC requested clarification on the effect of taking into account, with respect to third category, accidents encountered in a Sevier D type setting in addition to those encountered in Sevier B type flight conditions. PFS has done this analysis which shows a negligible effect.

PFS reviewed the F-16 accident data base to identify those "Normal In-flight" accidents that occurred at altitudes within the Sevier D airspace, the airspace just above Sevier B and going from 9,500 ft. MSL to the bottom of the Positive Controlled Airspace at 18,000 ft. MSL. There were four Normal In-flight accidents that occurred at these altitudes (4 April 91 at 7,000-8,000 ft. AGL/MSL, 16 Dec 91 at 16,300 ft. MSL, 7 Jun 96 at 10,000 ft MSL, and 21 Nov 96 at 10,000 ft MSL). All four of these accidents were included in the "Skull Valley Type Events" and "Normal In Flight" categories of the original analysis.

The first of these (occurring on 4 April 91) was previously closely examined for inclusion in the three categories evaluated in Tab H. This examination is detailed in the Report, Tab H, pages 18 and 19. The pilot was descending into weather conditions with several layers of clouds and was between cloud layers at 7,000 to 8,000 feet AGL when he attempted to move to a fighting wing formation position on his leader and lost situational awareness because of the lack of outside visual references to the ground or sky. The PFS examination concluded that, because of the combination of this flight maneuver, and the weather conditions (multiple layer of clouds), and altitude the accident was unlikely to occur in Skull Valley. For conservatism, however, the accident was included in the statistics for the "Skull Valley Type Event" and "Normal In-flight" categories, but was excluded from the statistics for the Sevier B category because it had not occurred under Sevier B flight conditions. Since the accident occurred at Sevier D altitudes, PFS will include the accident, for conservatism, with respect to this analysis for Sevier D, as it did with respect to the "Skull Valley Type Event" and "Normal In-flight" categories.

The other three accidents occurring at Sevier D altitudes were engine failures in which the pilot retained control and would have been able to avoid a structure on the ground. They were not included in the original 'Sevier B Flight Conditions' category, but were included in both the "Normal In-flight" category and in "Skull Valley Type Event" categories in the original Tab H analysis.

Considering the 4 accidents together, for the lower conservative bound, there are then 3 of the 4 accidents occurring under Sevier D flight conditions in which the pilot would retain control of the aircraft to be able to avoid a structure on the ground, or 75% (the lower bound). Excluding the 4 April 91 accident event, the upper bound would be 100%.

In determining the impact of including these accidents with the Sevier B statistics, PFS has considered the relatively few flights that occur in Sevier D in comparison with Sevier B and therefore used a weighted average of the two. Based on information set forth above, for the years FY99 and FY00 combined, there were 576 flights in Sevier D airspace and 10,006 in Sevier B airspace, so 5.4% of the total were Sevier D and 94.6% were Sevier B. Using the 75% lower bound for the percent of accidents in which the pilot retained control to be able to avoid a ground structure for Sevier D, and using the lower probability bound for Sevier B of 89% (TAB H, page 26), yields a combined probability lower bound of 88%. This percentage is not a significant or meaningful change in this lower bound from the calculation included in Tab H for "Sevier B Flight Conditions," leaves intact the 100% upper bound,[35] and does not affect the conclusions drawn by PFS in Tab H of the Report.

E. Change in Crash Hazard from that Calculated in the Report

In Section III.A of the Report, PFS calculated the probability that an F-16 transiting Skull Valley could crash and impact the PFSF using the equation $P = C \times N \times A / w \times R$, where

P = probability per year of an aircraft crashing into the PFSF
C = in-flight crash rate per mile
N = number of flights per year along the airway
A = effective area of the PFSF in square miles
w = width of airway in miles
R = the probability that the pilot of a crashing aircraft would be able to take action to avoid hitting the PFSF

The only change to the input parameters for this equation from those set forth in the Report is that the N in this equation would become 5,870 instead of 3,871 (which it was in the Report). This in turn would increase the annual crash impact probability for F-16s transiting Skull Valley (assuming a fully loaded 4,000 cask facility) by a factor of 5,870/3,871, or 1.516, from 2.05 E-7 to 3.11 E-7.[36]

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[35] The 'Normal In-flight' category calculations and the 'Skull Valley Type Event' category calculations would be unaffected by including the Sevier D type accidents with the Sevier B accidents.

[36] As a sensitivity analysis, PFS has examined the use of the FY00 number F-16 Skull Valley sorties of 5,757 as the norm (as opposed to the average of the FY99 and FY00 numbers of sorties) and adjusted it upward by 17.4%, to 6,759 sorties (to account for the new aircraft to be based at Hill AFB), as the new steady state number. While PFS does not believe this number is likely to be the steady state number, using it increases the Skull Valley F-16 crash impact probability from 3.11 E-7 to 3.58 E-7.

II. CRASH IMPACT RISK POSED BY OPERATIONS ON THE UTTR (SUPPLEMENTING SECTION IV OF THE REPORT)

In Section IV of the Report, PFS conservatively calculated the hazard posed by air-to-air combat operations[37] on the UTTR to the PFSF using the following relationship:

$P = C_a \times A_c \times A/A_p \times R$, where

P = annual crash impact probability
C_a = total air-to-air training crash rate per square mile on the UTTR
A_c = the area of the UTTR from which aircraft could credibly impact the PFSF in the event of a crash (i.e., the "cut-out" area)
A = effective area of the PFSF in square miles
A_p = the footprint area, in which a disabled aircraft could possibly hit the ground in the event of a crash
R = the probability that the pilot of a crashing aircraft would be able to take action to avoid hitting the PFSF

In the Report, PFS calculated a probability of 7.35 E-8 for risk from the UTTR. However, as PFS noted in its Report, because of substantial conservatism in the calculation "the true impact hazard would be much lower" and "as a practical matter, air operations on the UTTR pose very little, if any, risk to the PFSF." Report at p. 44. In the January 2001 Addendum, PFS evaluated the substantial conservatism in light of new expert information and concluded that the hazard probability to PFSF from aircraft operating on the UTTR is negligible relative to other aircraft crash hazards, i.e., less than 1 E-8. The primary and controlling conservatism is that the activity on the UTTR occurs too far away from the PFS to pose a hazard to the facility.[38]

In the Report, PFS's calculation of the impact hazard posed to the PFSF by aircraft conducting training on the UTTR was based on the assumption that aircraft experiencing an in-flight emergency within 10 miles of the PFSF that led to a crash could possibly impact the PFSF. This assumption resulted in using an arc with a radius of 10 miles to establish the "cut-out" area (A_c) in the above formula which delineates the area of the UTTR from which an aircraft could

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[37] In its Report, PFS concluded that the only activity on the UTTR that might pose a conceivable but insignificant hazard to the PFSF is air-to-air training conducted by fighter aircraft. Report at IV.A and IV.B.

[38] This was the "third major conservatism in the UTTR calculation" discussed in the January 2001 Addendum at pp. 24-27. The first conservatism (variation of aircraft operational activity in Ranges R-6402 and R-6406 and the location of the areas relative to the PFSF) accounted for a factor of two reduction in the calculated hazard. Id. at 22-23. The second conservatism (of the crash rate) accounted for a factor of three reduction in the calculated hazard. Id. at 24. The first conservatism no longer provides any appreciable reduction given that the variation in aircraft operational activity between R-6402 and R-6406 was significantly reduced in FY99 and FY00. See May 31 Response at pp. 5-7. Tab HH. The second conservatism with its three-fold reduction would remain applicable, however.

credibly impact the PFSF in the event of a crash. This assumption is, however, highly conservative in two respects:

- First, PFS's assessment set forth in Tab Y of the Report of the F-16 crash reports for accidents occurring during special in-flight operations in which the pilot does not maintain control of the aircraft (e.g., a mid-air collision or controlled flight into the ground) indicates that most such accidents would occur toward the center of the restricted ranges and that most likely such crashing aircraft would travel less than 5 miles horizontally before impacting the ground.
- Second, PFS's assessment of accidents in which a pilot does maintain control indicates that invariably the pilot would steer the aircraft away from a large facility on the ground, such as the PFSF, and would particularly have the capability to do so from a distance of five miles or more.

These two cases are discussed more fully below, but in either case, aircraft operating on the UTTR more than five miles from the PFSF would pose no hazard to the facility. Since aircraft on the UTTR would rarely operate within five miles of the PFSF, the hazard posed to the PFSF by aircraft operation on the UTTR would as a practical matter be zero. New expert information confirms this conclusion. The expert witness for the state of Utah, Lt. Col. Hugh Horstman, USAF (Ret.), who was Deputy Operations Group Commander with the 388th Fighter Wing and who also flew F-16s on the UTTR, agrees that aircraft operating on the UTTR would pose no hazard to the PFSF.[39]

As stated in Tab Y of the Report, the aggressive maneuvering on the UTTR most likely to result in an accident in which a pilot does not maintain control of the aircraft occurs toward the center of the restricted area ranges, not near the edges. PFS's analysis of the F-16 mishap reports further shows that virtually all of the accidents on the UTTR in which a pilot would not maintain control of the aircraft would occur during high-stress, aggressive maneuvering and that the crashing aircraft do not travel far from the point at which the event causing the mishap occurs. These conclusions were reached by Brigadier General James Cole, Jr., USAF (Ret.), Major General Wayne Jefferson, Jr., USAF (Ret.), and Colonel Ronald Fly, USAF (Ret.) based on their in-depth analysis (as part of their review of the 126 F-16 mishap reports) of the 35 reports concerning special inflight operations accidents in which the pilot could not have avoided

[39] See deposition pages of Lt. Col. Horstman attached as Tab BB.

a ground facility. Therefore, accidents on the UTTR that did not leave the pilot in control of the aircraft would not pose a hazard to the PFSF

If an in-flight mishap did leave the pilot in control of his aircraft, then, as discussed in the Report (Section III.A.5 and Tab H, p. 28, note 22), the pilot would be able to direct his aircraft away from the PFSF. Throughout the F-16 mishap reports reviewed by PFS, there were numerous references to the pilot consciously considering vulnerable structures or populated areas on the ground and turning his aircraft so as to avoid them. In no case was it mentioned that a pilot had control and time but failed to guide his aircraft so as to minimize damage to a facility or populated area on the ground. That data supports assigning a percentage approaching zero for the likelihood that a pilot with the time, opportunity and awareness of the PFSF would fail to direct a crashing F-16 away from the facility. Furthermore, by its very purpose, the UTTR, itself, presents a significant safe area to receive a descending aircraft (thereby increasing a pilot's opportunity to avoid a manned site on the ground). Therefore, an aircraft experiencing an engine failure would not glide across the Cedar Mountains toward the PFSF in the middle of Skull Valley – which would be over 5 miles away and off the range – and impact it while under a pilot's control. The extensive training program for military pilots instills a responsibility to avoid inhabited, populated areas if possible in the event of an emergency in order to avoid harm to the general public. Therefore, if a pilot were to suffer an in-flight mishap that left him in control of the aircraft (e.g., an engine failure), he would guide the aircraft toward a controlled bailout area or an open area on the range before ejecting where the aircraft would do no collateral damage when it struck the ground (or toward Michael Army Airfield on Dugway Proving Ground if the aircraft were within range to make a forced landing there).

As shown in Section IV.8 of the Report, if PFS were to incorporate the 5-mile distance within which a crashing aircraft might pose a hazard to the PFSF, discussed above, into its analysis, which would be more than amply supported by the accident data, it would define the "cutout area" (A_c) in its UTTR calculation in Section IV of the Report (and in Section I.D above) by drawing an arc with a radius of 5 miles centered at the PFSF. A 5-mile arc, however, would reduce the applicable crash rate to zero, in that the PFSF is located 2 miles east of the UTTR restricted areas and, on the basis of where F-16s fly on the UTTR, PFS has utilized a 3-mile buffer zone just inside the UTTR restricted areas in defining where aircraft do not fly while conducting aggressive maneuvering flight operations. Thus, the PFSF is located 5 miles east of the closest point at which an event leading to a crash would be expected to occur and hence, a crashing aircraft on the UTTR would not be able to reach the facility before impacting the ground.

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

Based on the above analysis, PFS believes that it is appropriate to use an arc with radius of 5 miles – and not 10 miles as done in the Report – to define the "cut-out" area (A_c) in the above equation for delineating the area of the UTTR from which aircraft could credibly impact the PFSF in the event of a crash. As discussed above, this reduces the calculated hazard probability of aircraft operating on the UTTR effectively to zero. Therefore, the hazard probability to the PFSF of aircraft operating on the UTTR is negligible relative to other aircraft crash hazards, i.e., less than 1 E-8.

III. AIRCRAFT USING THE MOSER RECOVERY (SUPPLEMENTING SECTION V OF THE REPORT)

In Section V of the Report, PFS calculated the average annual crash impact probability for aircraft flying the Moser recovery, using the same method that PFS used for calculating the hazard from F-16 flights through Skull Valley (i.e., $P = C \times N \times A / w \times R$). The upper bound of the number of aircraft, N, is very conservatively taken to be five percent of the total F-16 flights on the South UTTR, or 286. The annual crash impact probability was then estimated to be 1.32 E-8. If this probability is increased to reflect the additional sorties expected to be flown by F-16s from Hill AFB, based on FY99 and FY00 sortie data and the stationing of the 12 additional F-16s at Hill, the probability would increase by a factor of 5,870/3,871, or 1.516, to 2.00 E-8.[40]

[40] If PFS were to base its calculation solely on the FY00 sortie number (as opposed to the average of the FY99 and FY00 sortie numbers), still accounting for the additional F-16s at Hill as well, the Moser recovery annual crash impact probability would increase from 2.00 E-8 to 2.30 E-8.

IV. FLIGHTS ON AIRWAY IR-420 AND TO AND FROM MICHAEL ARMY AIRFIELD (SUPPLEMENTING SECTION VI OF THE REPORT)

In its May 31 Response, PFS estimated the level of traffic to and from Michael Army Airfield in the direction of airway IR-420 that could pass in the vicinity of the PFSF on the basis of FY00 operations data from Michael. PFS showed that the assumption of 414 flights per year in the Report is conservative in light of actual traffic and the fact that PFS has accounted for any direct F-16 traffic between Michael AAF and Hill Air Force Base in its Skull Valley transit hazard assessment. May 31 Response, RAI Question 2(a). PFS also confirmed that most of the aircraft that fly to and from Michael AAF that are not F-16s are transport aircraft. May 31 Response, RAI 2(c).[41]

V. SECTION V (THROUGH PAGE 28) INTENTIONALLY REMOVED.

[41] While not directly pertinent to PFS's IR-420 and Michael Army Airfield assessment, PFS provided in its May 31 response to the RAI that there are five standard flight plans by which pilots routinely enter the UTTR South Area from Hill AFB other than via Skull Valley or IR-420. May 31 RAI Responses, 2(b).

VI. JETTISONED ORDNANCE HAZARDS (SUPPLEMENTING SECTION X OF THE REPORT)

A. Evaluation of Additional Information Concerning Impact Hazard of Jettisoned Ordnance

In Section X.C.3 of the Report, PFS used the equation $P = N \times C \times e \times A/w$, to calculate the probability that jettisoned ordnance would impact the PFSF, where N is the number of F-16s carrying ordnance (live or inert) through Skull Valley per year, C is the F-16 crash rate per mile, e is the fraction of the crashes attributable to engine failure or some other event leaving the pilot in control of the aircraft (in crashes attributable to other causes it was assumed that the pilot would eject quickly and would not jettison ordnance), A is the effective area of the PFSF, from the perspective of ordnance jettisoned from an aircraft flying from north to south over the site, and w is the width of Skull Valley. The jettisoned ordnance impact probability calculated in the Report was 9.85 E-8.

As discussed above, PFS received additional information from the Air Force on F-16 sorties transiting Skull Valley in FY99 and FY00 which showed an increase in the number of F-16s transiting Skull Valley. PFS also received, however, additional information regarding the carrying of ordnance by F-16s transiting Skull Valley in FY99 and FY00 that was incorporated into PFS's May 31 response to the NRC RAI Questions 7(a) and 7(b) which reflects a large reduction in the fraction of Skull Valley F-16 sorties that carry ordnance. The large reduction in this fraction significantly reduces the probability that an ordnance impact would occur at the PFSF.

If PFS were to reasonably assume that the number of sorties carrying ordnance through Skull Valley, N, would increase in proportion to the total increase in sorties transiting Skull Valley and the increase in aircraft at Hill AFB, then the jettisoned ordnance impact probability (accounting for the change in the number of sorties alone) would increase by a factor of 5,870/3,871, or 1.516. Therefore, the new probability would be 1.49 E-7. This is based on 5,870 flights which was the approximate average of F-16 flights through Skull Valley for FY99 and FY00 (4250 +5757 divided by 2), increased by 17.4% to account for the increased numbers of F-16s to be stationed at Hill AFB. This probability was the jettisoned ordnance hazard probability for the base case reported in the January 2001 Addendum.

However, subsequent to the January 2001 Addendum, PFS received the additional information on the fraction of F-16 sorties carrying ordnance in FY99 and FY00, which PFS reported in its May 31 response to the NRC RAI Questions 7(a) and 7(b). This additional data showed that the average fraction of 388th FW sorties carrying ordnance in FY99 and FY00 was 0.020 compared to a fraction of 0.118 FY98 used in the Report. Incorporating the average fraction of actual sorties carrying ordnance by F-16s in FY99 and FY00 (analogous to averaging the FY99 and FY00 F-16 sorties for the base case F-16 crash hazard calculation in Section I), and adjusting the calculation for other additional information concerning ordnance,[54] reduces the probability hazard from jettisoned ordnance from 1.49×10^{-7} to 3.2×10^{-8}. This in turn reduces the cumulative aircraft hazard to the PFSF calculated in the January 2001 Addendum for the expected, or base, case from $<5.34 \times 10^{-7}$ to $< 4.17 \times 10^{-7}$. See May 31 Response, RAI 7(b) at p. 14-15.

PFS also performed a sensitivity analysis assuming that the higher FY00 F-16 Skull Valley sortie number of 5,757 would be the expected norm (as opposed to the approximate average of the FY99 and FY00 numbers), increased by 17.4% to account for the increased numbers of F-16s to be stationed at Hill AFB. Using the FY00 sortie count and the FY00 ordnance count and adjusting the calculation for other additional information concerning ordnance referred to above, reduces the probability hazard calculated for jettisoned ordnance in the January 2001 Addendum for the sensitivity analysis from 1.72×10^{-7} to 3.318×10^{-8}. This in turn reduced the cumulative hazard calculated in the January 2001 Addendum for the sensitivity case from $<6.04 \times 10^{-7}$ to $< 4.65 \times 10^{-7}$. See May 31 Response, RAI 7(b) at p. 15.

In its March 30, 2001 response to the NRC RAI, PFS demonstrated that the angle at which jettisoned ordnance impacted the ground would have practically no effect on the probability that jettisoned ordnance would impact the PFSF. March 30 Response, RAI 7(c).

In its May 15, 2001 clarification no. 5, PFS noted that pilots jettisoning ordnance would be aware of, and often consider, the location of sensitive areas on the ground, such as inhabited

[54] The other additional information that PFS learned concerning ordnance was that the ordnance counts it had received from Hill AFB may not include ordnance carried on sorties flown by the 419th Fighter Wing stationed at Hill AFB. See May 31 Response, RAI 7(a) note 27 on p. 12. Therefore, PFS has chosen to conservatively assume that the ordnance counts provided by Hill AFB are for the 388th Fighter Wing only, and has proportionally increased those numbers to account for ordnance carried by the 419th Fighter Wing. See May 31 Response, RAI 7(a) and 7(b) at pp. 12-16.

areas or a facility like the PFSF, before jettisoning the ordnance. However, as stated in the Report, PFS has calculated the jettisoned impact hazard to the PFSF assuming that "no steps are taken by the pilot to avoid jettisoned ordnance from striking populated areas and structures, such as the PFSF." Report at p. 79. Therefore, PFS's jettisoned ordnance impact probability hazard to the PFSF is conservative in that it makes no allowance for potential avoidance action taken by pilots in jettisoning ordnance.

B. Potential Explosion of Ordnance Impacting Near the PFSF

1. Evaluation of Additional Information

In Section X.D of the Report, PFS calculated the probability that ordnance jettisoned from or carried aboard a crashing aircraft that impacted near the PFSF would explode and damage the facility. Here PFS incorporates the effect of the additional Air Force information regarding sortie counts and the carrying of ordnance by F-16s transiting Skull Valley in FY99 and FY00. The same factors of increase applied to the probability of a direct impact by jettisoned ordnance could be applied to PFS's calculation of the hazard to the PFSF posed by the potential explosion of live ordnance upon impact near the PFSF.

In Section X.D.5.c of the Report, PFS calculated that the annual probability that exploding ordnance would damage a spent fuel storage cask or the canister transfer building would be 2.43 E-10. However based on the new flight number of 5,870, the adjusted probability would increase by a factor of 1.516 to 3.68 E-10. As before, this probability is negligible relative to the other aircraft crash and jettisoned ordnance impact probabilities at the PFSF. Therefore, any increase in this probability that would result from the increased sortie numbers and additional aircraft based at Hill AFB would also be negligible relative to the other aircraft crash and jettisoned ordnance impact probabilities at the PFSF. Furthermore, since the fraction of F-16 flights carrying ordnance dropped by roughly a factor of six in FY99 and FY00 relative to FY98, the hazard posed by nearby explosions of ordnance would be significantly lower than the hazard calculated above, and therefore well below 1 E-10.

2. Clarification in Response to July 5, 2001 Conference Call

In the conference call of July 5, 2001, the NRC Staff asked PFS for clarification of its analysis of exploding ordnance in two respects, the first concerning the overpressure used in the calculations and the second, concerning potential multiple ordnance explosions. Each is discussed in turn below.

a. Overpressure

As set forth in Section X.D of Aircraft Crash Impact Hazard at the Private Fuel Storage Facility, Revision 4 (Aug. 10, 2000) ("Report"), pp. 83b-83c, PFS used a value of 10 psi for the spent fuel storage casks and 1.5 psi for the canister transfer building (CTB) to evaluate the susceptibility of the PFSF to the overpressure created by the explosion of the ordnance. The value for the spent fuel casks is from the Final Safety Analysis Report ("FSAR") for the Holtec HI-STORM-100 spent fuel storage cask, pp. 3.4-65 to –68, which specifically analyzes the susceptibility of a cask to a nearby explosion. The value for the CTB is from the PFSF SAR, p. 8.2-23c, which states that the CTB can withstand pressure drops of 1.5 psi arising from the design basis tornado.

PFS recognizes that it used a conservative standard of 1.0 psi to evaluate the susceptibility of the PFSF to potential explosions at the Tekoi Rocket Engine Test Facility (now defunct) and potential explosions of propane gas at the PFSF. See PFSF SAR pp. 8.2-23c to –23p. Nevertheless, PFS believes that the 10 psi limit for the spent fuel casks remains appropriate because of the robust nature of their construction and the specific explosion analysis contained in the HI-STORM 100 FSAR. PFS also believes that the 1.5 psi limit for the CTB is appropriate in light of the fact that a short transient pressure wave produced by an explosion is less damaging to a structure than a longer transient pressure drop produced by the design basis tornado. See HI-STORM 100 FSAR, p. 3.4-66 (use of a steady state force to calculate the effects of an explosion is very conservative).

However, even if one were to use 1.0 psi as a conservative limit for the CTB, the results of the analysis would be the same—the hazard posed by potential nearby explosions of ordnance would be insignificant. The effect of using a 1.0 psi limit for the CTB instead of a 1.5 psi limit would be to increase the explosive radius of the ordnance, r_e, i.e., the distance from the explosion at which the overpressure would exceed the CTB's limit. See Report at pp. 83d, 83g-83h.

The explosive radius r_e (in feet) for a given amount of explosive W (in pounds) that will produce a blast overpressure of 1.5 psi is calculated as follows:

$$r_e = 33\ W^{1/3}$$

Report, p. 83h. The explosive radius for a given amount of explosive that will produce a blast overpressure of 1.0 psi is calculated as follows:

$$r_e = 45\ W^{1/3}$$

PFSF SAR at, p. 8.2-23h. Thus, r_e for an overpressure of 1.0 psi is 45/33 or 1.364 times greater than r_e for an overpressure of 1.5 psi. If the exploding ordnance is conservatively taken to be a 2,000 lb. bomb, containing an equivalent of 1,075 lbs. TNT (see Report at p.83h), then r_e for the ordnance would be equal to $45 \times (1{,}075)^{1/3}$ or 461 ft.

The probability that a piece of ordnance (conservatively assumed to be a 2,000 lb. bomb) would land and explode close enough to the PFSF to damage a spent fuel storage cask or the CTB is calculated on pages 83j to 83l of the Report. Performing that calculation (following the format used on pp. 83j-83l of the Report) using an explosive radius of 461 ft. for the bomb with respect to the CTB, corresponding to a blast overpressure of 1.0 psi,[55] gives the following results:

(1) Ordnance Carried Onboard Crashing Aircraft

Applying the equations derived in Section X.D of the Report (pp. 83j-83l) and using the values in the Report's calculation, the probability that unarmed ordnance carried aboard a crashing aircraft would explode and damage a spent fuel storage cask in the cask storage area at the PFSF is equal to 7.2×10^{-12}. Report at p. 83j.

PFS applies the same equations to the CTB to calculate the probability that unarmed ordnance carried aboard a crashing aircraft would explode and damage the building, except that now uses a value of r_e for the CTB corresponding to the 1.0 psi limit. For the CTB, $r_e = 461$ ft., $L_f = 260$ ft. (Section III.C.3.b), $W_f = 200$ ft. (at its widest point) (PFSF SAR Fig. 4.7.1) and all other variables are the same. Thus, $A_{nml} = 461\ (260 + 200 + 2 \times 246) + 3.1416 \times (461)^2 =$ 1,106,528 sq. ft. or 0.03969 sq. mi. Therefore,

$$P_{nml} = 3{,}871 \times 2.736 \times 10^{-8} \times 0.03969/10 \times 0.005 \times 0.01 = 2.102 \times 10^{-11}.$$

[55] For comparison, the calculation in the Report for a blast overpressure of 1.5 psi used $r_e = 338$ ft. for the CTB.

Thus, the cumulative probability that an unarmed bomb onboard a crashing aircraft would impact nearby and explode and damage a spent fuel storage cask or the CTB is equal to $7.20 \times 10^{-12} + 2.102 \times 10^{-11} = 2.822 \times 10^{-11}$.

(2) Jettisoned Live Ordnance

Applying the equations derived in Section X.D of the Report, the probability that jettisoned live ordnance would impact nearby and explode and damage a spent fuel storage cask in the cask storage area at the PFSF is equal to 1.09×10^{-10}. Report at p. 83k.

The same equations for jettisoned ordnance apply to the CTB. All variables are the same as those applied for the CTB in the case of ordnance onboard a crashing aircraft in subsection a. above (i.e., the variables are the same as those used in the Report, except for r_e corresponding to a limit of 1.0 psi). Thus, $A_{nm2} = 2 \times 461 (260 + 200) + 3.1416 \times (461)^2 = 1{,}101{,}776$ sq. ft. or 0.03952 sq. mi. Therefore,

$P_{nm2} = 3{,}871 \times 2.736 \times 10^{-8} \times 0.03952/10 \times 0.045 \times 0.01 = 1.88 \times 10^{-10}$.

Thus, the cumulative probability that a jettisoned unarmed bomb would impact nearby and explode and damage a spent fuel storage cask or the CTB is equal to $1.09 \times 10^{-10} + 1.88 \times 10^{-10} = 2.97 \times 10^{-10}$.

(3) Live Ordnance Cumulatively

Therefore, if one used a conservative blast overpressure limit of 1.0 psi for the CTB instead of the 1.5 psi used in the Report, the cumulative probability that live ordnance either carried aboard a crashing aircraft or jettisoned from a crashing aircraft would impact nearby and explode and damage a spent fuel storage cask or the CTB at the PFSF is equal to sum of the probabilities calculated above: $2.822 \times 10^{-11} + 2.97 \times 10^{-10} = 3.25 \times 10^{-10}$. This remains far less than the probability that a crashing aircraft or jettisoned ordnance would impact the site directly. This is true even if the probability is increased further to reflect the higher number of F-16 sorties transiting Skull Valley in FY99 and FY00. In fact, the probability would be lower if it were adjusted to reflect the actual use of ordnance by F-16s transiting Skull Valley in those years. Therefore, as stated in the Report, p. 83l, because the probability is so low and because PFS's analysis is only based on the hypothetical possibility of an explosion involving unarmed ordnance, such can be discounted as a risk to the PFSF.

b. Potential Multiple Ordnance Explosions

The second question regarding the exploding ordnance hazard posed by the NRC Staff in the July 5 conference call was, how did PFS address the possibility of multiple bomb explosions—from an aircraft carrying more than one bomb—nearby the PFSF?

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

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

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

VII. UPDATED CUMULATIVE AIRCRAFT CRASH IMPACT HAZARD AT THE PFSF

The cumulative aircraft crash (and jettisoned ordnance) impact hazard to the PFSF changes as a result of this Addendum as shown in the table below. The table includes both current calculated values and values as had been calculated in the Report prior to the Addendum. As can be seen in the table, the crash impact hazard calculations that were not discussed in this Addendum did not change.

Calculated Aircraft Crash Impact Probabilities		
Aircraft	**Annual Probability (Report)**	**Annual Probability (Addendum)**
Skull Valley F-16s	2.05×10^{-7}	3.11×10^{-7}
UTTR Aircraft	7.35×10^{-8}	$< 1 \times 10^{-8}$
Aircraft Using the Moser Recovery	1.32×10^{-8}	2.00×10^{-8}
Aircraft on Airway IR-420	3.0×10^{-9}	3.0×10^{-9}
Aircraft on Airway J-56	1.9×10^{-8}	1.9×10^{-8}
Aircraft on Airway V-257	1.2×10^{-8}	1.2×10^{-8}
General Aviation Aircraft	2.36×10^{-7}	$< 1 \times 10^{-8}$
Cumulative Crash Probability	5.62×10^{-7}	$<3.85 \times 10^{-7}$
Jettisoned Military Ordnance	9.85×10^{-8}	3.2×10^{-8}
Cumulative Hazard	6.60×10^{-7}	$<4.17 \times 10^{-7}$

As noted above, PFS has done a sensitivity analysis assuming that the FY00 F-16 Skull Valley sortie number of 5,757 were the expected norm (as opposed to the average of the FY99 and FY00 numbers of sorties). Adjusting this number upward by 17.4%, (to account for the additional aircraft to be based at Hill AFB), the new steady state number would be 6,759. While PFS does not believe this number is likely to be the steady state number, using it would increase (1) the Skull Valley F-16 crash impact probability from 3.11 E-7 to 3.58 E-7; (2) the Moser Recovery crash impact probability from 2.00 E-8 to 2.30 E-8, and (3) the Jettisoned Military Ordnance crash impact probability from 3.2 E-8 to 3.32 E-8 (accounting also for the reduced fraction of aircraft carrying ordnance in FY00). Thus, the Cumulative Hazard probability in the above Table would be 4.65 E-7, still well below 1 E-6. [56]

[56] PFS also did a second sensitivity analysis assuming that the new expected norm for Skull Valley flights would be the sum of FY00 operations for Sevier B and Sevier D MOA, adjusted upward by 17.4%. This second sensitivity analysis would result in a cumulative hazard of <4.90 E-7, again well below the regulatory limit of 1 E-6. May 31 Response at pp. 15-16.

VIII. CONSERVATISM REMAINING IN PFS'S AIRCRAFT CRASH IMPACT HAZARD CALCLULATIONS

Even though PFS has quantified in this Addendum some of the conservatisms identified in its Report, the calculated cumulative hazard to the PFSF set forth in the Table above still retains other substantial conservatisms. First, with respect to the F-16s transiting Skull Valley and flying on the Moser recovery, PFS used a crash rate that included not only destroyed aircraft, but also Class A and B mishaps in which no aircraft was destroyed. Report at 25; id. Tab H at 4 n.8. Since, in the 10 years from FY89 to FY98 there were 162 Class A and Class B mishaps but only 139 destroyed aircraft, the crash rate is overstated by 16.5%, which reasonably applies to both the normal and special in-flight operations accident rates used in the analysis. In other terms, for this conservatism alone, the correct calculated impact hazards are about 14% lower than those shown. Using this factor alone, the Skull Valley F-16 hazard would be reduced from 3.11 E-7 to 2.67 E-7 per year and the Moser recovery hazard would be reduced from 2.00 E-8 to 1.72 E-8 per year.

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

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

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

Fourthly, PFS's calculated hazard from jettisoned ordnance is also conservative in a number of respects. First, as discussed in Section X of the Report, the calculation does not take into account the fact that half of the cask storage area at the PFSF will consist of open space where ordnance could impact and do no damage. Report at p. 83. Second, a recent letter to the State of Utah from the Air Force states that none of the inert munitions listed in the letter as having been tested by the Air Force would penetrate the lid of a storage cask if they struck it.[57] Those weapons tested included the Mark 82, Mark 84 and CBU-87 which make up the great majority of the jettisonable ordnance carried by F-16s on the UTTR (See Table 4 in the Report at p, 81 and May 31 Response at p.13). The Mark 84 (2000 lb. bomb) could penetrate the outside wall of the cask (if it struck the wall as opposed to the lid), but it is unclear from the Air Force letter if it would then penetrate the 2-inch steel inner shell or fuel canister shell. Since sorties carrying Mark 84s make up only 22% of the sorties carrying jettisonable ordnance (May 31 Response at 13), in any event the actual risk from jettisoned ordnance is probably well below the figure of 3.2 E-8 calculated in Section I.B above, and is probably on the order of 7 E-9.[58]

Finally, as discussed in Section III.A.8 of the Report, all of PFS's calculations assume a fully loaded site with 4,000 spent fuel storage casks. In fact, the PFSF would contain 4,000 casks for only one year during its lifetime. If PFS considered a time-weighted average size for

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

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

the cask storage area, the effective area of the site would be only 55 percent of the area of the site at full capacity. Thus, the average aircraft crash impact hazard for the PFSF is only 55 percent of the peak hazard. Since effective area is integral to all calculations of risk, the total risk could likely be reduced by a factor of approximately 45% for an average risk value. Inclusion of this factor in PFS's assessment, which affects all of the separate risk factors, would alone reduce the cumulative hazard to the PFSF from 4.17 E-7 to 2.29 E-7 per year.

The cumulative effect of the conservatisms listed in this chapter of the Addendum, though somewhat more difficult to quantify and therefore not included in the Table above, would reduce the Cumulative Hazard shown in the Table from 4.17 E-7 to 3.5 ~~2.6~~ E-7 if no adjustment is made for the lifetime average site effective area. If this cumulative hazard is adjusted for the lifetime average site effective area, the hazard becomes roughly ~~1.43~~ E-7.[59]
1.90

[59] The estimates were made as follows. First, the hazard from F-16s transiting Skull Valley is reduced from 3.11 E-7 to 2.67 E-7 by accounting for Class A and B mishaps that do not result in destroyed aircraft. ~~It is reduced further to 1.87 E-7 by accounting for the impact penetration resistance of the storage casks.~~ The hazard from aircraft flying the Moser recovery is reduced from 2.0 E-8 to 1.72 E-8 by accounting for the Class A and B mishaps ~~and to 1.2 E-8 by accounting for the penetration resistance of the casks.~~ The jettisoned ordnance impact hazard is reduced from 3.2 E-8 to 7 E-9 by accounting for the ordnance impact penetration resistance of the casks. If those hazards are summed, along with the other hazards listed in the table in Section IV, the result is a cumulative hazard to the PFSF of ~~2.6~~ E-7. If that cumulative hazard is adjusted to account for the lifetime average site effective area, the hazard becomes ~~1.43~~ E-7.
3.5
1.90

In The Matter Of:

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BY MR. BARNETT:

Q: Did you review the assessment in PFS' aircraft crash report regarding the hazard posed by flights on the UTTR?

A: Yes.

Q: Did you review the NRC staff's safety evaluation report regarding the hazard posed by aircraft flights on the UTTR?

A: Yes.

Q: Are there any additional documents that you plan to review in preparation for your testimony regarding UTTR flights or

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hazards posed there?

A: Not that I can think of right now, no.

Q: And is there any further work that you plan to do regarding your testimony in preparation for your testimony?

A: I think we'll probably put, ask for a single block of airplanes, if you want to say the F-16A model, and we'll ask for the F-16A model crash rates from introduction to, because they are all about gone, been retired, we are going to ask for those from the Air Force so we can show historically that, in fact, there is a higher crash rate at the end.

Q: Is there anything else that you can think of?

A: No, uh-uh.

Q: Is there any respect, why don't we look at the aircraft crash report, since I'll be referring to that, the assessment of the hazard posed by flights on the UTTR, which is

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chapter 4, I believe, which begins on page 28.

Are there any specific respects in which you believe PFS' assessment of the hazard posed by flights on the UTTR is deficient in any way?

A: No.

Q: So you —

A: There's — the weather issue will enter into it, but as far as all the rest of the data, I have no objection to any of it. It speaks for itself, if an airplane has a problem up there, 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.

Q: Well let me go back to the Moser Recovery for just a brief few questions here, a few things that we didn't cover a few minutes ago.

When using the Moser Recovery, or let's go back to when you were talking about

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Skull Valley, you said that if the PFS facility were built, that you thought that some of the pilots flying down Skull Valley would aim at the site to calibrate their instruments?

A: I think I said the majority of them, but yes.

Q: Do you have any reason that pilots flying on the Moser Recovery would deliberately aim at the PFS facility?

A: They would intentionally fly the procedure without regard to where the facility is.

Q: All right. If an aircraft was flying on the Moser Recovery and, say, it was in the beginning part of the route here which is still over the restricted area on the UTTR, if that aircraft were to experience an engine failure, would it try to go back to Michael Army Airfield?

A: In 99 percent of the cases, absolutely. The other 1 percent would be

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random. That's what everybody I know would do. It's the nearest field and you would go there.

Q: And in your opinion, if you were too far up the route, so to speak, back toward Hill to get back to Michael, would the, if the aircraft were then gliding without an engine, in the event of an engine failure, do you believe it would glide past the PFS site, so if it were to impact the ground, it would impact the ground past the PFS facility?

A: Oh, yeah, absolutely, just because of the geography of it.

Q: I know you said at the beginning of the deposition this morning that you weren't going to testify on general aviation; is that correct?

A: Correct.

Q: But in your experience on flying on the UTTR, how much general aviation did you see in Skull Valley?

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A: Minimal. There is some activity, but it's minimal.

Q: All right.

A: Does it pose a risk to the airplanes, the F-16s flying down there, no, I wouldn't say it does.

Q: How would you say the level of activity compares to, say, the rest of the State of Utah, outside, away from the UTTR?

A: Well, there's a lot of different areas. The area over Interstate 80 and the area between the UTTR and the Seviers and the mountains over here, there's a great deal of traffic.

Q: That's like towards Salt Lake City and Rush Valley?

A: That's the only place they can go. They can't in there, they can't go over the mountains, really. So all the traffic is going to go through here or in and out over Interstate 80 towards Wendover.

Q: When you say in through here, this

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is Rush Valley here?

A: Yeah, if you just look down here, this is where, essentially if you're transiting Utah to the north, and you're not high altitude, as in, you know, a Boeing kind of aircraft, you are probably going to go through this area.

And, quite honestly, most of them would avoid the Seviers because they know that high speed airplanes are in it, most of them, not all, but that's why it's minimal risk in there.

Q: All right, well let's turn to cruise missiles here for a moment.

What aspect of cruise missile testing were you planning to testify on? You said you might testify.

A: Just generic, more of the range usage as opposed to the actual, you know, what a cruise missile is, what it does. I'm a little familiar with that, but more familiar with the scheduling and the planning

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and when they shut the range down and they build some of their routes, et cetera. That's about all I know.

Q: Now in your resume you said you were deputy commander of the 388th operations group?

A: Yes.

Q: And before that you held a number of positions with Air Force units in Europe?

A: Uh-huh.

Q: And you were at headquarters air combat command?

A: Yes.

Q: What experience did you have with cruise missile testing, per se?

A: When I started flying the B-52, we transitioned to the airlines cruise missiles and I learned a little bit about a generic cruise missile then.

I worked on two classified projects with some Navy cruise missiles, and that's all essentially dated informat-

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

28 Dec 00

Utah Department of Environmental Quality
Attn: Connie Nakahara
168 North 1950 West
P.O. Box 144810
Salt Lake City, Utah 84114

This letter is in response to several written and verbal requests for information regarding jettisoned weapons and the proposed nuclear waste storage facility in Utah. This is not a response to the Freedom of Information Act (FOIA) Request from the Utah Department of Environmental Quality. The Air Force's response to the FOIA Request will be forwarded under separate cover.

The PC effects model in the Joint Munitions Effectiveness Manual Air to Surface Weaponeering System (JAWS) and other JAWS data were used to estimate penetration of the materials listed below. This PC-based, mission planning tool provides an operational estimate, as opposed to an engineering analysis, on the likelihood that a weapon would destroy a target consisting of a certain thickness of material or combination of materials. The Air Force confirmed with Mr. Steve Rush on 27 Dec 00 that calculations only on the storage container will be sufficient at this time.

Thickness from the outside wall toward basket

1. Steel overpack outer shell (SA516, Gr 70)	0.75 in
2. Concrete shield (4000 PSI @ 28 days)	26.75 in
3. Steel shield shell (SA516, Gr 70)	0.75 in
4. Steel overpack inner shell (SA516, Gr 70)	1.25 in
5. Steel canister shell (304 or 316 SS)	0.50 in
Total:	30.00 in

Thickness from outside lid toward basket

1. Steel top plate (SA516, Gr 70)	4.00 in
2. Concrete lid shield (4000 PSI @ 28 days)	10.50 in
3. Steel lid bottom plate (SA 516, Gr 70)	1.25 in
4. Steel canister lid (304 or 316 SS)	9.50 in
Total:	25.25 in

UT-45794

The following weapons were used in the model:

- BSU-49
- BSU-50
- CBU-87 (intact)
- GBU-10
- GBU-12
- GBU-24A
- GBU-24B
- MK-82
- MK-84

Assumptions / Caveats:

Only inert weapons data was used.
No consideration was given to buckling or cracking of the container or detonation of a weapon.
The concrete description in the original written request showing 400 PSI was assumed to be 4000 PSI concrete.
Because impact speed and angle are classified, they cannot be addressed in this letter.

Results from JAWS showed that none of the weapons would penetrate through the lid of the structure. The GBU-24/B, GBU-24 A/B, GBU-10, MK-84, and BSU-50 can penetrate the outside wall. None of the other weapons can penetrate the wall.

I hope you find the above information helpful. Please do not hesitate to call me at (703) 601-0213 with questions.

//SIGNED//

LEE C. BAUER, Colonel, USAF
Deputy Associate Director
for Ranges and Airspace

PFS RRRC Lic Com.

Private Fuel Storage, L.L.C.

7677 East Berry Ave., Englewood, CO 80111-2137
Phone 303-741-7009 Fax: 303-741-7806
John L. Donnell, P.E., Project Director

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

March 30, 2001

REQUEST FOR ADDITIONAL INFORMATION
ON AIRCRAFT HAZARDS – PARTIAL RESPONSE
DOCKET NO. 72-22 / TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

Reference 1: NRC Letter, Delligatti to Parkyn, Request for Additional Information, dated March 9, 2001.

Reference 2: February 27, 2001 teleconference between PFS and the NRC.

Reference 3: PFS Letter, Donnell to Delligatti, Request for Additional Information, dated March 20, 2001.

Attached please find the partial response by Private Fuel Storage (PFS) to the Request for Additional Information on Aircraft Hazards from the Nuclear Regulatory Commission (NRC) dated March 9, 2001 (Reference 1). As identified to the NRC in Reference 3, Freedom of Information Act (FOIA) requests have been submitted to the U.S. Air Force to resolve, if possible, the balance of the information request. The questions that remain open are identified in the Attachment.

If you have any questions regarding this response, please contact me at 303-741-7009.

Sincerely

John L. Donnell

John L. Donnell
Project Director
Private Fuel Storage L.L.C.

Copy to:

Mark Delligatti
John Parkyn
Jay Silberg
Sherwin Turk
Asadul Chowdhury
Scott Northard
Denise Chancellor
Richard E. Condit
John Paul Kennedy
Joro Walker

RESPONSE TO MARCH 9, 2001 NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING AIRCRAFT AND CRUISE MISSILE HAZARDS AT THE PRIVATE FUEL STORAGE FACILITY

AIRCRAFT DEPLOYMENT AND SORTIES

1. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from the additional F-16 aircraft and resulting sorties at Hill Air Force Base:

(a) Clarify the total number of F-16 aircrafts that would be stationed at Hill Air Force Base as a result of the addition of 12 new F-16 aircraft.

Exhibit 9a the Declaration of James L. Cole, Jr., Wayne O. Jefferson, Jr. and Ronald E. Fly before the Atomic Safety and Licensing Board, December 30, 2000 (Cole et al.), indicates the total number could be 84 rather than 81 which is referenced in your letter dated January 19, 2001.

Response

The total number of aircraft to be stationed at Hill AFB after the addition of the 12 new aircraft, and when all are at home station (none deployed) is 81. At the time the Report was written (August 2000), there were 69 F-16s assigned to Hill AFB, 54 of which were assigned to the 388th Fighter Wing and 15 assigned to the 419th Reserve Fighter Wing. If an additional 12 are assigned to the 388th FW (no additional F-16s are foreseen to be added to the 419th RFW), then the total will rise from 69 to 81.

Exhibit 9a is a memorandum from State of Utah witnesses Matt Lamb and Marvin Resnikoff to Hugh Horstman, dated December 5, 2000. PFS has since confirmed its information on the number of F-16s assigned at Hill AFB from Hill; PFS is unaware of why Mr. Lamb and Dr. Resnikoff stated that there were a different number of F-16s at the base.

(b) Discuss whether the number of F-16 aircraft deployed at Hill Air Force Base is directly proportional to the number of sorties flown through Skull Valley and the UTTR. For example, discuss whether an increase in the number of deployed F-16 aircraft could actually result in a less-than or more-than proportional increase in the number of sorties flown each year.

Response

Changes in the number of F-16 aircraft at Hill AFB will result in a proportional change in the approximate number of sorties flown through Skull Valley and on the UTTR. Since the squadrons at Hill AFB all have similar training requirements, they tend to fly similar schedules in terms of airspace usage and mission types (simulated air-to-air combat, medium altitude surface attack, low altitude navigation and bombing, etc.). As a result, with the addition of F-16 aircraft to Hill AFB, it is reasonable to assume that there will be an approximately proportional increase in flights through Skull Valley and the other portions of the UTTR. Similarly, with the departure of aircraft from Hill AFB, it is reasonable to assume that there will be an approximately proportional decrease in flights through Skull Valley and the UTTR. For example, if a fighter squadron were to deploy to Southwest Asia with its entire complement of airplanes, it is reasonable to assume that there would be a proportional decrease in the overall flight activity (sorties, Skull Valley transits, UTTR missions) from Hill AFB for the duration of the deployment.

(c) Discuss the relationship (e.g. proportional increase) of the deployment of additional aircraft at Hill Air Force Base to the assignment of additional flight crews and maintenance personnel to operate and maintain the additional aircraft. Specify whether the assignment of additional flight crews and maintenance personnel is a determining factor in the number of sorties flown.

Response

As the number of assigned aircraft is increased, there will be an approximately proportional increase in pilots and maintenance personnel. Squadron pilot and maintenance manning is based upon the number of assigned aircraft (the Air Force term is Primary Aircraft Authorized (PAA)). As the PAA for the 388th Fighter Wing is increased, additional pilots and maintenance personnel will be will be assigned to the Wing.

In addition to the increase in pilots and maintenance personnel, additional funding, flying hours and resources will be provided when the number of assigned aircraft is increased. The operating budget is funded on a dollars per flying hour basis. The flying hour program (FHP) is directly proportional to the number of PAA at the base. The total flying hour budget is based upon a per dollar rate times the total Flying Hour Program. As the number of aircraft increases, the support funding will increase proportionally.

Therefore, as the number of F-16 aircraft assigned PAA to the 388th FW increases, the number of pilots, maintenance personnel, flying hours and the amount of support funding will increase proportionally. These are determining factors in the number of sorties flown and a change in them will result in a directly proportional change in sorties flown.

Occasionally, the Air Force will assign one or more extra aircraft to a wing which are not counted as PAA. These are known as backup aircraft inventory (BAI) aircraft. When these are assigned to a wing, no additional pilots, maintenance personnel, support funding or flying hours are given to the wing.

(d) Provide an estimate of the number of flights through Skull Valley and to the UTTR South over the proposed life of the facility based on the new data for additional F-16 deployment.

Response

An estimate of the number of flights through Skull Valley and to the UTTR South must be based on the assumption that the number of flights (sorties) through Skull Valley and into the

UTTR South is proportional to the number of F-16s at Hill AFB. (See response to question 1b, above). The number of F-16s at Hill AFB will not be more than the number assigned to the Fighter Wings there (with the exception of possible BAI aircraft as discussed in 1(c) above, which do not affect numbers of sorties), and will be less as some of those aircraft are deployed to other locations for various military reasons. The best information at this time is that the maximum number of F-16s assigned PAA to Hill AFB will be 81 (see 1(a) above). There is no information to indicate that aircraft will be added or removed from either Fighter Wing at Hill AFB in the foreseeable future. Nor is there any information to indicate that additional wings will be stationed at Hill AFB.

Based on this, PFS estimates that the number of sorties through Skull Valley and to the UTTR South will be not more than that seen in FY 2000, as adjusted for the newly assigned aircraft, and probably less as a result of probable aircraft deployments for extended periods of time to other locations. Hence, PFS has projected sortie counts as an average of FY 1999 and FY2000 counts, adjusted for the newly assigned aircraft. This projection is valid for the foreseeable future. Since the proposed life of the facility is 40 years, projections for that length of time are necessarily limited.

(e) Provide data on the number of F-16 sorties flown through Skull Valley each year from FY 1998 to FY 2000 and the number of aircraft stationed at Hill AFB for the same years.

(f) Provide a breakdown of the number of flights to the UTTR South area including number of hours spent in each discreet area of restricted air space in FY 1999 and FY 2000.

(g) Discuss whether the number of hours spent in air-to-air and air-to-ground combat training on the UTTR South area increases proportionally with the total number of F-16 sorties flown through Skull Valley.

Response

Questions 1(e), (f), and (g) will be answered upon the receipt of responses to PFS Freedom of Information Act (FOIA) requests to the U.S. Air Force and U.S. Army.

2. Provide the following items which are related to the effect on the aircraft crash probability at PFSF from aircraft sorties flown in IR-420:

(a) Specify the number of flights through IR-420 in FY 2000.

(b) Identify and describe any routes other than Skull Valley and IR-420 by which aircraft enter the UTTR South area and provide the associated traffic rates in relation to the known air traffic rate for Skull Valley.

(c) Specify whether all of the aircraft going to Michael Army Air Field through IR-420 are transport aircraft.

Response

Questions 2(a), (b), and (c) will be answered upon the receipt of responses to PFS FOIA requests to the U.S. Air Force.

CALIBRATION AND TARGETING

3. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from turning point maneuvers of F-16 aircraft:

(a) Define and discuss the meaning of "turning point in Skull Valley" and discuss the maneuvers associated with this term, as referenced in Cole et al.

Response

The term "turning point" is used to indicate a navigation point as part of the route of flight. The normal route of flight for transiting Skull Valley is to pick up a south, southwesterly heading while over the western portion of the Great Salt Lake and enter Skull Valley from the north. From the northern portion of the valley, pilots will turn to a southerly heading and fly toward the narrow neck of the airspace east of English Village on Dugway Proving Ground (a/k/a Dugway). If desired, pilots may select a turn point somewhere in the valley. This point is normally visually identifiable such as a road intersection, a ranch or any other recognizable feature. Pilots will occasionally select a turn point that is only an intertial navigation system (INS). See response to question 4 for an explanation of the INS point that does not have any visually distinctive characteristics. As an example, a pilot may select a turn point in the narrow neck portion of the Sevier B MOA, southeast of English Village, to have an INS point that could be used to ensure the flight stayed within the narrow corridor. Having an INS turn point is especially useful when navigating unfamiliar terrain as it allows the pilot to track his progress with the onboard navigation systems.

The great majority of the time, the weather[1] permits pilots to navigate through Skull Valley using only visual references, without requiring a turning point in Skull Valley. The Stansbury and Cedar Mountains provide excellent visual references that enable pilots to maintain their positional awareness and obviate the need for a turning point in Skull Valley. On the other hand, pilots always have the option of using a turn point in Skull Valley even when the weather is clear.

When approaching a turn point, the pilot will typically do the following things: confirm he is on course and on-time, monitor the position of his flight members, plan and clear his flight path for the turn to the next heading, and select the next INS steer point.

(b) Verify whether the Air Force will use the proposed PFSF as a turning point in Skull Valley and if this would result in flights directly over the proposed PFSF.

[1] Refer to the responses to question 9 for a more detailed discussion on the weather conditions in Skull Valley and their impact on flight operations.

Response

As stated in the Report[2], the primary route of flight in Skull Valley is down the eastern portion of the valley toward the Stansbury Mountains. An overview of the airspace and geography of the area is helpful in understanding why this is the predominant route of flight.

The MOA is significantly wider at the northern portion of Skull Valley than at the southern end, narrowing from approximately 17 statue miles to 7 statute miles[3]. As a result of this narrowing, the operational utility of the airspace west of Skull Valley Road, located in the center of the valley and under which the PFSF site is located, decreases significantly toward the southern portion of Skull Valley, up to the point where Skull Valley Road is itself underneath the restricted airspace of R-6402. Since the airspace "funnels" the flights eastward as they approach the southern portion of valley, flights tend to favor the eastern portion of the airspace as they transit from north to south.

Pilots may or may not elect to have a turn point in Skull Valley. If they elect to have a turn point in Skull Valley, they may or may not select the proposed Private Fuel Storage Facility as that turn point. While the proposed facility would have the advantage of being larger than any other man-made feature in the valley, the close proximity of restricted airspace to the west and the south (within 2 miles of the site) is a disadvantage that does not affect other potential turn points. In addition, if the proposed PFS site was one of the planned turn points, it would require a second turn point approximately 10 miles southeast of the PFSF (at which point the pilot would turn back to a more southerly heading) to stay within the MOA.

Further, pilots tend to perform a variety of checks and routine maneuvers (e.g. G awareness maneuver) in Skull Valley that are intended to prepare for the tactical training portion of the mission. The Stansbury and Cedar mountains are more than adequate references for pilots to maintain their positional awareness during these maneuvers and checks. Thus a turn point in the valley is not required.

Pilots normally fly toward their selected turn points. Therefore, it would be expected that if pilots selected the PFSF as a turning point, they would fly toward and perhaps over the PFSF site. Due to the proximity of the restricted airspace however, pilots may elect to turn prior to reaching the facility.

While it is not unreasonable to assume that some of the pilots may select the proposed PFSF as a turn point; given the shape of the MOA and the proximity of the restricted airspace, there is no compelling reason to assume that building the PFSF will cause a significant change in the historic flight patterns. Use of the PFSF as a turn point adds little for the types of flying normally done in Skull Valley.

[2] Aircraft Crash Impact Hazard at the Private Fuel Storage Facility, August 10, 2000 (Revision 4), page 5.

[3] Refer to Question 8 for a more detailed description of the airspace over Skull Valley.

4. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from navigation sensor calibrations on F-16 aircraft:

Response

Before addressing the specific items in question 4, the Inertial Navigation System (INS) is the basis for the onboard F-16 navigation capability. The INS is aligned to the aircraft's current position after engine start. After being aligned, the INS continuously updates the aircraft position and velocity based upon accelerations sensed by its internal gyroscopes. In addition, to knowing the aircraft's current position, the INS data is used to compute the bearing and distance to the selected steer points[4].

The Block 40 F-16 flown by the 388FW is capable of receiving and using the Global Positioning System (GPS) navigation signal. The GPS can be used to automatically update the INS's current or "present" position in the event of an INS "drift error"[5]. This is the normal mode of operation for the 388FW[6].

(a) Define and discuss the meanings of "sensor alignment," "reference point for navigation," and navigational system steer points," as referenced in Cole et al.

Response

The term sensor alignment is used to refer to the pilot monitoring and ensuring that the INS present position is accurate. Pilots typically do this visually[7] by using the information depicted on the Head Up Display (HUD)[8] to cross check the INS system. However, pilots may do this using the radar if the selected steer point is capable of being detected by the radar[9].

A "reference point for navigation" can be any identifiable point that can assist in navigation. Road intersections, water towers, mountain ranges and peaks, bodies of water,

---

[4] The route of flight for each mission is programmed into the INS as a series of steer points (destinations). The pilot normally has the next steer point on the route of flight selected, although, he may select any steer point. Steer points are also known as turning points or navigation points.

[5] An INS normally has a small drift error measurable in the feet per second range. In essence, it is common for an INS to sense a small velocity when the aircraft is in fact stationary. Over time the cumulative effect of this drift translates into an error in the current or present position. The present position error can be corrected by updating the INS. However, INS updates only correct the position error, they do not correct the inherent drift problem.

[6] The 419FW has the Block 30 aircraft which is not GPS capable. If the INS present position has drifted, the pilot must update the INS manually. This can be done either visually or using the radar.

[7] In order for the selected steer point to be displayed in the HUD, it must be within 15° of the nose of the aircraft (the HUD field of view is 30° wide) and no lower than approximately −11° in elevation, the point at which it starts to be blanked by the aircraft radome. As a practical matter, it is normally within a few degrees laterally of the nose and approximately −5° to −10° in elevation when this is accomplished.

[8] A "TD Box" is displayed on the F-16 Head Up Display (HUD) where the system calculates the INS steer point to be located. If the TD box is not over the actual steer point (e.g. building, road intersection, etc.) then either the target coordinates are incorrect, there is an INS present position error, or a combination of the two.

[9] Refer to question 9(c) for a more detailed discussion of the F-16 radar.

buildings or cities, etc. are all examples of "reference points for navigation". These points may or may not be programmed as one of the INS steer points but provide the pilot with visual cues that enable him to maintain his positional awareness.

"Navigation system steer points" are the steer point latitude and longitude coordinates programmed into the INS. The intended route of flight is normally programmed as a sequential series of points. Additional points of interest, such as potential divert or emergency airfields, are generally programmed as well.

(b) Discuss whether it is a standard practice for pilots to calibrate aircraft sensors during flight or during pre-flight on the ground.

Response

The INS and the LANTIRN (Low Altitude Navigation and Targeting Infrared Night) system are the primary sensors of interest concerning calibration on the ground and in-flight. INS calibration was discussed in the introduction to the response to question 4 and in the response to question 4(a).

The LANTIRN system has two components, the navigation pod and the targeting pod. The navigation pod is used at night to assist with navigation. The navigation pod is a relatively wide field of view (28°) imaging infrared (IIR) sensor that projects the IR image on the HUD, thereby enabling the pilot to visualize the terrain ahead. Since the navigation pod is mounted below and to the side of the aircraft fuselage, a small parallax error may cause the IR image to be slightly offset in the HUD (e.g., the IR image of a tower directly in front of the aircraft may not be exactly overlaid on the actual water tower). The pilot can easily correct this with a one-time adjustment either on the ground or in the air.

The targeting pod is used for laser guided bombs[10]. The targeting pod is normally positioned (boresighted) to look at the selected INS steer point; the pilot does not have any capability to adjust this automatic positioning function[11]. The pilot can, however, adjust the targeting pod focus. The targeting pod initial focus setting is in the middle of the adjustable range when the pod is first turned on. This initial focus setting is normally adequate for successful operation of the system. Pilots can manually adjust the focus if desired. If the pilot elects to focus the targeting pod, he will normally attempt to do this at approximately 6-8 miles[12]

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

[11] The pilot can take control of the targeting pod sensor and position it as desired. He can also command it to track an object. Neither of these affect the boresight however.

[12] The aircraft does not need to be pointed at the point of interest to focus the pod, it must however be within the gimble limits of the targeting pod which can swivel to see most of the sphere below the aircraft. As a practical matter the pilot is normally pointed toward the INS steer point and it is within the HUD field of view. If a flight of two aircraft was flying a line abreast formation with 2nm separation between aircraft, the flight was 8nm from the

Footnote continued on next page

from the selected point of interest. This is the range at which he would be finalizing his target tracking solution if this was a bombing pass. Focusing the targeting pod is normally a once per mission event, and may be accomplished on the ground or in the air, if required.

As discussed in the answer to question 4(e), a pilot might use the PFSF to focus his targeting pod, but there would be no requirement that he do so.

(c) Discuss whether pilots currently calibrate aircraft navigational sensors and the targeting pod during flight.

Response

As discussed in 4(a), the INS is normally automatically updated by the GPS system both on the ground and in the air. The 419FW pilots must manually update their INS if there is a present position error. In either case, pilots will routinely monitor the INS during flight to ensure there are no malfunctions.

As discussed in response to question 4(b), the targeting pod does not necessarily require focusing. On those occasions when it does, the pod may be focused on the ground or in the air. As a practical matter, pilots normally check and adjust the targeting pod focus on the ground prior to takeoff.

(d) Describe the pilot's current actions while flying through Skull Valley, including activities associated with the calibration of navigational instruments.

Response

As noted in the Report[13] Skull Valley is used primarily as a transition corridor to the southern UTTR. Many of the pilot actions are geared toward completing checks and maneuvers in preparation for the tactical training portion of the mission, the demanding portions of which typically occur within the confines of the restricted airspace to the west of Skull Valley.

The following is a typical sequence of events for flights transiting Skull Valley. It is a representative sequence that includes the types of things normally done in Skull Valley. Flight leads have a significant degree of latitude in determining what will be done and when, as long as those things required by existing policies and regulations are accomplished. However, there tend to be generally accepted ways of doing business. Flight leads tend to accomplish administrative requirements such as fence checks, G awareness turns, etc. early in the flight to minimize impact on the tactical maneuvering portions of the mission.

Footnote continued from previous page

steer point, and the steer point was between the paths of the two aircraft, each aircraft would be pointed one mile to the side of the steer point, which would be approximately 7°-8° laterally off the nose.

[13] Aircraft Crash Impact Hazard at the Private Fuel Storage Facility, August 10, 2000, (Revision 4), Tab E

1. As the flight approaches Skull Valley, they will change to a discrete radio frequency as directed by Clover Control for communication between each other and with the range controllers.

2. The flight leader will direct an "ops (operations) check". Pilots will confirm normal operations of the aircraft systems (hydraulic pressures, oil pressure, engine instruments, exhaust nozzle, etc.) and proper fuel distribution and fuel transfer from the external tanks[14].

3. The flight lead will then call for a "fence check". During the fence check, the pilot will position his aircraft offensive and defensive systems switches in preparation for combat as if he were "crossing the fence" into hostile territory. During the fence check the pilot will: select (but not arm) the appropriate air-to-air and surface attack weapons, confirm or select the desired radar submodes, confirm proper radar operation, check for proper HUD and radar symbology, adjust the threat warning system audio and visual displays, select the appropriate electronic countermeasures (ECM) pod settings, select the appropriate defensive countermeasures (chaff and flare) settings.

4. If not previously accomplished, the flight lead will then direct the flight to a tactical (spread out) formation. The flight will then accelerate and accomplish a G awareness maneuver[15].

5. Typically, this series of checks can be completed prior to passing English Village if the flight lead so desires and sequences them appropriately.

6. Depending on the programmed steer points and the mission profile, the flight may or may not verify Inertial Navigation System (INS) accuracy and focus the LANTIRN targeting pod[16], if required, in Skull Valley.

See question 4(e) for a discussion of the conduct of these activities if the PFSF were built in Skull Valley.

(e) Discuss and analyze the impact on the pilot's actions, if the proposed PFSF is constructed.

The analysis should consider any potential narrowing of the effective width of the flying area as a result of the proposed PFSF.

Response

[14] To check proper fuel distribution and external fuel tank transfer, the pilot must rotate the fuel quantity select knob to the desired position, let the reading stabilizes (typically a few seconds), and rotate it to the next position, until complete. This can be accomplished in approximately 15-20 seconds.

[15] Refer to answer 6c for a more detailed discussion of the G Awareness maneuver.

[16] Refer to answers 4b and 4c for a more detailed discussion on focusing the LANTIRN targeting pod.

As noted in the Report[17], the predominant route of flight through Skull Valley is toward the eastern side of the valley along the Stansbury Mountains. This historic pattern is in part attributable to the eastern protrusion of restricted area R-6402 which significantly narrows the width of the Sevier MOAs in the vicinity of English Village. This narrowing funnels the traffic pattern toward the southern neck of Skull Valley which is easily identifiable by the southeastern end of the Cedar Mountains. As a result, pilots tend to point at and fly toward the narrow, southern portion of Skull Valley as they enter it from the north. This historic flight pattern is a function of the airspace shape, which is not affected by any man-made structures. Thus, the PFSF will not affect the effective width of the flying area in the valley.

The proposed PFSF location is relatively close to R-6402,[18] approximately halfway down the border between restricted airspace (R-6402) and the western Sevier B MOA boundary that slopes toward the southeast and funnels the flights toward the east. Although it is possible that some flights may elect to use the PFSF as a navigation point or to focus the LANTIRN targeting pod, there is no requirement for either[19]. In addition, the desire to verify the INS present position against a known point on the ground, or focus the targeting pod if required, would not obviate the requirement to avoid R-6402 west and south of the PFSF. Therefore, it is reasonable to assume that pilots using the site for this purpose would turn prior to reaching the site as stated by Lt. Col. Horstman[20] in his deposition.

In the event a flight leader decided to use the PFSF as an INS steer point or to align his sensors, it is reasonable to assume that every pilot in the flight would have specific knowledge and awareness of the PFSF location as they entered Skull Valley. As noted in the Report[21], due to the small area of the PFSF, only a small turn of a few degrees would be required to avoid the site in the event of an emergency.

In addition, in the event a flight decided to use the PFSF as a reference point for either navigation or to focus the targeting pod, at least 50% of aircraft in those flights that use the PFSF as such a reference would not be pointed at the site[22] (i.e. if the flight lead is pointed directly at the site, his wingman, nominally 9,000 ft. line abreast of the leader, would be pointed in the general direction of the site but over a mile to the side of the site). It is quite possible that neither aircraft would be pointed directly at the site even though both aircraft may be pointed in the general direction of the site[23].

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[17] Aircraft Crash Impact Hazard Report at the Private Fuel Storage Facility, August 10, 2000, (Revision 4), page 5.

[18] Refer to question 8 for a more detailed discussion of Skull Valley and the Sevier MOA dimensions.

[19] Refer to questions 4(b) and 4(c).

[20] Deposition of Hugh Horstman (Dec. 11, 2000) at 229-30.

[21] Report at 22-23 & n.28.

[22] Lateral separation between aircraft is nominally 9,000 ft., approximately six times wider than the PFSF. Depending on visibility and other environmental factors it may vary between 6,000 ft. and 12,000 ft. Due to the excellent visibility typically found at the UTTR, flights tend to favor the 9,000 ft.+ separation.

[23] See answer to question 4(c).

Alternatively, as noted in the answer to question 3(b), if the flight planned to use the PFSF as a navigation point, they would need a second turn point approximately 10 miles to the southeast to avoid the restricted airspace to the west and the south of the PFSF. With the prevailing excellent visibility associated with the UTTR, the flight lead may point his flight toward the narrow southern neck of Skull Valley, then individual flight members could select an INS steer point with the PFSF coordinates programmed to focus their targeting pod. From the northern portion of the MOA this would provide both flight members the opportunity to focus their targeting pods, if required, while maintaining a southerly heading and flying to the east of the proposed PFSF and avoiding the restricted airspace to the west and the south of the PFSF.

The basic airspace configuration over Skull Valley will continue to be the primary factor in determining the predominant aircraft flow. With the close proximity of the restricted airspace to the proposed PFSF, there is no compelling reason to assume that the historic aircraft flow will be fundamentally changed and shifted west to over fly the PFSF. Even those flights which elect to use the PFSF for INS alignment or to focus their targeting pods can be expected to frequently turn toward the narrow neck of the airspace prior to reaching the site.

5. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from targeting actions on F-16 aircraft:

(a) Discuss whether the pilots would point and target their aircraft instruments on the proposed PFSF and the circumstances for performing such action (e.g., only for updating instruments for turning, G-awareness maneuvers).

Response

The different circumstances in which pilot would point and target their aircraft instruments on the proposed PFSF are described in the answers to questions 4, 6 and 9. During G awareness turns, if the aircraft were to point at the PFSF it would only be momentary. As stated elsewhere, there is no requirement to use the proposed PFSF for any of the described purposes, although the pilot would have the option of doing so. A pilot who elected to use the proposed PFSF for updating his instruments would still need to remain cognizant of the restricted airspace to the west and to the south of the site.

(b) Discuss the range of distance(s) from the proposed site and length of time that the pilots would initiate and continue the point and target action.

Response

If the pilot were to use the proposed PFSF site as a navigation point, it is reasonable to assume he would be pointed toward the site from a location starting in the northern portion of the valley. As noted in the answer to question 4, a maximum of 50% of those aircraft in the flights that elected to use the PFSF as a navigation point would actually be pointed at the site. If the pilots in a flight elected to focus their targeting pods on the PFSF, they would need to have the targeting pod, not necessarily the aircraft, looking at the site for approximately 10 seconds (during which time the aircraft would fly approximately 1.1 nautical miles (assuming a speed of 400 knots)).

(c) Describe the pilots subsequent actions and aircraft maneuvers after pointing and targeting the proposed PFSF.

Response

The pilot actions are described in the answers to question 4.

AIRCRAFT MANEUVERS

6. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from certain aircraft maneuvers:

   (a) Discuss whether regrouping after maneuvering in a simulated engagement is similar to normal flight activities and whether it is consistent with the definition given in the DOE ACRAM study.

Response

The flight regrouping after maneuvering is a normal flight activity consistent with the ACRAM study definition of Normal flight. During air-to-air training, the aggressive maneuvering, often referred to as "tactical maneuvering", which takes place toward the center of the area, ceases when one of the flight members, normally the flight lead, transmits a "Terminate" radio call. The "terminate" call is subsequently acknowledged by all the flight members. The most common reason for the "terminate" call is the desired learning objective has been achieved, although other situations, such as a stalemate, or reaching the planned fuel for returning to base, etc. are also reasons for terminating the engagement[24]. In the less likely event a more serious situation that may compromise safety of flight has developed, cessation of the aggressive (tactical) maneuvering may be initiated with a "Knock it off" call[25]. In either case, the first two actions taken by the pilots are 1) visually ensure a clear flight path and 2) cease tactical maneuvering,

After the tactical maneuvering has ceased, pilots will then reform their flight(s) and prepare for the next training event (also referred to as an "engagement"). If the next event is planned as a "within visual range" engagement, then pilots will maintain visual contact with each other while positioning themselves with respect to each other and within the area. Typically, this will include climbing up to the desired altitude; checking fuel and engine operation, etc., and briefly discussing the previous engagement and/or the upcoming engagement. During this phase of flight, visual contact is maintained by the pilots and separation of aircraft tends to be in the 1 mile range[26]. Maneuvering is generally minimized and designed to keep the flight toward the center of the area.

In the event the next engagement is to start beyond visual range, typically in excess of 25nm separation, the flights will proceed toward their designated start (rendezvous) points. En route to the points, pilots will perform the same checks and tasks discussed in the previous paragraph. Once at their respective start points, the flights will establish benign maneuvering

[24] Air Force Instruction 11-214, 28 February 1997, *Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Air Operations*, paragraphs 2.7.3.4 and 2.7.3.5

[25] *Ibid*, paragraphs 2.7.3.2 and 2.7.3.3

[26] This is at the flight lead's discretion; a mile separation enables the pilots to relax while climbing to altitude, perform the required checks, etc. without having to fully concentrate on the lead aircraft. Many flight leads will use a variation of a lead-trail formation for this maneuvering, although some prefer a line abreast.

orbits until such time as everyone is ready for the next engagement[27]. At that time, a "fight's on" call is transmitted and the flights will turn towards each other if they have not done so already. At that point, the pilots will maneuver as planned to accomplish their objectives. Typically, the aggressive maneuvering associated with simulated aerial combat will take place toward the center of the area after the flights merge well away from the starting points.

(b) Specify whether the air space in Sevier B MOA near the proposed PFSF is authorized for conducting low altitude training, air-to-air combat training, and major exercises and if such exercises have been performed.

Response

As indicated in the Report[28], the airspace over Skull Valley is used primarily as a transition corridor for the South UTTR. Due to the small size and the shape of the airspace over Skull Valley it is not suitable for the tactical maneuvering typically associated with air-to-air combat training or surface attack training with the exception of low altitude navigation[29]. In addition, the high terrain on both sides further restricts the utility of the airspace, particularly that below 5,000 ft. AGL (Sevier B MOA), for tactical maneuvers other than low level navigation. Low level navigation at 1,000 ft. AGL (the minimum altitude in Skull Valley north of English Village) is a low risk event involving monitoring position, maintaining visual contact with your other flight members, and general situation awareness concerning the flight.

According to the U.S. Air Force, the preponderance of flights transiting Skull Valley use Sevier B MOA with a maximum altitude of 9,500 ft. MSL or 5,000 ft. AGL. Therefore, although not practical for the reasons stated above, only LIMITED[30] intercept maneuvering would be authorized if pilots were to attempt tactical air-to-air training in Skull Valley. LIMITED intercept maneuvering restricts pilots to a maximum of 180° of offensive or defensive turns, it prohibits exaggerated vertical maneuvering, and requires a minimum airspeed of 350KIAS[31]. This is significantly different from the UNRESTRICTED maneuvering associated with aggressive air-to-air combat training commonly referred to as "dog fighting" which must be conducted <u>above</u> 5,000 ft. AGL[32]. PFSF is unaware of any flights conducting intercept training in Skull Valley.

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[27] If for any reasons the pilots within a flight do not have visual contact with each other, they will maintain altitude separation until establishing visual contact. Pilots will use their radar, other onboard systems, and geographic references to aid them in establishing visual contact.

[28] Aircraft Crash Impact Hazard at the Private Fuel Storage Facility, August 10, 2000 (Revision 4), Tab E

[29] PFS is unaware of any unique restrictions on the types of maneuvering that can be conducted over Skull Valley except for the minimum altitude of 1,000' AGL.

[30] AFI 11-214, 23 February 1997, *Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Aircrews*, para 5.2.8.2

[31] AFI 11-2F-16 Volume 3, 1 July 1999, *F-16 Operations Procedures*, paragraph 5.3.2

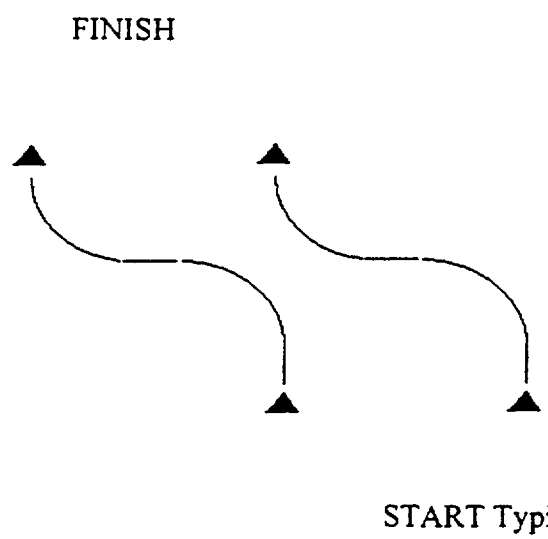
[32] AFI 11-214, 23 February 1997, *Aircrew, Weapons Director, and Terminal Attack Controller Procedures for Aircrews*, paragraphs 5.2.7.1 and 5.2.8.1

The airspace above Skull Valley is not suitable for large force exercises except for use as the southern UTTR access corridor previously discussed. Large force exercises typically involve twelve or more aircraft and require larger amounts of airspace for maneuvering purposes than the typical flight of two or four aircraft. Thus, Skull Valley is not suitable for the large force exercise tactical maneuvering such as intercepts or simulated bombing attacks. This type of training is conducted in the larger, more suitable areas of the UTTR.

(c) Describe the consequences if a pilot fails to withstand G forces or if the pilot's anti-G suit does not operate properly during G-awareness maneuvers in Skull Valley.

Response

A G Awareness maneuver is a series of two turns. A typical G Awareness series in Skull Valley would consist of the following steps. First, the leader would direct his flight members into one of several "spread out" formations. Distance between flight members is generally a few thousand feet up to approximately two miles. Second, the flight will accelerate to approximately 425 kts. Although there is no prescribed initiating airspeed, pilots will generally start the turn with the airspeed between 400KCAS (kts. calibrated airspeed) and 450KCAS. Pilots will then roll into approximately 90° of bank, advance the throttle to military power (maximum power without using the afterburner), and start a 4-5 G turn for 90 degrees. They then roll-out, accelerate, and start a second 90 degree turn normally in the opposite direction. After the second turn, the maneuver is complete and they are back on the original heading.



Typical G Awareness Maneuver

As noted in the aircraft hazard Report by the Air Combat Command Chief of Safety[33], "G Awareness turns are not high risk, but merely a warm-up exercise...". This is supported by Col.

[33] HQ ACC Chief of Safety Memorandum 15 Oct 99, Aircraft Crash Impact Hazard at the Private Fuel Storage Facility, August 10, 2000 (Revision 4), Tab F

Fly's (USAF, retired) memorandum[34] which indicates that G Awareness turns fall into the "...routine and administrative categories, both of which are low risk phases of flight."

The 4-5 G's experienced for a relatively short period of time during these maneuvers are easily tolerated by the pilots. Pilots undergo extensive training on how to withstand high G forces for longer time periods. This training includes academic sessions, centrifuge training during which pilots are subjected to 8-9 G's for up to 20 seconds and videotaped for debriefing purposes, and periodic monitoring of proper breathing techniques by reviewing mission videotapes. Pilots routinely experience significantly higher G forces, typically 7+ G's, during simulated aerial combat maneuvering.

In the event a pilot's G suit did not perform normally during a G awareness turn, he would not be at risk during the maneuver. The maneuvers are designed to check for proper G suit operations at a low enough G loading, that given the pilot's ability to sustain G forces, the maneuver can ensure everything is working properly without putting the pilot at risk. If the G suit did not perform properly, the first thing a pilot would do is to check his G suit connections. An improperly connected G suit or a pinched connection hose are the most probable cause of a failure. Actual failure of the pressured air system that inflates the G suit is rare. If the pilot determined that it has failed, his actions would depend upon the rest of the mission. If the remainder of the mission was benign, such as medium altitude tactics, employing laser guided bombs, the mission may be continued without any changes. Conversely, if the mission was planned as simulated air-to-air combat, which normally involves sustained high G maneuvering, the mission profile may be modified to less demanding intercepts without any simulated air-to-air combat. If the pilot was part of a larger flight and changing everyone's mission was unacceptable, the pilot may depart from the rest of the flight and complete an alternate mission such as instrument training. It is worth reiterating that this failure of the G system is rare.

[34] October 21, 1999 Memorandum, Aircraft Crash Impact Hazard at the Private Fuel Storage Facility, August 10, 2000 (Revision 4), Tab E

AIRCRAFT ORDNANCE

7. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from aircraft ordnance:

(a) Provide a breakdown of the live and inert ordnance (e.g., numbers of each type such as MK84, CBU, etc.) carried by F-16 aircraft while transiting through Skull Valley in FY 2000, including the number of flights that carried each type.

(b) Specify whether the same types and proportional mix of ordnance were used in both FY 2000 and FY 1998.

Response

Questions 7(a) and (b) will be answered upon the receipt of responses to PFS Freedom of Information Act (FOIA) requests to the U.S. Air Force.

(c) Describe a typical impact angle of an ordnance dropped from an F-16 and compare it to the impact angle of an F-16 crash.

Response

The impact angle, as measured from the horizontal, of ordnance dropped from an F-16 in Skull Valley will vary by the altitude at which it is released, whether the plane is in level flight or climbing, and the speed of the aircraft at the point of release. Other things being equal, the higher the altitude, the steeper the angle of impact. Using level flight as a reference, if the plane is climbing, the impact angle will be steeper (because of lofting the ordnance). Again, other things being equal, the faster the aircraft as the point of jettisoning, the shallower the impact angle.

F-16s in Skull Valley generally fly 350 to 400 knots and 3,000 ft. to 4,000 ft. AGL in level flight. (Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Report), page 19b). There may of course be some flights at lower altitudes, down to 1,000 ft. AGL or if the Sevier D MOA airspace is used, up to 14,000 ft. AGL.

Using the conservative bounds of the generally flown speeds and altitudes, 400 knots at 3,000 ft., the impact angle of a Mark 84 2,000-pound bomb would be 34 degrees (i.e., 56 degrees from the vertical), as measured by the Joint Munitions Effects Manual Trajectory Model, given by the Joint Technical Coordinating Group, Eglin AFB, FL. If the aircraft had engine failure and was beginning a zoom maneuver to climb at a 30-degree angle and was in a 15 degree climb at the point of release, the impact angle would be 37 degrees. PFS therefore feels that an angle in this range (34 to 37 degrees, or 53 to 56 degrees from the vertical) would be appropriate as a typical impact angle.

The impact angle of the Mark 82 500-pound bomb is essentially the same as the angle for the 2,000-lb. bomb if it is jettisoned singly. Both it and the Mark 84 will descend in a streamlined fashion because of their fin design and will achieve the lowest drag trajectory and therefore the shallowest impact angle possible. However, if Mark 82 bombs (3) were to be carried on a Triple Ejector Rack (TER), as is normally done, the entire rack and bomb assembly would be jettisoned as a unit with all three bombs still attached to the rack. Because the TER is a suspension device and was not designed for free-fall ballistic flight, the TER with the bombs attached would not streamline and would slow down quickly resulting in a steepening of the impact angle.

The net effect on the effective area of the PFSF (see pages 80-81 of the Report) of considering the impact angle of jettisoned ordnance is negligible. Assuming an impact angle of 34 degrees from the horizontal (the flattest of the impact angles discussed above), the depth of the cask storage area (the dimension of the cask storage area along the F-16 flight path and hence the trajectory of the jettisoned ordnance) would increase by an amount equal to the height of a spent fuel storage cask divided by the tangent of the impact angle. The height of a storage cask is 19.6 ft. (Report p. 15). The tangent of 34 degrees is 0.675. Thus, the cask storage area effective depth would increase by 29.1 ft (19.6 ft./0.675). The depth of the cask storage area is 1,590 ft. (Report p. 82). Thus, considering the impact angle of jettisoned ordnance increases the effective depth of the cask storage area, and hence the effective area of the cask storage area, at most, by 1.8 percent ((1,590 + 29.1)/1,590).

The impact angle, as measured from the horizontal, of the F-16 itself during an inflight crash was taken from Accident Analysis for Aircraft Crash into Hazardous Facilities, DOE STD-3014-96 (1996) and is 6 degrees 50 minutes. (Page B-29). The cotangent of this angle was used in PFS's calculation of effective areas. (Report, page 15). This number was developed in the Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard (1996) through the study of many small military aircraft crashes. (ACRAM Pages 4-23 and 4-24).

WIDTH OF USABLE AIR SPACE

8. Specify the width of usable air space in Skull Valley at the navigational latitude where the proposed site would be located and at a point 10 miles north of the proposed site.

> This information pertains to the relationship of usable air space to the aircraft crash probability at the proposed PFSF.

Response

The Sevier B MOA in Skull Valley is 12 statute miles wide at the latitude of the PFSF. (Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Report), page 6) At this latitude, the PFSF sits in the Valley at a point 2 miles to the east of the western boundary of the MOA, at an altitude of 4,500 ft. MSL. The top of the MOA is established at 9,500 ft. above sea level (MSL). Air Force Instructions pertinent to the UTTR establish a floor at 1,000 ft. AGL below which aircraft may not fly through Skull Valley. Rising terrain on the east side of the MOA intersects the top of the MOA 10 miles to the east of the PFSF at 9,500 ft. MSL (5,000 ft. above the PFSF) at the MOA's eastern limit (see Report, Figure 1. Note the greatly exaggerated vertical scale (representing less than 1 mile of altitude) on this figure). Because of the rising terrain, flight is not practical at all altitudes from 1,000 ft. to 5,000 ft. above the PFSF for the entire width of the MOA. While an F-16 could in fact fly in the MOA airspace at a point over 9 miles east of the PFSF, implying a usable width of the airway of over 11 miles, PFS has chosen to assume a more conservative 10 mile value for the usable width.

TAB A of the Report depicts Sevier B MOA in Skull Valley. The northern border of the MOA, which slants from its northwestern tip in an east-southeasterly direction in the Valley, is 17.5 statute miles long. The eastern edge then goes southward in a straight line along the Stansbury Mountains ridge while the western edge slants to the southeast, closing on the eastern edge until it reaches a point 10 statue miles south of the PFSF, east of the valley road and near English Village on Dugway Proving Ground.

If F-16s do fly above the Sevier B MOA, in the Sevier D MOA airspace, they are not constrained by the terrain and hence have the full 12 mile width of the MOA available as usable airspace. In fact, if the pilots were operating under visual flight rules (VFR) above Sevier B, they could fly to the east of the Stansbury mountains (i.e., to the east of the MOA) if needed or desired, using an even wider airway width.

At a latitude 10 statute miles north of the PFSF, the eastern edge of the Valley is just north of the northern boundary of the Sevier B MOA (i.e., the edge of the Valley is outside the MOA). Measuring from the western edge of the MOA (which is up against the Restricted area R-6406B) at this latitude to the other side of the valley at the crest of the Stansbury Mountains in the east, the distance is 17.0 statute miles. (The valley itself is 18.2 statute miles wide, ridge to ridge from the Stansbury Mountains to the Cedar Mountains, but F-16s cannot use the westernmost 1.1 miles because of the restricted area R-6406B).

Beginning on the west side of the Valley, in the MOA and next to the Cedar Mountains, the terrain is at 5,500 ft. MSL. It drops to 4,500 ft. in 3.7 statute miles and is generally flat for 7.2 miles, reaching a low of about 4,300 ft. at the floor of the valley. At a point 10.9 miles from the western edge of the Valley, it begins a rise from 4,500 ft. to 5,500 ft. in 2.7 miles. It levels at just above 5,500 ft. for 0.3 miles, then climbs again over the next 3.1 miles to reach 8,000 ft. MSL at the crest of the Stansbury Mountains. Because of this geometry at this latitude, the entire width of the MOA is usable airspace. In addition, the portions of the airspace just to the north of the MOA are not limited by the MOA maximum altitude, although in practice aircraft transiting the Valley will be close to or below it because of the short distance until they are in the MOA.

At a latitude 10 statute miles south of the PFSF, the Sevier B narrows to its narrowest width. At this latitude it is 7.1 statute miles wide. Hence, within a north-south distance of 20 statute miles, the MOA has narrowed by almost 10 statute miles.

The terrain within the MOA here is basically flat. At the western edge of the MOA it is at about 4,800 ft.. It rises to 5,000 ft. in 4.6 sm., then continues a gradual climb to 5,800 ft at the eastern edge of the MOA. Hence, the entire width of the MOA at this latitude is usable airspace.

CLOUD COVER

9. Provide the following items which are related to the aircraft crash probability at the proposed PFSF from cloud cover in the Skull Valley region:

(a) Define and discuss the meaning of "5/10 cloud cover" as referenced in Cole et al.

Response

Weather is measured in terms of cloud cover and visibility. Cloud cover is normally reported in feet above ground level and the percent of sky covered (in eighths or tenths). 5/10 cloud cover means five tenths (half) of the sky is covered by clouds at some specified altitude Above Ground Level (AGL). This represents a summation of cloud cover up to that altitude where it covers half the sky. For example, 2/10th's cloud cover at 3,000 ft. AGL and 3/10th's cloud cover at 5,000 ft. AGL would constitute 5/10th's cloud cover at 5,000 ft. AGL with half the sky covered at 5,000 ft. AGL. A "ceiling" is defined as the summation of sky cover totaling more than half the sky, and is labeled "broken" or "overcast." Department of Transportation/Federal Aviation Administration Order 7900.5A defines "broken" as sky cover 5/8th's to 7/8th's and "overcast" as sky cover of 8/8th's. Air Force Manual 15-111 defines "broken" as "a summation of sky cover of 5/8th's through less than 8/8th's" and "overcast" as "a summation of sky cover of 8/8th's."

(b) Discuss whether pilots fly under IFR or VFR rules if there is cloud cover in Skull Valley.

Response

As a general rule pilots fly under visual flight rules (VFR) in Skull Valley and on the UTTR when conducting training missions. Most tactical maneuvering for combat training requires the pilot to be VFR.

The visibility and ceiling on the UTTR are normally excellent[35]. However, it is worth noting that pilots often conduct training and maintain VFR when there are clouds present. All that is required is for the pilot to maintain the required separation from clouds. In fact, it is possible to conduct VFR operations on top of a complete undercast, if the weather above the undercast permits.

According to the Air Force, F-16s typically transit Skull Valley via the Sevier B MOA (i.e., 1,000 to 5,000 ft. AGL). As noted in the detailed Air Weather Service (AWS) ceiling and visibility data for Dugway Proving Ground, the ceiling is greater (higher) than 5,000 ft. AGL (9,500 ft. MSL in the Sevier B MOA) with 7 statute miles or greater visibility 91.5% of the time. Further, the data also shows that there is no ceiling, with a visibility of 7 statute miles, more than 70% of the time. Thus, pilots can transit through Skull Valley under visual flight rules the vast majority of the time.

[35] Air Weather Service, Ceiling and Visibility Data for Dugway Proving Ground (attached).

To remain under VFR in Skull Valley, the pilot must have 3 miles in-flight visibility and be able to maintain clearance 500 ft. below, 1,000 ft. above, and 2,000 ft. horizontal from clouds. For example, a pilot could fly at 1,500 ft. AGL below a 2000 ft. AGL cloud deck and remain VFR. In addition, as noted above, if the clouds were all low, the pilot could fly above them and remain VFR. If the weather and cloud cover in Skull Valley are such that a pilot can not proceed VFR, then the pilot must request and secure an Instrument Flight Rules (IFR) clearance from Air Traffic Control to continue the flight. This is accomplished by contacting the nearest air traffic control facility such as Clover Control or Salt Lake City Approach Control or Salt Lake City Center. With an IFR clearance the pilot will be under radar control and receive radar separation from other aircraft. Under an IFR clearance, there is no requirement to maintain visual references, and the pilot can fly entirely in the clouds. (Source: AFR 60-16/AFI 11-206, 25 JUL 94). However, because of the high terrain on both sides of Skull Valley, the minimum IFR altitude for a significant portion of the valley must high enough to keep the pilots safely above the Stansbury and Cedar mountain ranges.

(c) Discuss whether the pilot can use radar to seek through cloud cover and aim the aircraft at a particular target.

Response

The radar does penetrate clouds and can be used to identify targets and other features on the ground. If the PFSF was programmed as one of the INS destinations (also referred to as steer points) and it was the currently selected destination[36], the site should be readily identifiable on the radar screen by the pilot. In the event the PFSF was not the currently selected INS destination, the PFSF may or may not be identifiable on the radar screen depending upon the location of the steer point and the current aircraft position.

The quality of the radar image depends on multiple factors including, but not limited to; distance to the target, vertical development of the target, target composition (type of materials), surroundings (water, buildings, hills, forests, etc.), approach heading, radar look angle (elevation and azimuth), etc. The ground map radar tends to be most useful at relatively shallow elevation angles, typically in the 0° to -15° range.

The F-16 radar has three basic submodes while operating in the ground map mode; ground map, expand, and doppler beam sharpening (DBS). In the basic ground map mode, the radar shows things such as land/water contrast and cultural returns (primarily buildings, roads may or may not show up). There is little clear definition to buildings, etc. even if they are relatively isolated. Buildings and other man made objects typically display as a few pixels that are brighter than those depicting ground returns. This enables the pilot to identify the building but it doesn't provide clear definition of the building shape.

[36] In the ground map mode, the radar will automatically center its sweep over the INS destination. Therefore, the PFSF structure should be identifiable on the radar scope.

The expand submode basically magnifies the area of interest as identified by the radar cursors[37] which the pilot controls[38]. In expand, it is easier to more precisely position the radar cursors if they are closely positioned to the intended steerpoint prior to selecting expand. Cultural returns tend to "bloom" in the expand mode which often makes it difficult to identify other objects within the field of view.

In the doppler beam sharpening mode, the radar presentation begins to look like a picture. Roads, buildings and other objects can start to be identified. Because of the way DBS is mechanized, the target must be a minimum of 5° off the nose for the system to work. The resolution improves by a factor of approximately eight when the target moves from 5° to at least 15° off the aircraft nose. The radar can be used to improve the INS navigation and steering cues provided to the pilot by precisely positioning the radar cursors over the designated steer point. As the radar cursors are moved, there is a proportional change in the steering cues.

(d) Discuss whether expected cloud cover at Skull Valley would be dense enough to prevent the pilots from visually locating PFSF and whether similar cloud cover would be present in ranges at UTTR South at the same time.

Response

As shown in the AWS Michael Army Airfield data, the limited cloud cover in Skull Valley allows pilots to visually locate the PFSF most of the time. As discussed in response to question 9(e), Sevier B MOA, has no ceiling, with 7 or more miles visibility, 91.5% of the time and it is the primary route airspace used while transiting Skull Valley. Furthermore, as also discussed in response to questions 9(a) above and 9(e) below (and as shown in the figures), a ceiling does not necessarily indicate a solid layer of clouds (i.e., an overcast). Thus even if a ceiling were present, it is possible that a pilot could see the PFSF site on the ground. Therefore, pilots should be able to visually locate the site the majority of the time. It is conceivable, however, that even though there is not enough cloud cover to constitute a ceiling, a cloud could be positioned to preclude visual contact with the PFSF at a particular moment. Clouds are generally dense enough that you can not see through them.

The weather conditions in Skull Valley are similar to those at Michael AAF and the South UTTR. However, the UTTR is large enough that the weather conditions may change as you get further away from Skull Valley.

(e) Examine the historical records for cloud cover in the UTTR and determine whether the UTTR South range would remain open for combat training under such weather events.

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[37] In the ground map mode, the radar cursors are normally automatically positioned over the selected Inertial Navigation System (INS) steerpoint or destination. The cursors consists of one vertical and one horizontal line on the radar display. They show the steerpoints relative azimuth and range from the nose of the aircraft. The cursor intersection represents the steerpoint position. The pilot may manually move and reposition the radar ground cursors if he so desires.

[38] Expand is a 4:1 expansion of the normal radar image.

Response

The detailed ceiling and visibility information for Michael AAF is a reasonable approximation for the weather in Skull Valley and the southern UTTR as discussed in the previous question. Figure 9-1[39] shows the vertical segregation of the airspace over Skull Valley with the associated historical ceiling and visibility for Sevier B MOA (ceiling above the MOA, visibility greater than 7 miles, 91.5% of the time) and the Positive Controlled Airspace (PCA) (no ceiling conditions observed, visibility greater than 7 miles, 70.5% of the time).

Figures 9-2 through 9-5 are examples of representative cloud coverage conditions[40] that could occur in the no ceiling and 7sm visibility conditions category. As shown in some of the examples, "no ceiling" does not necessarily mean "no clouds". A ceiling is defined as a cumulative coverage of 5/8ths (five eighths or approximately 60%). When there is no ceiling present, conditions are favorable for VFR operations.

Figures 9-9 through 9-12 show examples of the ceiling and visibility which correspond to the Sevier B MOA. As can be seen from the AWS data, this is the prevailing ceiling and visibility condition 91.5% of the time. In essence, pilots should be able to maintain VFR in the Sevier B MOA the vast majority of the time.

Figures 9-6 through 9-8 are examples of the ceiling and visibility at 14,000 ft. AGL, which is 500 ft. above the Positive Control Airspace[41] (which begins at 18,000 ft. MSL). Note that if there is "no ceiling," there is also no ceiling at 14,000 ft. By comparing the AWS data for ceiling above 14,000 ft. AGL with the no ceiling data, it can be deduced that only approximately 4% of the time is there a ceiling above 14,000 ft. AGL. Although there may be clouds below 14,000 ft. MSL, the lack of a ceiling at 14,000ft. with 7sm visibility indicates VFR operations can be conducted approximately 74% or more of the time.

As discussed in response to question 9(b), if there is a cloud layer or layers that preclude pilots from operating at specific altitudes, then they may operate VFR above or below those cloud layers as long as they meet the VFR weather requirements. Thus the presence of a ceiling does not necessarily prohibit VFR operations. As can be seen from the historical weather data, pilots have the option to fly through Skull Valley VFR approximately 91% or more of the time.

In the event weather conditions precluded VFR operations in Skull Valley, it is reasonable to assume that similar weather conditions would be present in the adjoining UTTR airspace. Therefore, you would anticipate the fighter squadrons would reduce their flying

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

[40] These are illustrative examples and are only intended to show some of the different types of cloud coverage conditions that could fall within the different ceiling and visibility categories.

[41] Flight in the PCA requires an IFR clearance unless operating in special use airspace such as a MOA or restricted airspace that extends above 18.000' MSL. Sevier B is the predominant route of flight through Skull Valley. If a pilot were to elect to fly VFR above Sevier B he must remain below 18,000' MSL to avoid the PCA.

activities accordingly. Since most of the tactical training requires VFR conditions, there would be little training accomplished if there was extensive vertical and horizontal cloud cover on the range. On the other hand, pilots do have requirements for instrument proficiency sorties, therefore some of those may be flown. In addition, there may be useable areas of airspace on the range that would support training for some flights.

(f) Discuss the flight restrictions during cloud cover and state whether a pilot has to fly at least 1,000 ft. below a cloud cover.

Response

As stated in response to question 9(b), to remain under Visual Flight Rules (VFR) in Skull Valley, a pilot must be able to maintain clearance at least 500 ft. below clouds. A pilot is also required, by Air Force Instructions, to maintain a minimum of 1,000 ft. AGL through Skull Valley in the vicinity of the PFSF. Consequently, a pilot could legally fly through Skull Valley at 1,000 ft. AGL with cloud cover if the ceiling (broken or overcast) cloud cover was as low as 1,500 ft. AGL.

As discussed in response to question 9(h) below, pilots may operate VFR above the clouds and maintain their positional awareness using on board systems. F-16s routinely operate VFR over clouds when required. It is routine, particularly in locations such as Germany, Korea and parts of the U.S. where there is more cloud cover than in Utah.

(g) Discuss whether a pilot experiencing engine trouble could avoid the proposed PFSF if there were a cloud cover at 3,000 ft. above ground level.

Response

A pilot would be able to avoid the proposed PFSF if there were a cloud cover at 3,000 feet above the ground.

If the pilot was operating VFR below the clouds and experienced engine trouble, he would have adequate time to respond to the problem and still avoid the PFSF if he was forced to eject. The amount of time available to the pilot would depend upon his altitude and airspeed when the problem occurred. Even using a "worst case" of 1,000 ft. AGL (the minimum altitude authorized in Skull Valley) and 350KCAS would provide the pilot with a minimum of 45 seconds to perform the required actions. This is more than enough time for the pilot to accurately assess his situation and make the small turn required to avoid the PFSF if he was pointing at it. Initial altitudes higher than 1,000 ft. or airspeeds greater than 350KCAS provide more time for the pilot to analyze the situation and take appropriate actions.

If the pilot is flying above a 3,000 ft. ceiling (broken or overcast) with no significant additional clouds above him, he could zoom in accordance with established procedures and after leveling off, commence airstart attempts. With a ceiling of only 3,000 ft. AGL, prominent terrain features such as the Cedar Mountains and the Stansbury Mountains, particularly Deseret Peak at 11,031 ft. would be readily visible to assist in confirming positional and situational awareness (see response to question 9(h) below). Moreover, as discussed in response to questions 9(b) and (e) above, a cloud ceiling is not necessarily a complete cloud cover (overcast) and it is possible that a pilot could see the PFSF even in the presence of a ceiling at 3,000 ft. The visual cues, coupled with navigation instrument displays would enable the pilot to steer away from the PFSF site.

(h) Provide the basis for the assertion that pilot positional awareness would be maintained when flying above the highest cloud cover by reliance on visual references to mountain ranges that are used for visual reference (e.g., will the mountain ranges extend above the highest cloud cover in Skull Valley).

Response

USAF pilots are trained to maintain situational and positional awareness at all times. They are also trained to "think ahead of the aircraft" and be cognizant of approaching terrain features or man made structures that can be used as an aid to navigation and position determination. Unless the pilot is flying above a total overcast (see 9(a) response), he will be able to see the ground to some extent. This will greatly aid in maintaining situational and positional awareness. Obviously, the pilot will be able to see more of the ground when flying above a scattered deck of clouds than a broken deck of clouds (see 9(a) response). Prominent mountain peaks can be particularly useful as well in maintaining situational and positional awareness. The Sevier B MOA extends up to 9,500 ft. MSL. Prominent mountain peaks include Deseret Peak at 11,031 ft. MSL east by northeast of the proposed PFSF site and the two peaks bounding Johnson Pass to the southeast of the proposed PFSF site at 10,330 ft. MSL to the north of the pass and 9,020 ft. MSL south of the pass. Deseret Peak is obviously the most visible followed by the other two peaks. Deseret Peak would also obviously be visible above a cloud deck at approximately 10,000 ft. MSL in the vicinity of the proposed PFSF site. Consequently, an F-16 pilot flying at 9,500 ft. MSL above a cloud deck at the very top of the Sevier B MOA would be able to see Deseret Peak and use it as a visual aid in determining situational and positional awareness. When a pilot is flying above cloud decks that are lower than 9,500 ft. MSL, Deseret Peak would be even more visible, and there will obviously be other prominent terrain features available, such as the two peaks bounding Johnson Pass.

In the event of an emergency, a pilot would be able to avoid the proposed PFSF site because of situational and positional awareness of where his aircraft is and where it is heading. The pilot would be able to do this without having to actually see the site itself, because he would know where it is relative to his known location.

The pilot 's ability to determine situational and positional awareness has improved continually over time due to constantly improving navigational equipment and better training. In years past, pilots flying propeller driven fighter aircraft and propeller driven transport aircraft often flew low level with no navigational aid assistance whatsoever and maintained situational and positional awareness by visual reference to the terrain alone. They also knew the locations of prominent terrain features such as mountain peaks and man made structures such as communications towers and were able to avoid them even in the event of adverse weather and inflight emergencies.

Today's pilots have far superior navigation equipment and better training than in years past to maintain situational and positional awareness and avoid prominent terrain features and man made structures. The F-16 has the TACAN (Tactical Air Navigation) System that provides bearing and distance information from the particular ground station that is selected at a given time. In addition, the F-16 is equipped with an INS (Inertial Navigation System). The INS is self-contained and uses a series of gyros to maintain a current position and flight direction and velocity. The INS can be used to either navigate to/from a selected set of latitude and longitude coordinates or maintain awareness of those coordinates' location. Some models of the F-16 are also equipped with a GPS (Global Positioning System) receiver. This uses the satellite navigation constellation to maintain positional awareness and help fine tune the INS position. During a typical mission pilots will use both visual references and on-board navigation systems in tandem to maintain their situational and positional awareness. Weather permitting, they will use prominent geographic features for general awareness and smaller features for more precise positioning while cross-checking and confirming their position using on-board systems such as TACAN and INS.

Air Weather Service Ceiling and Visibility Data for Dugway Proving Ground

:STA 690110 | DPG | DUGWAY PROVING GROUND , ,US
:LAT 40 12N :LONG 112 56W :ELEV 4349(ft) 1326(m) :TYPE AWS SCT V2.0 11051992
Percent Frequency of CEILING versus VISIBILITY (from HOURLY obs)

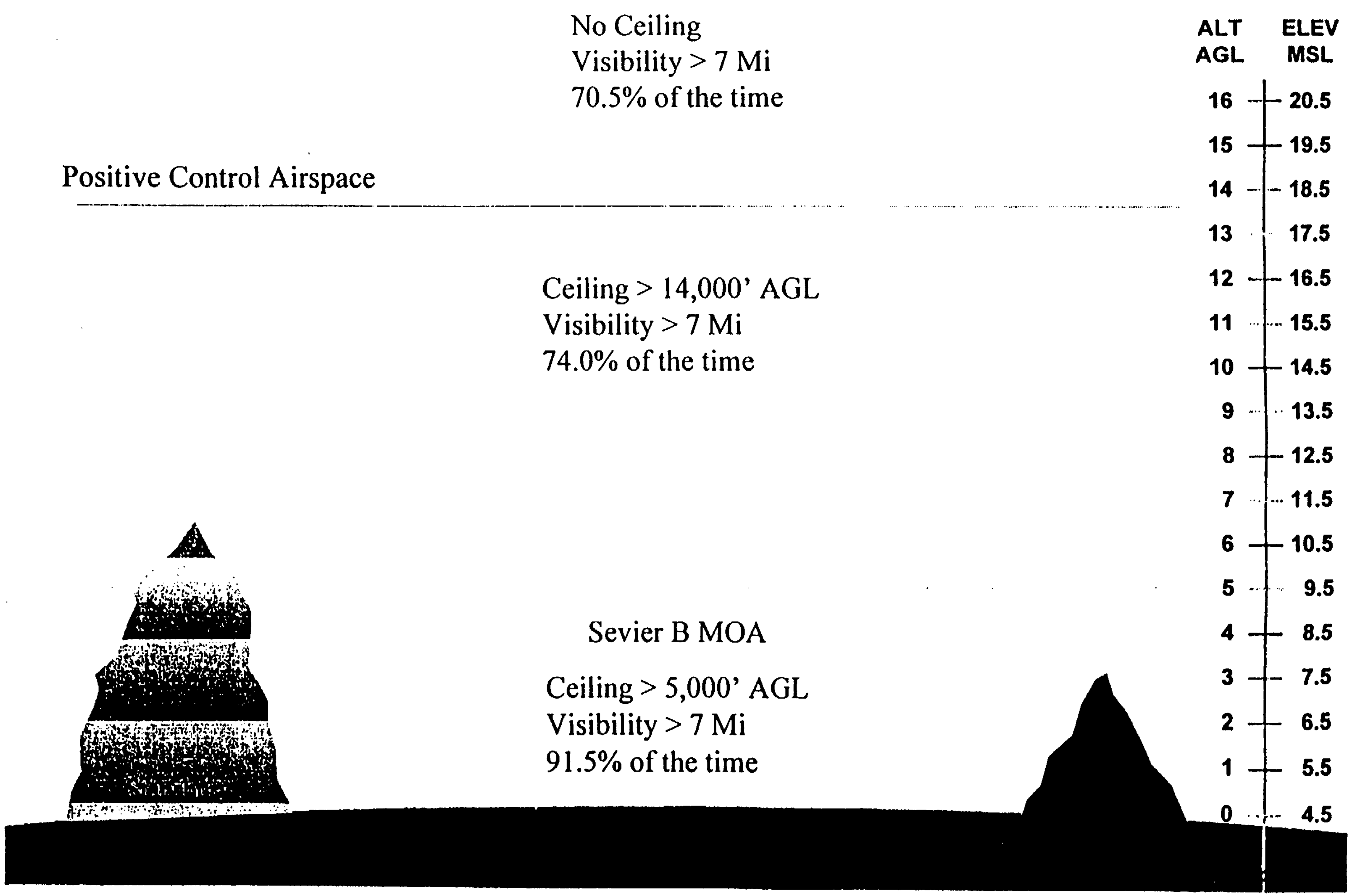
ALL

CEILING IN FEET	VISIBILITY IN STATUTE MILES GE 7	GE 6	GE 5	GE 4	GE 3	GE 2 1/2	GE 2	GE 1 1/2	GE 1 1/4	GE 1	GE 3/4	GE 5/8	GE 1/2	GE 3/8	GE 1/4	GE 0
NO CEIL	70.5	70.6	70.7	70.8	70.8	70.8	70.9	70.9	70.9	70.9	70.9	71.0	71.0	71.0	71.0	71.1
GE 20000	72.3	72.3	72.4	72.5	72.6	72.6	72.6	72.7	72.7	72.7	72.7	72.7	72.7	72.8	72.8	72.9
GE 18000	72.5	72.5	72.6	72.7	72.8	72.8	72.8	72.8	72.8	72.9	72.9	72.9	72.9	73.0	73.0	73.0
GE 16000	72.7	72.8	72.9	73.0	73.0	73.1	73.1	73.1	73.1	73.1	73.2	73.2	73.2	73.2	73.3	73.3
GE 14000	74.0	74.1	74.2	74.3	74.3	74.3	74.4	74.4	74.4	74.4	74.5	74.5	74.5	74.5	74.5	74.6
GE 12000	77.1	77.2	77.3	77.4	77.4	77.4	77.5	77.5	77.5	77.5	77.6	77.6	77.6	77.6	77.6	77.7
GE 10000	80.4	80.5	80.7	80.8	80.8	80.9	80.9	80.9	80.9	81.0	81.0	81.0	81.0	81.0	81.1	81.1
GE 9000	81.6	81.7	81.8	81.9	82.0	82.0	82.0	82.1	82.1	82.1	82.1	82.1	82.2	82.2	82.2	82.3
GE 8000	83.6	83.7	83.8	83.9	84.0	84.0	84.1	84.1	84.1	84.1	84.2	84.2	84.2	84.2	84.3	84.3
GE 7000	85.6	85.7	85.8	85.9	86.0	86.1	86.1	86.1	86.1	86.2	86.2	86.2	86.2	86.2	86.3	86.3
GE 6000	88.6	88.7	88.9	89.0	89.1	89.1	89.2	89.2	89.2	89.2	89.3	89.3	89.3	89.3	89.4	89.4

GE 5000	91.5	91.6	91.8	91.9	92.0	92.1	92.1	92.2	92.2	92.2	92.2	92.2	92.3	92.3	92.3	92.4
GE 4500	92.1	92.3	92.5	92.6	92.7	92.8	92.8	92.9	92.9	92.9	92.9	92.9	93.0	93.0	93.0	93.1
GE 4000	93.4	93.6	93.8	94.0	94.1	94.2	94.2	94.3	94.3	94.3	94.4	94.4	94.4	94.4	94.5	94.5
GE 3500	94.1	94.3	94.5	94.7	94.9	94.9	95.0	95.0	95.0	95.1	95.1	95.1	95.2	95.2	95.2	95.3
GE 3000	95.0	95.2	95.5	95.7	95.9	96.0	96.1	96.1	96.1	96.2	96.2	96.2	96.3	96.3	96.3	96.4
GE 2500	95.5	95.7	96.0	96.3	96.5	96.5	96.6	96.7	96.7	96.8	96.8	96.8	96.9	96.9	96.9	97.0
GE 2000	95.8	96.1	96.5	96.8	97.0	97.1	97.2	97.2	97.3	97.4	97.4	97.4	97.5	97.5	97.5	97.6
GE 1800	95.9	96.1	96.5	96.8	97.1	97.1	97.2	97.3	97.3	97.4	97.5	97.5	97.5	97.6	97.6	97.7
GE 1500	96.0	96.3	96.8	97.1	97.4	97.4	97.6	97.7	97.7	97.8	97.9	97.9	97.9	98.0	98.0	98.1
GE 1200	96.1	96.4	96.9	97.3	97.6	97.6	97.8	97.9	97.9	98.1	98.1	98.1	98.2	98.2	98.3	98.3
GE 1000	96.2	96.5	97.1	97.4	97.8	97.9	98.1	98.2	98.2	98.4	98.4	98.5	98.5	98.6	98.6	98.7
GE 900	96.2	96.6	97.1	97.5	97.9	97.9	98.1	98.2	98.3	98.5	98.5	98.5	98.6	98.7	98.7	98.8
GE 800	96.3	96.6	97.2	97.6	97.9	98.0	98.2	98.3	98.4	98.6	98.7	98.7	98.8	98.8	98.9	98.9
GE 700	96.3	96.6	97.2	97.6	98.0	98.1	98.3	98.4	98.5	98.7	98.8	98.8	98.9	99.0	99.0	99.1
GE 600	96.3	96.6	97.2	97.7	98.1	98.1	98.4	98.5	98.6	98.8	98.9	98.9	99.1	99.1	99.2	99.3
GE 500	96.3	96.6	97.2	97.7	98.1	98.2	98.5	98.6	98.7	98.9	99.0	99.0	99.2	99.3	99.4	99.5
GE 400	96.3	96.7	97.3	97.7	98.1	98.2	98.5	98.6	98.7	98.9	99.1	99.1	99.3	99.3	99.5	99.7

GE 300	96.3	96.7	97.3	97.7	98.1	98.2	98.5	98.6	98.7	98.9	99.1	99.1	99.3	99.4	99.6	99.8
GE 200	96.3	96.7	97.3	97.7	98.1	98.2	98.5	98.6	98.7	98.9	99.1	99.1	99.3	99.4	99.6	99.9
GE 100	96.3	96.7	97.3	97.7	98.1	98.2	98.5	98.6	98.7	98.9	99.1	99.1	99.3	99.4	99.6	100.0
GE 000	96.3	96.7	97.3	97.7	98.1	98.2	98.5	98.6	98.7	98.9	99.1	99.1	99.3	99.4	99.6	100.0

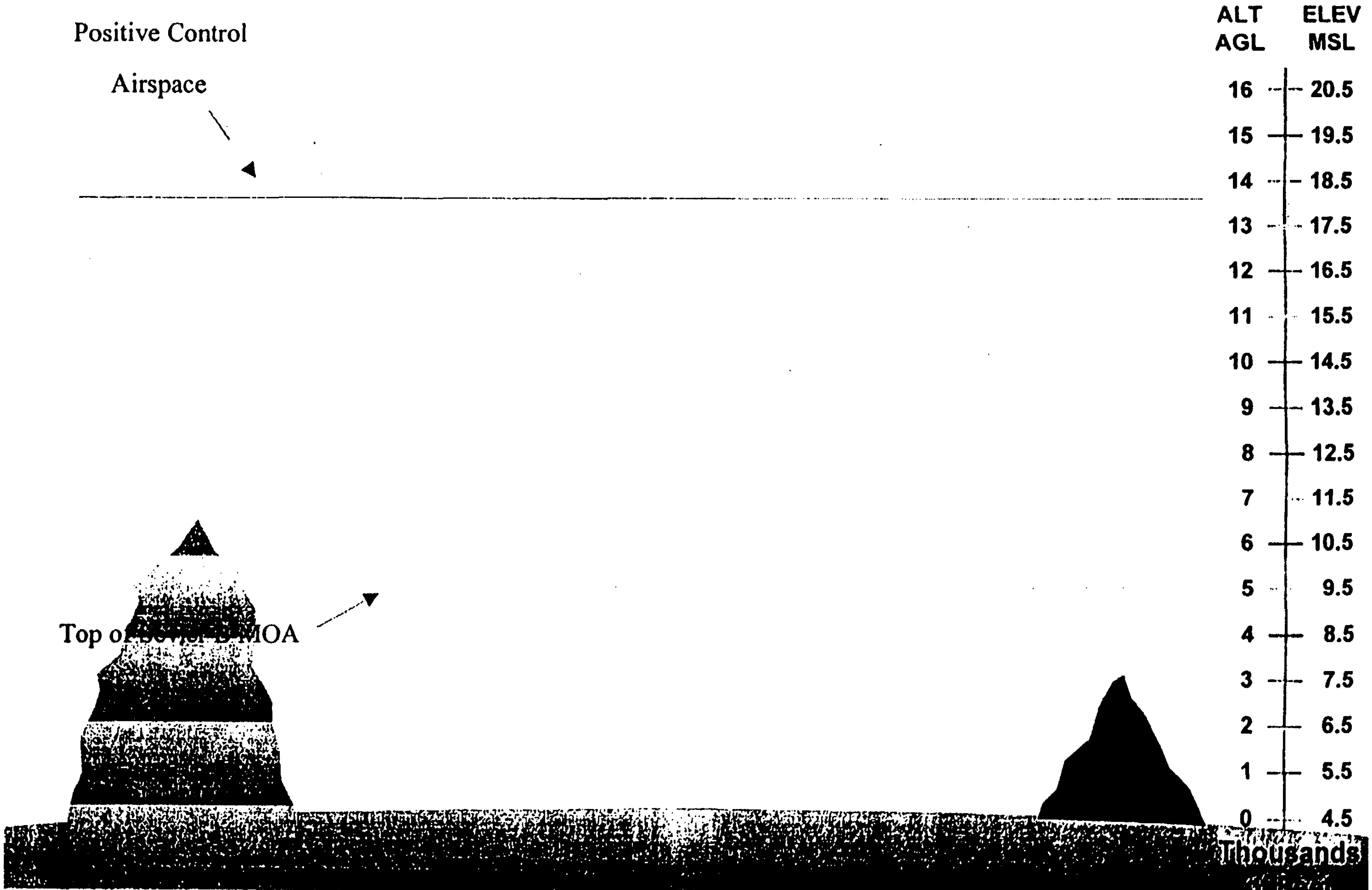
Skull Valley Airspace (Fig. 9-1)



Skull Valley Airspace (Fig. 9-2)

No Ceiling and Visibility> 7 Statute Miles, 70.5% of the time

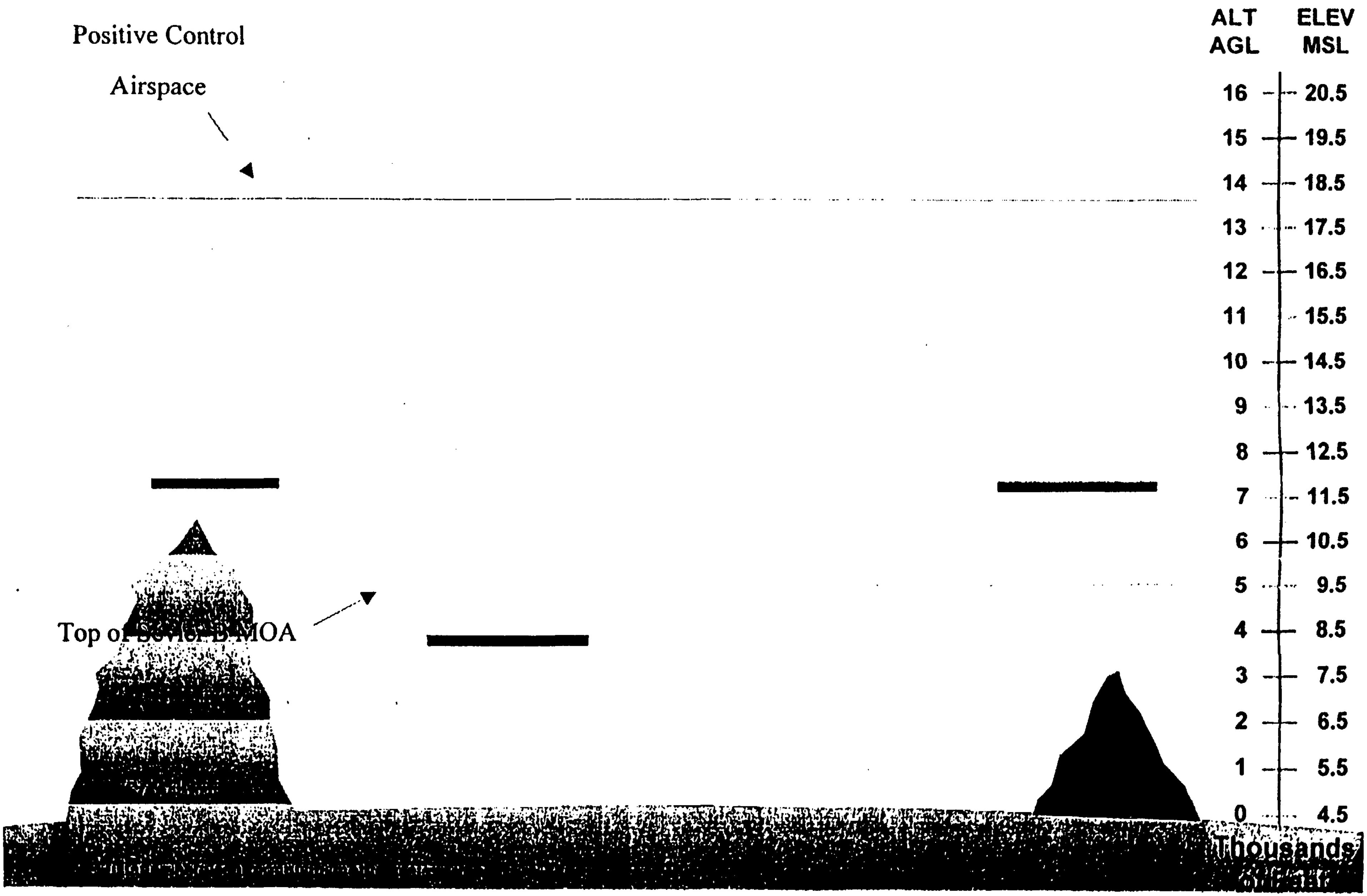
Depicted Weather: Sky Clear (no clouds)



Skull Valley Airspace (Fig. 9-3)

No Ceiling and Visibility> 7 Statute Miles, 70.5% of the time

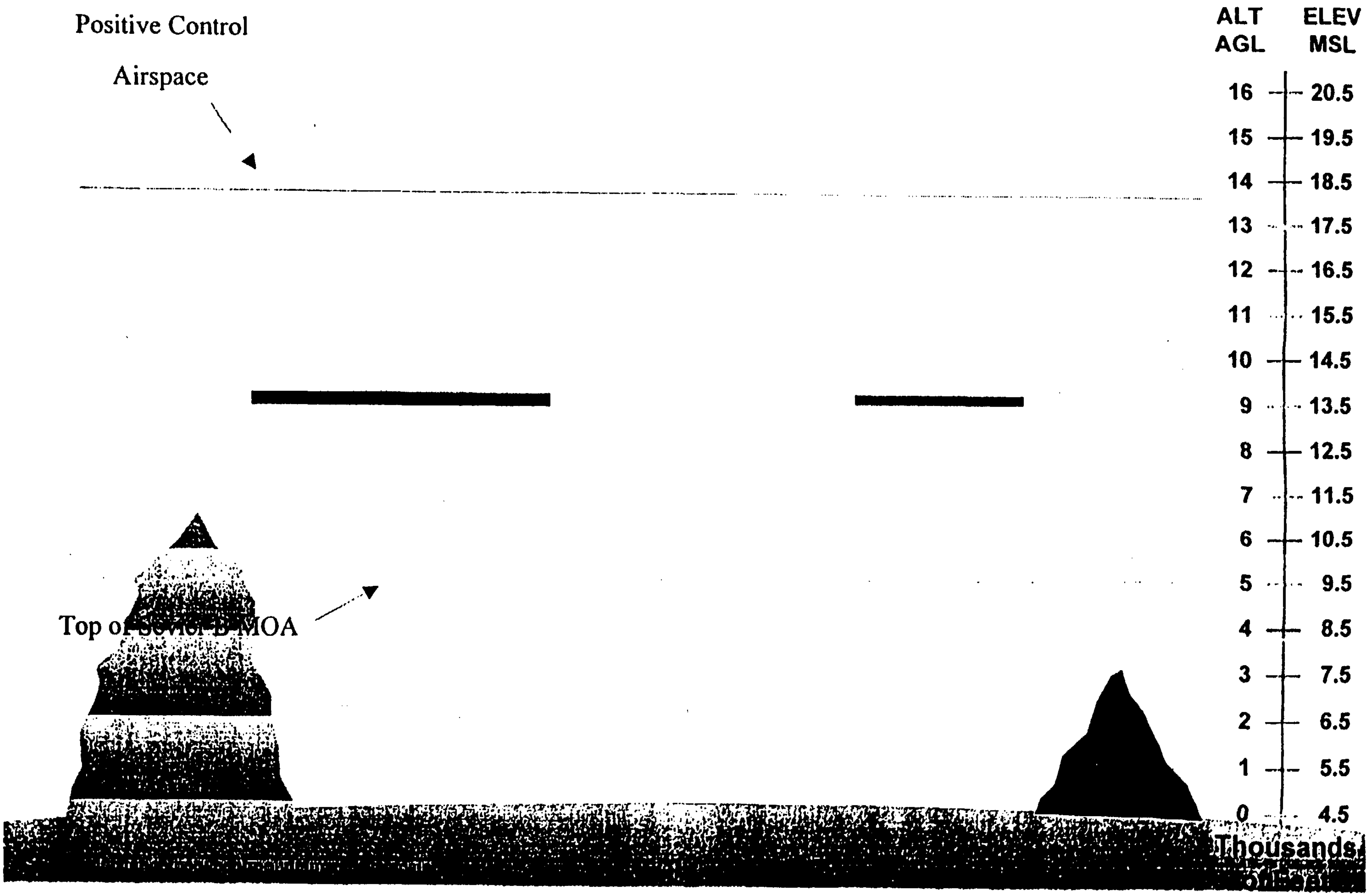
Depicted Weather: 1/8 (Few) @ 4,000', 2/8 (Few) @ 7,000'



Skull Valley Airspace (Fig. 9-4)

No Ceiling and Visibility> 7 Statute Miles, 70.5% of the time

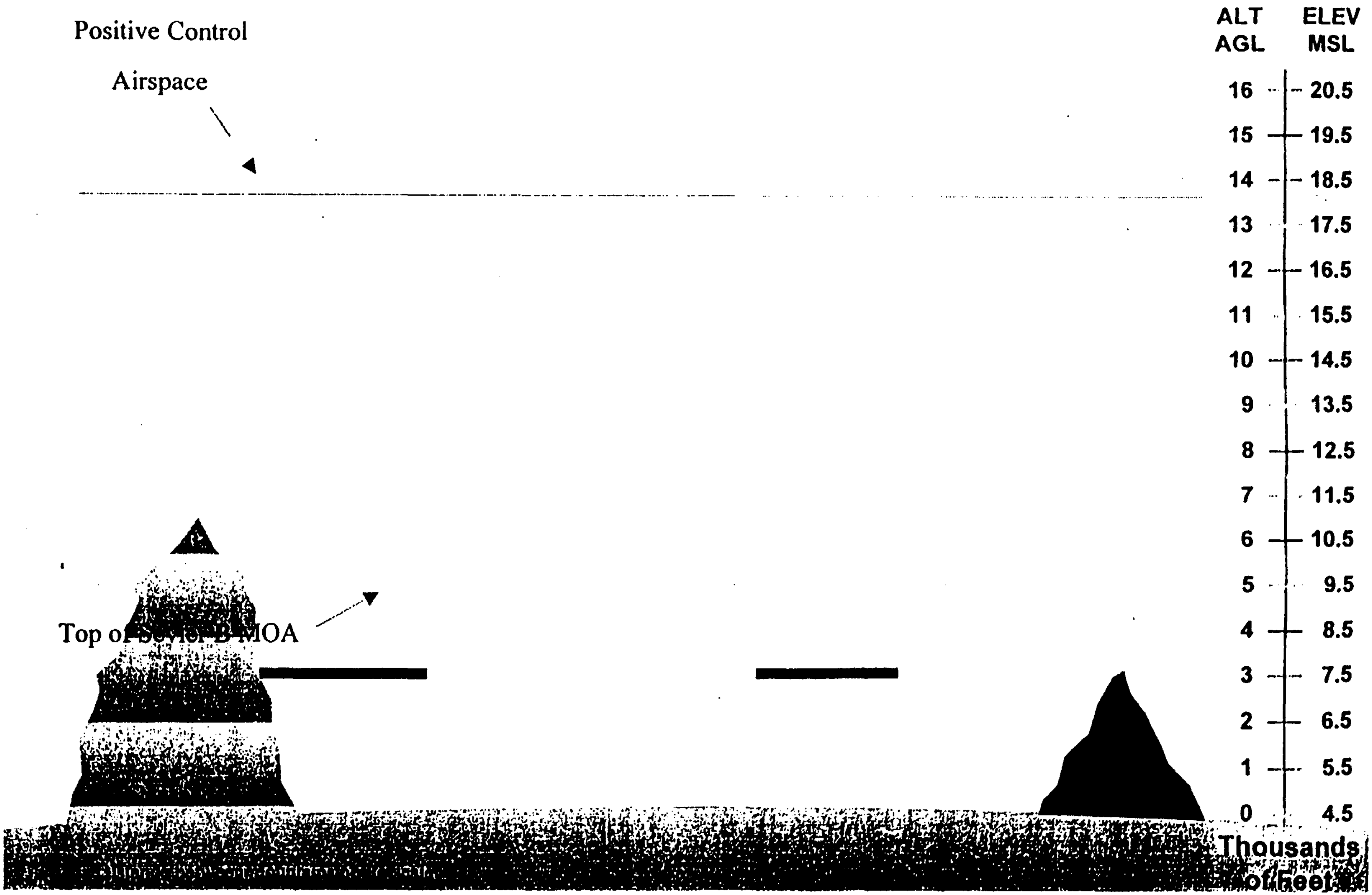
Depicted Weather: 3/8 (Scattered) @ 9,000'



Skull Valley Airspace (Fig. 9-5)

No Ceiling and Visibility> 7 Statute Miles, 70.5% of the time

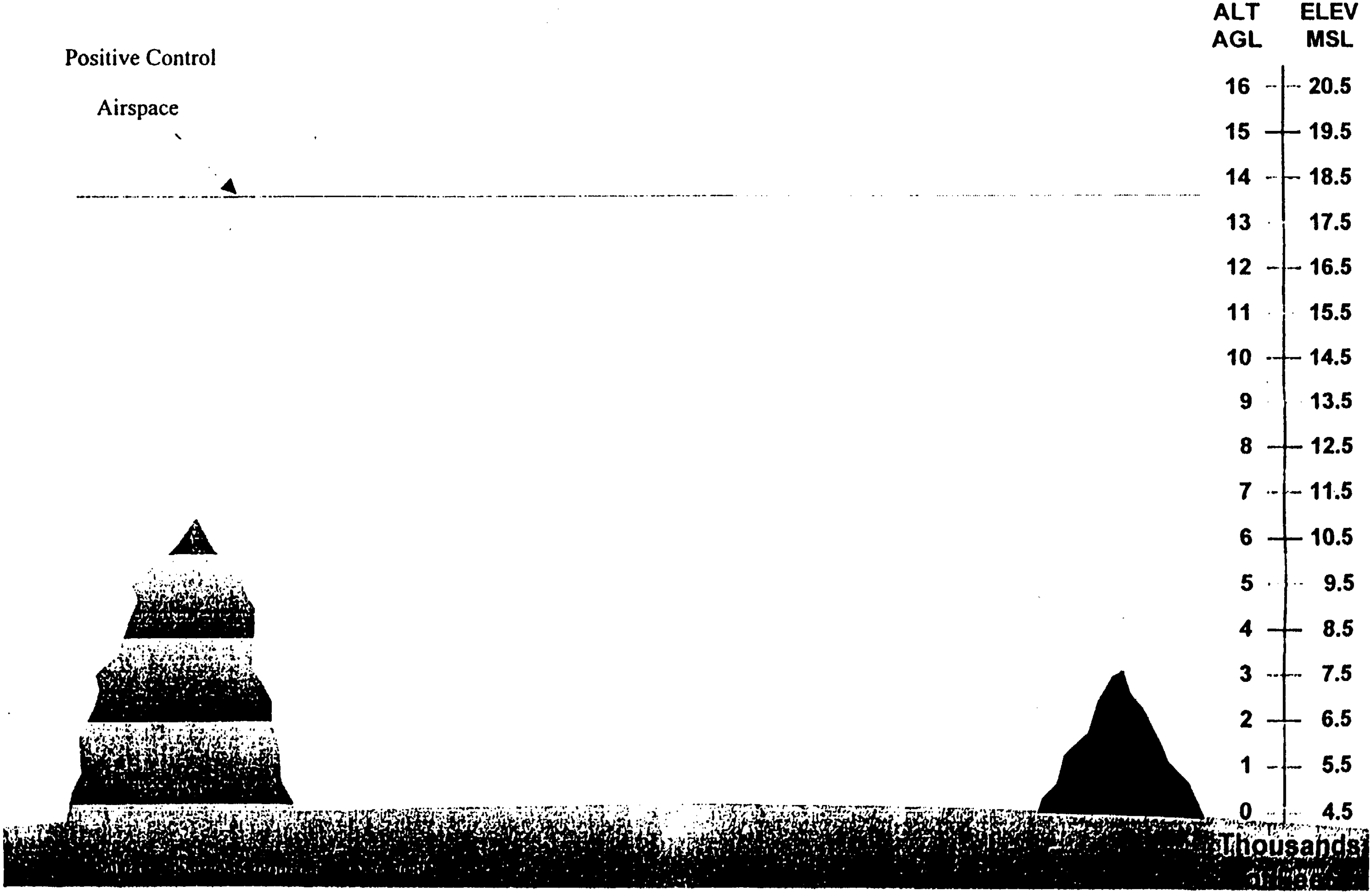
Depicted Weather: 2/8 (Few) @ 3,000'



Skull Valley Airspace (Fig. 9-6)

Ceiling > 14,000' & Visibility > 7 Statutes Miles, 74.0% of the time

Depicted Weather: Clear Sky

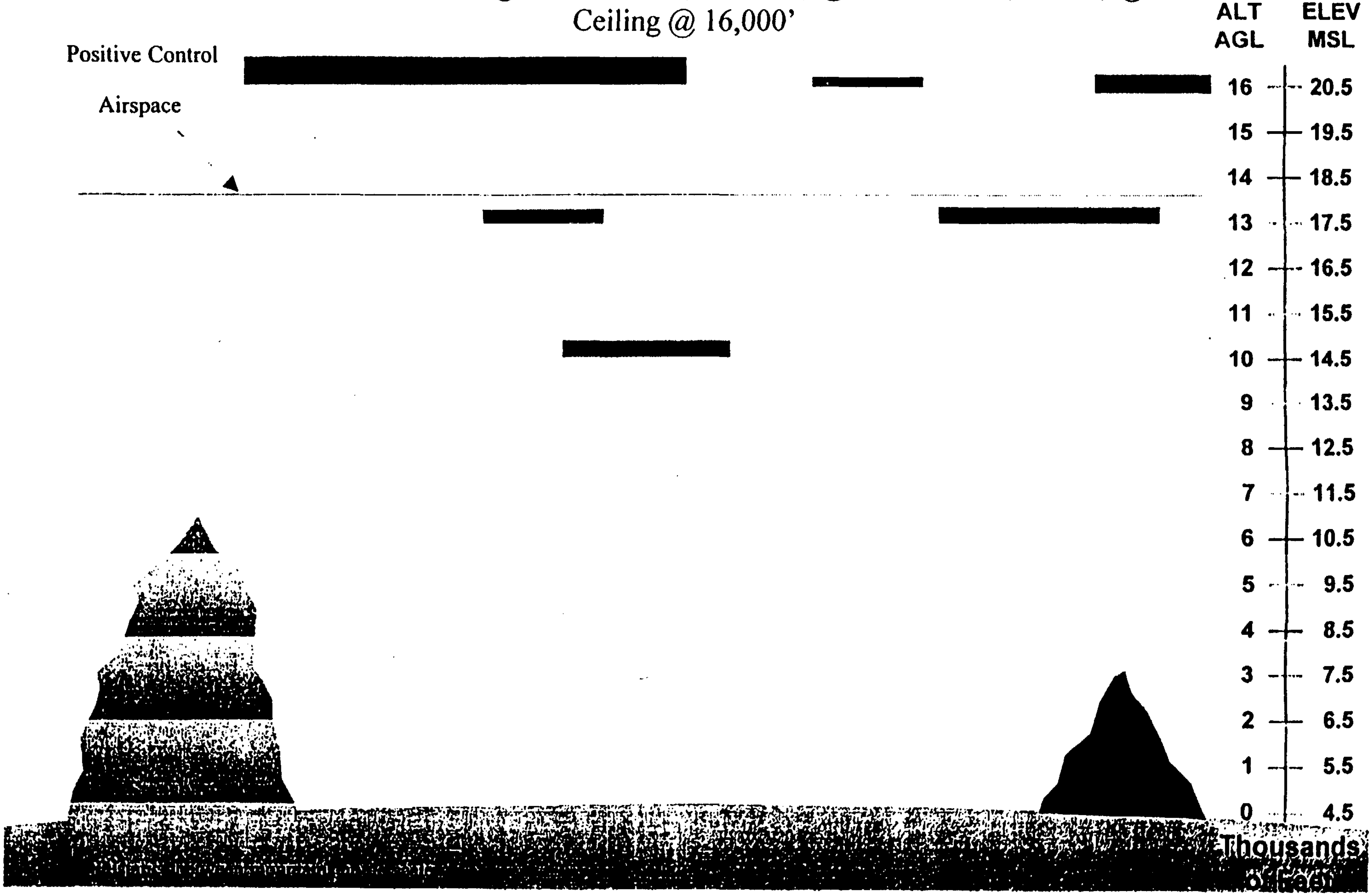


Skull Valley Airspace (Fig. 9-7)

Ceiling > 14,000' & Visibility > 7 Statutes Miles, 74.0% of the time

Depicted Weather: 1/8 (Few) @ 10,000', 3/8 (Scattered) @13,000'. 5/8 (Broken) @16,000'

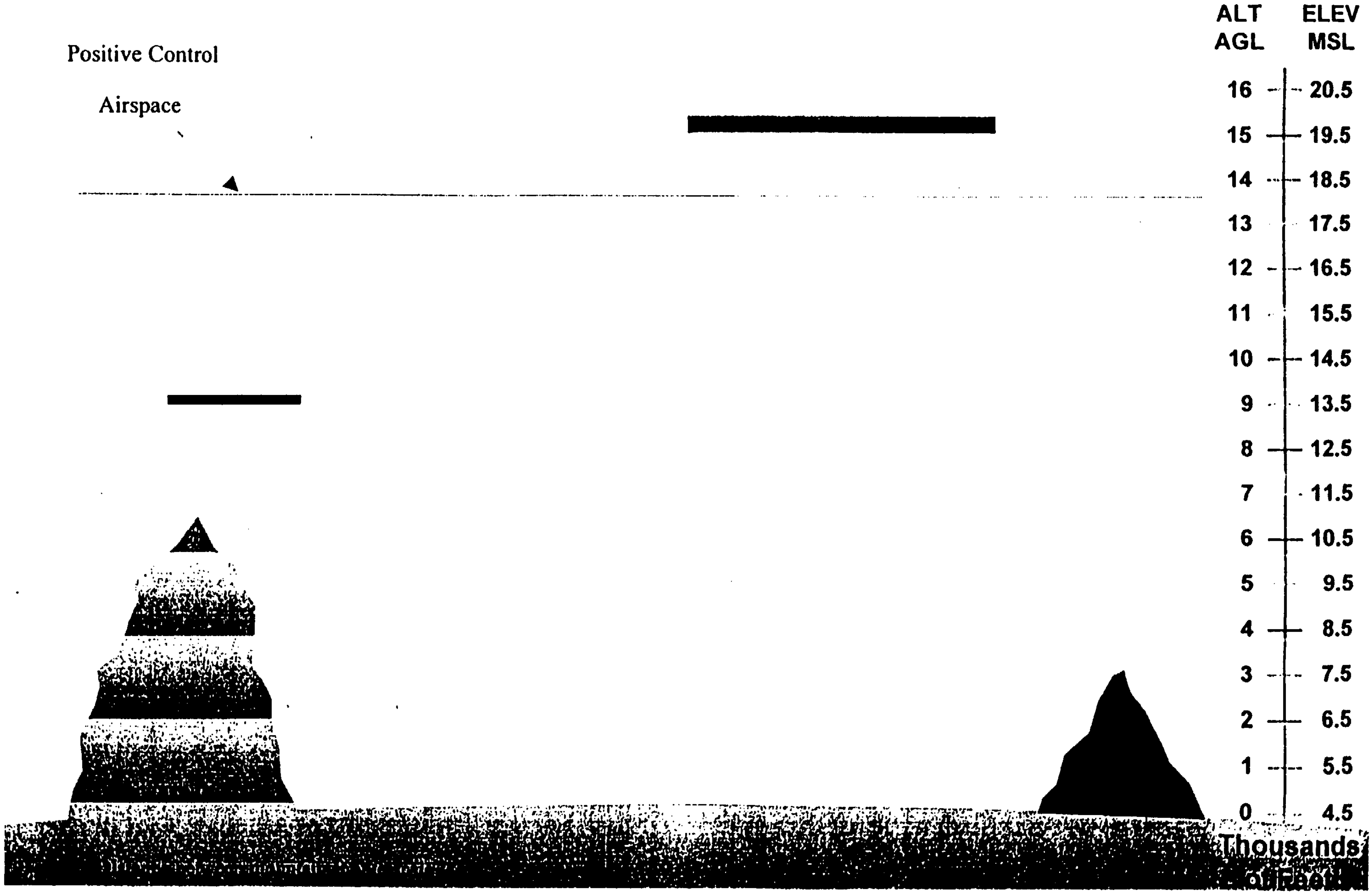
Ceiling @ 16,000'



Skull Valley Airspace (Fig. 9-8)

Ceiling > 14,000’ & Visibility > 7 Statutes Miles, 74.0% of the time

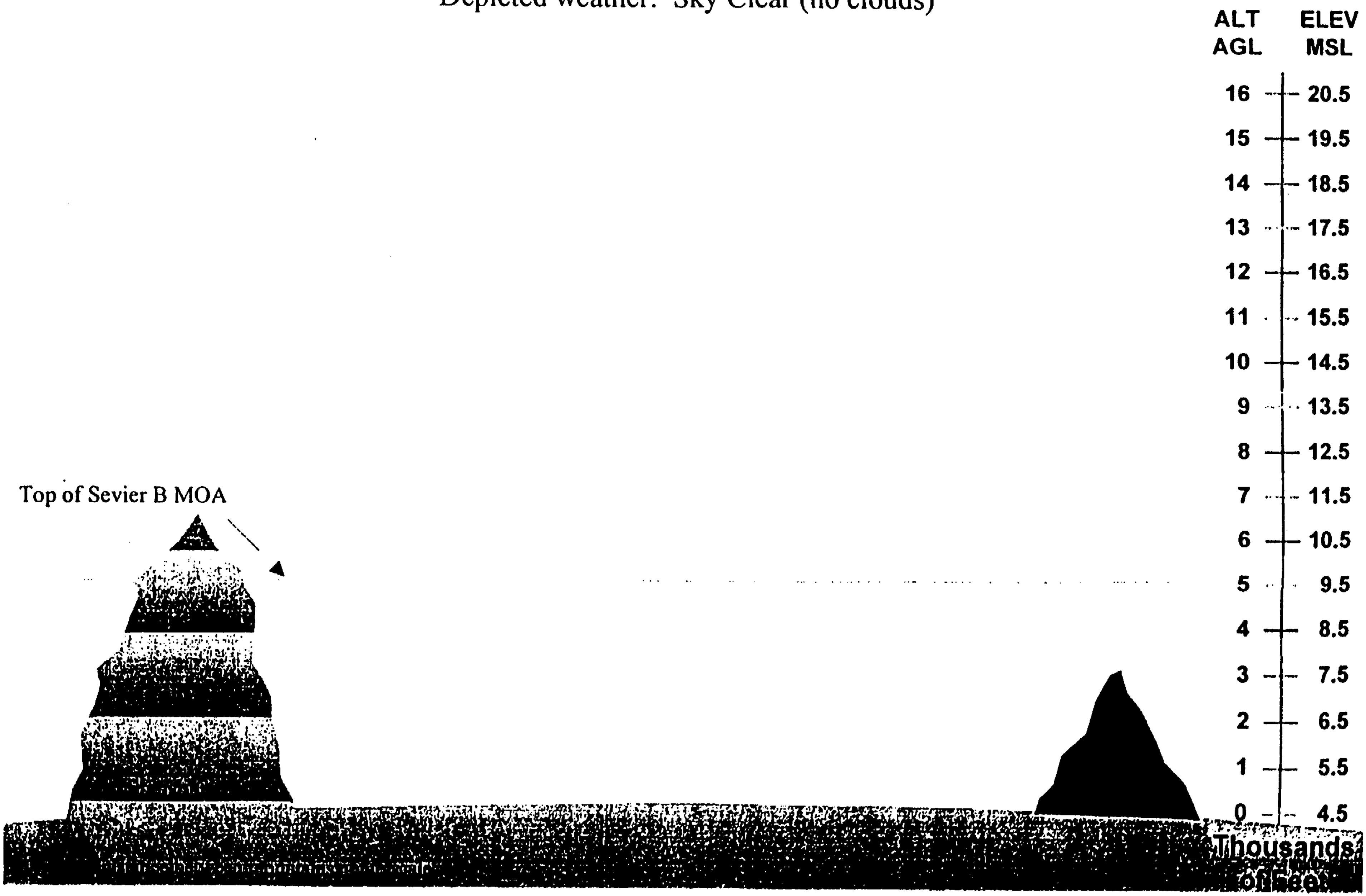
Depicted Weather: 1/8 (Few) @ 9.000’, 2/8 (Few) @ 15,000’; No ceiling



Skull Valley Weather (Fig. 9-9)

Ceiling > 5,000' & Visibility > 7 miles (representative) 91.5% of the time

Depicted weather: Sky Clear (no clouds)

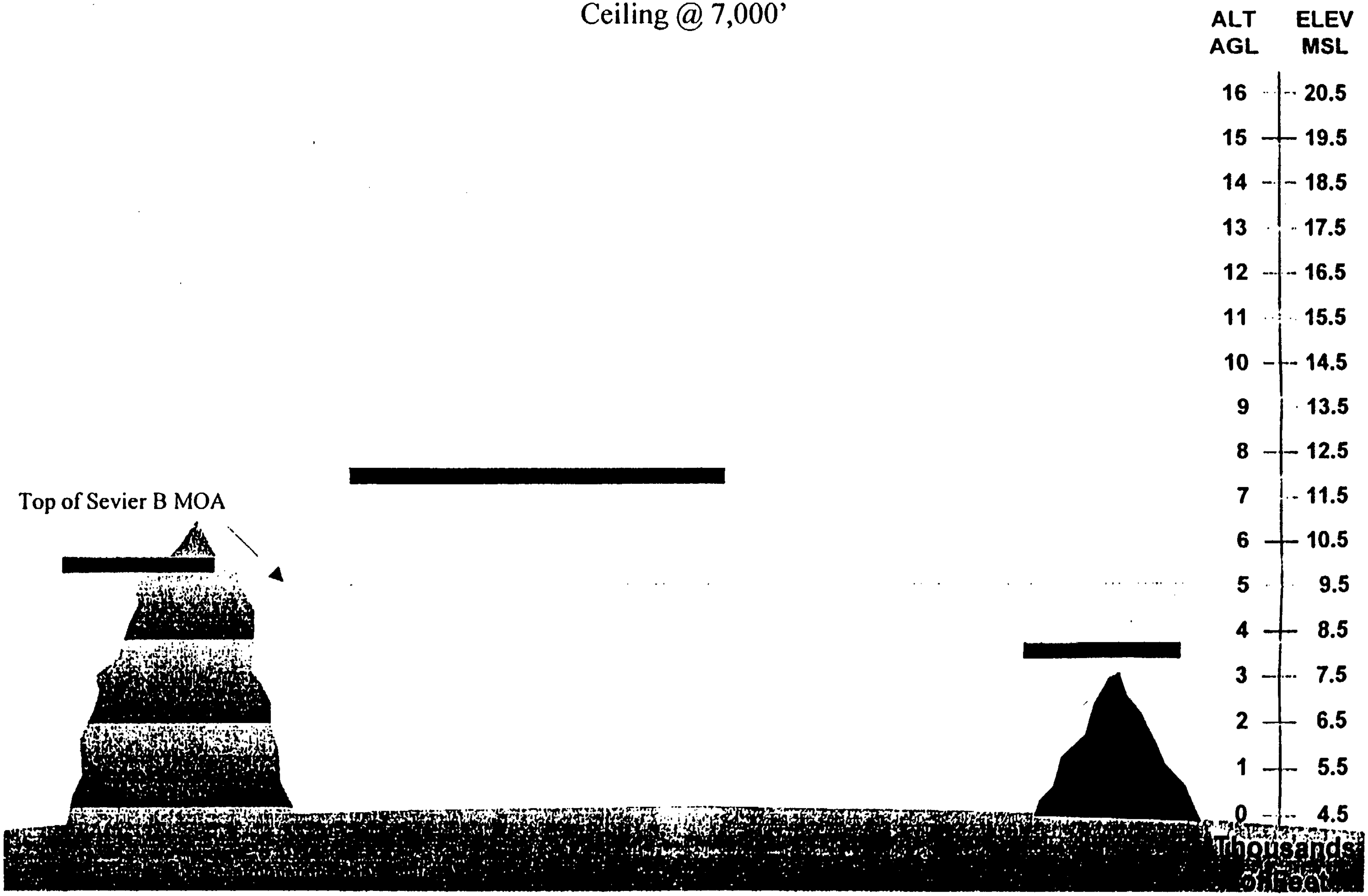


Skull Valley Weather (Fig. 9-10)

Ceiling > 5,000' & Visibility > 7 miles (representative) 91.5% of the time

Depicted Weather: 1/8 (Few) @ 3,500', 1/8 (Few) @ 5,500', 3/8 (Scattered) @ 7,000';

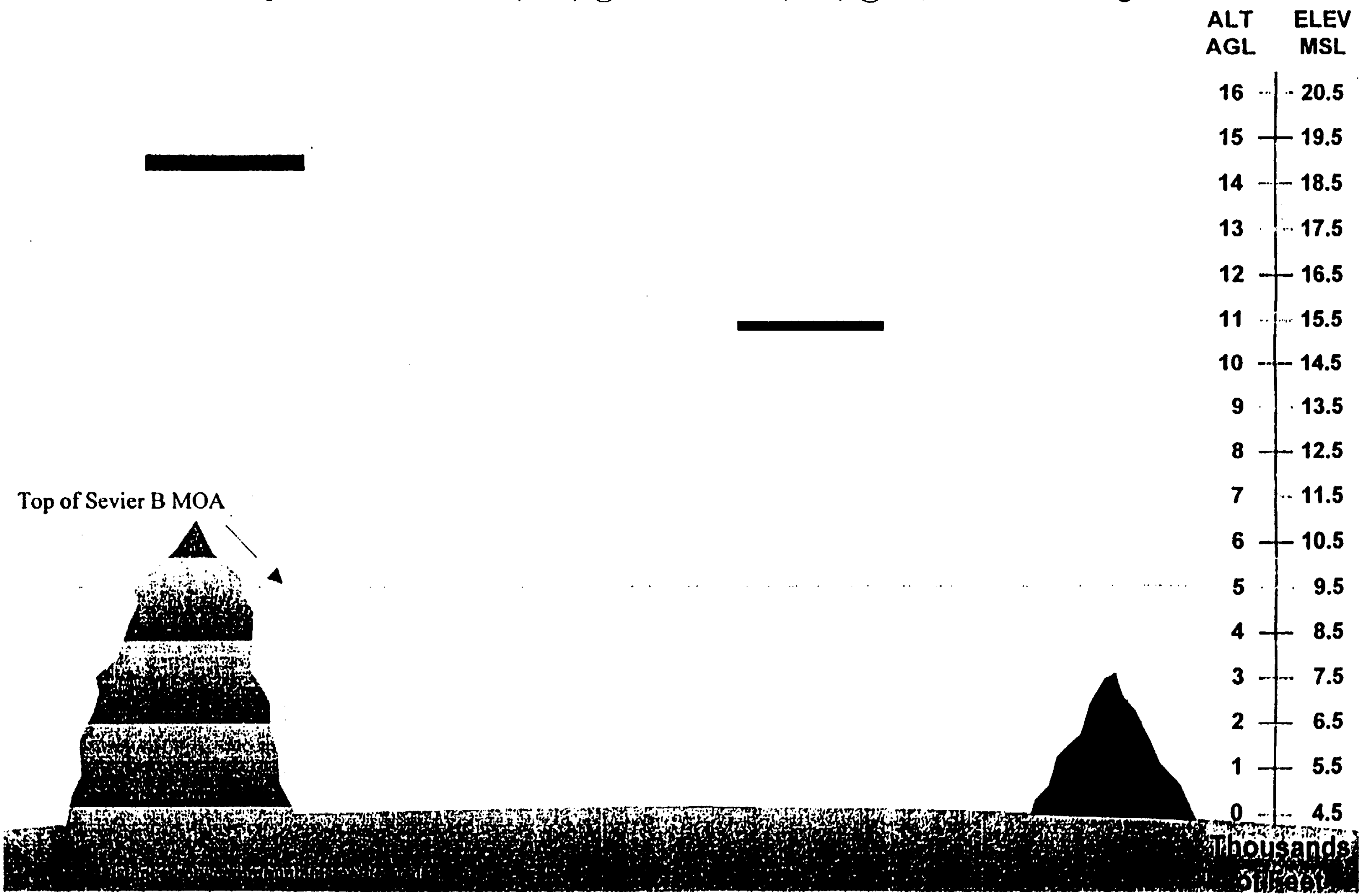
Ceiling @ 7,000'



Skull Valley Weather (Fig. 9-11)

Ceiling > 5,000' & Visibility > 7 miles (representative) 91.5% of the time

Depicted weather: 1/8 (Few) @ 11,000', 1/8 (Few) @ 14,000': No ceiling

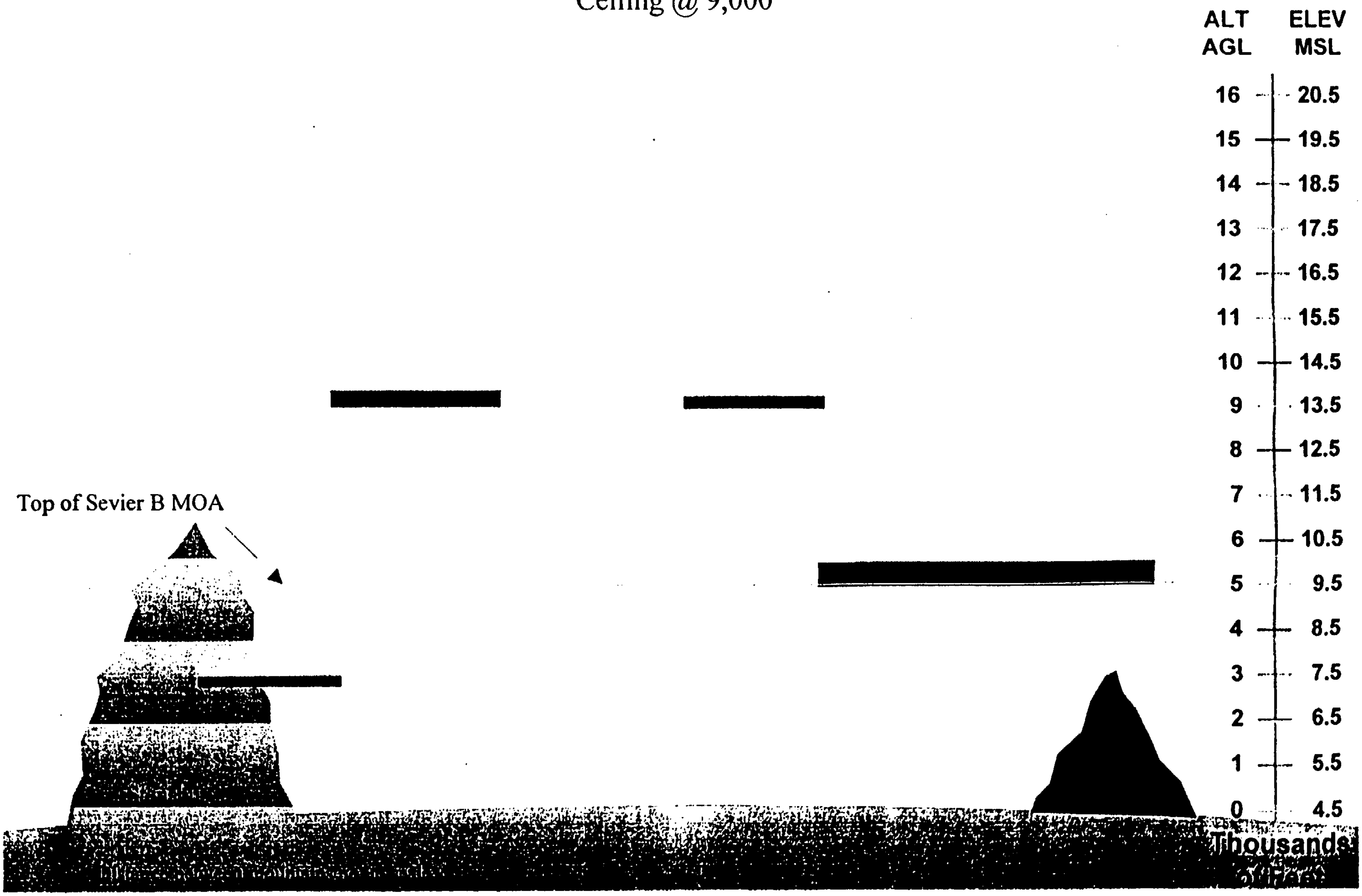


Skull Valley Weather (Fig. 9-12)

Ceiling > 5,000’ & Visibility > 7 Statute Miles, 91.5% of the time

Depicted Weather: 1/8 (few) @ 3,000’, 2/8 (few) @ 5,000’, 2/8 (few) @ 9,000’

Ceiling @ 9,000’



BIRD STRIKES

10. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from potential bird strikes:

(a) Discuss the extent to which crashes caused by bird strikes were considered in using historical crash data for estimating the F-16 aircraft crash frequency under Skull Valley type conditions.

Response

In analyzing the historical database of F-16 crashes, every accident report received was closely examined. (Report, TAB H). Out of the 121 aircraft crashes, there were 4 crashes (18 Apr 91, 17 Dec 92, 1 Jul 94, 13 May 98) caused by bird strikes. These 4 events were included in the statistics covering losses.

(b) Indicate the bases for exclusion if bird strike induced crashes in the historical crash database were excluded on the basis of non-applicability to Skull Valley. For example, describe specific factors, such as bird size, and flight altitude and frequency, which would form a basis for including or excluding a specific crash in estimating the aircraft crash frequency in Skull Valley.

Response

Of the 4 crashes caused by bird strikes, all 4 occurred during low level flight. Three of the 4 occurred during special in-flight maneuvering, including one in low level navigation training with the bird strike at 300' AGL, one during an air to ground attack training at 1,000 ft. AGL, and one in low level air to air training at 1,000 ft. AGL. All 3 of these accidents were therefore rated as belonging to the Special Inflight category, and therefore not applicable to the Sevier B MOA category of events. All 3 bird strikes resulted in engine failure due to bird ingestion into the engine, and therefore all 3 were considered as engine failure accidents. The pilots all remained in control after the bird strike so all were judged as accidents in which the pilot would have been able to avoid a structure on the ground. Additionally, because they were judged as possible in Skull Valley despite being in the Special Inflight category, they were included in the Skull Valley Type Event calculations.

The 4th bird strike also occurred in low level navigation training, but because it occurred at 830 ft. AGL, it was rated as 'Normal Flight' in accordance with the definitions set forth in TAB H of the Report at page 10, which defined low level flight above 500 ft. as normal flight. The aircraft struck a flock of American White Pelicans while it was on a low level training route near the Missouri River in Nebraska. It was flying in formation with the lead aircraft which was at 500 ft. AGL. The airspeed was 520 knots. With these airspeed and altitude flight parameters, this could have logically been considered as a Special Inflight (increased hazard) category accident, but to be consistent with the previously defined categories and to be conservative, PFS elected to specifically consider it as a normal flight loss and a possible Sevier B MOA or a Skull Valley Type Event accident. The accident resulted from striking at least five of the large pelicans, one or more of which struck and broke the canopy windscreen, causing temporary incapacitation of the pilot and his immediate ejection from the aircraft. It was therefore not rated as an engine failure accident nor as one in which the pilot would be able to avoid a ground structure after the emergency started. This accident is closely detailed in TAB H of the Report, pages 24 and 25.

After very careful consideration, this accident was categorized as not a Sevier B MOA Type Event nor a Skull Valley Type Event for a number of reasons.

1. Most importantly, it involved the collision with a flock of very large water birds near the Missouri River. There is no water in Skull Valley anywhere near the PFSF to attract these birds and they have not been observed in the Valley. According to the Utah State Division of Wildlife Resources, American White Pelicans and several other species of large birds have been observed in the Timpie Springs Wildlife Area, which is 25 miles north of the PFSF and at the edge of the Great Salt Lake north of Interstate 80. The large pelicans are seasonal and dependent on the water level there. They breed on the north side of the Great Salt Lake and are generally in that area. They were observed in the Timpie Springs area in April to May (max count 8) and June/July (max count 2) in 2000. A maximum of 11 (also in May) were seen in 1999, a maximum of 5 in 1998 (in May), but only 2 in 1997. They are dependent on the water level, and in a dry year (lower water level) they will tend to stay away from the Timpie Springs area. Canada Geese are also seen there, predominately during the Fall, a maximum of 37 were seen in Sept 2000, 62 in 1999, 47 in 1998, and 59 in 1997. No white pelicans and only 4 geese (in 1997 and again in 1998) were seen in these years in the Magnesium Corporation bay just west of Stansbury Island.

2. Additionally, bird strikes tend to occur at low altitudes. Air Force bird strike data shows that 70 % of all bird strikes occur at or below 1,000 ft. AGL (95 % occur below 3,000 ft. AGL and 98 % occur below 4,000 ft. AGL). F-16s in Skull Valley are normally at 3,000 ft. to 4,000 ft. AGL. Very few of the reported bird strikes have occurred in this range.

3. A search of the U.S. Air Force Safety Center's Bird Avoidance Model data (http://www.ahas.com/bam) covering all reported bird strikes since 1985 through June 25, 2000 reveals that no bird strikes have occurred in Skull Valley despite the thousands of flights per year through there. The closest bird strike was 25 statute miles from the PFSF on 7 April 1994 on the UTTR (Restricted Area 6406A), when a B-52H bomber struck one bird at 7 PM during low level cruise flight at 600 fee altitude, with no appreciable damage ($726) to the aircraft. Of note, the cross sectional area of a B-52H when viewed from head-on is very large when compared to that of the F-16. Therefore, an F-16 flying the exact same profile would've had much less of a probability of striking that same bird than did the B-52H.

   The next closest bird strike was 37 statute miles away near the north UTTR, on March 2, 1988 when an F-16 struck a bird while flying at 800 feed altitude at 1046 AM during low level cruise flight, with no damage to the aircraft.

   The Bird Avoidance Model (BAM) also shows that of all the bird strikes in the database

(7 strikes in 15 years) within 50 statute miles of the PFSF, none occurred above 800 ft. altitude AGL.

4. The F-16s transiting Skull Valley are normally flying at 350 to 400 knots, so the chances of actually breaking the canopy windscreen are much less even if the aircraft were to strike a large bird. If the bird did not strike the canopy/windscreen but were ingested by the engine, there might be engine problems but the pilot would remain in control and be able to avoid a site on the ground.

5. It could have been eliminated on the grounds that it occurred below the 1,000 ft. AGL threshold minimum altitude for Skull Valley transit, but PFS elected to not consider this factor. (This factor applies to the Sevier B MOA category in Tab H only.)

CRUISE MISSILES

11. Provide the following items which are related to the effect on the potential cruise missile hazard at the proposed PFSF from cruise missile flights in the UTTR:

(a) Specify which cruise missile crashes listed in Table 1 of the cruise missile risk assessment report (letter dated January 25, 2001) occurred outside the UTTR ground or air boundaries.

(b) Describe the planned routes (ground or air) for the cruise missiles that crashed outside the UTTR boundaries and the distance between the crash location and the nearest point to the planned trajectory (i.e., lateral distance).

(c) Clarify whether the cruise missiles crashed within their lateral limits and whether controllers took control and redirected the missiles once a malfunction was realized.

Response

Questions 11(a), (b), and (c) will be answered upon the receipt of responses to PFS Freedom of Information Act (FOIA) requests to the U.S. Air Force.

(d) Discuss whether there is a difference between the tests of stockpile (i.e. operational) cruise missiles and developmental cruise missiles that incorporate some new features or characteristics, as discussed on page 32 of the cruise missile risk assessment report.

Response

The policies, procedures and requirements for test of developmental and stockpile cruise missiles are identical. All must be equipped with an approved Flight Termination Systems (FTS), and tests are conducted with the same scrutiny.

Development Flight Tests are conducted to prove the design of a new missile, or upgrades to missiles in production, while stockpile test are conducted to verify mature system reliability. New designs do not have the mature system reliability, with flight tests conducted to validate the design and grow system reliability. Tests during the development phase tend to be shorter and more restricted in area covered (i.e. more conservative and constrained), with specific test objectives to be accomplished during the test to verify functions and design. These developmental missiles typically have additional telemetry information transmitted during flight to collect the data necessary to validate the design and to diagnose deviations from expected parameters.

Stockpile tests are conducted to verify the "health" of production missiles in inventory and tests typically mirror real-world missions in length and objectives. In both development and stockpile cases, the same procedures and safety precautions are employed, and missiles are kept under positive control of accompanying chase aircraft and range control aircraft to ensure safety.

PFS NRC Lic Con

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May 15, 2001

**REQUEST FOR ADDITIONAL INFORMATION
ON AIRCRAFT HAZARDS—CLARIFICATION
DOCKET NO. 72-22 / TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.**

Reference 1: NRC Letter, Delligatti to Parkyn, Request for Additional Information, dated March 9, 2001.
Reference 2: PFS Letter, Donnell to Delligatti, Request for Additional Information on Aircraft Hazards—Partial Response, dated March 30, 2001.
Reference 3: April 25, 2001 teleconference between PFS and the NRC.

In Reference 1 the NRC submitted a request for additional information regarding the supplements to PFS's license application that PFS submitted under letters dated January 19 and 25, 2001 and other documents related to aircraft hazards. PFS answered the questions for which it had the information to do so on March 30, as submitted with Reference 2.

On April 25, 2001, PFS and the NRC participated in a teleconference (Reference 3), in which the NRC requested clarification of some of the information PFS had provided to the NRC in Reference 2. The attached submittal documents the answers to the NRC's questions that PFS provided in the teleconference.

If you have any questions regarding this response, please contact me at 303-741-7009.

Sincerely

John L. Donnell

John L. Donnell
Project Director
Private Fuel Storage L.L.C.

Copy to:

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PFS Answers to NRC Questions Regarding Aircraft Hazards to the PFSF, April 25, 2001

1. If the engine of an F-16 fails, will the aircraft's navigation systems (e.g., INS, GPS, TACAN) still function?

The INS and the TACAN will still function if the engine fails. The INS provides bearing and distance to the selected steer point; the TACAN provides bearing and distance to the selected ground-based navigation aid (TACAN).[1] The Global Positioning System will be inoperative. In the event of an engine failure, the main and standby generators will no longer operate and the emergency generator will be the main source of power to the aircraft systems. As a general rule, the emergency generator only provides a "get home" capability. Systems such as navigation and communications that are necessary to fly the airplane safely to base are in this category. Systems required for combat employment of weapons such as the radar, LANTIRN and others will not operate on the emergency generator.

2. Is the F-16 aerodynamically stable if the pilot ejects?

Yes, the F-16 is stable if the pilot ejects. The plane will go in the direction it was pointed prior to the pilot ejecting. The flight control computers will also tend to seek level flight as the airplane decelerates until a preprogrammed angle of attack is reached. A more detailed discussion may be found on page 21 of the Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Rev 4).

3. Considering both day and night flight, when would F-16 pilots fly through Skull Valley using visual flight rules (VFR) and instrument flight rules (IFR)?

Pilots normally transit Skull Valley using Visual Flight Rules (VFR); this is true both during the day and at night. As shown by the Air Weather Service historic cloud cover and visibility charts in the March 30, 2001 PFS response to the NRC Staff Request for Additional Information (RAI), the weather in Skull Valley is conducive for VFR operations the large majority of the time. In addition, most simulated combat training, both air-to-surface and air-to-air, requires the pilot to be flying clear of clouds. Thus, there is little utility to flying in the weather for the tactical (simulated combat) portion of training missions. The squadrons will normally start to reduce or cancel the number of sorties to be flown as the weather in the UTTR becomes unusable.

In order to fly under Instrument Flight Rules (IFR), it is necessary to have an IFR clearance with the appropriate air traffic control agency. This is normally done prior to takeoff by filing an IFR flight plan, although it is possible to obtain an IFR clearance while airborne.

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[1] RAI Response, March 30, 2001, pages 7, 28.

IFR flight is normally conducted on established airways. However, pilots have the option of flying from point to point outside of the established airways if approved by air traffic control. These points are normally defined by bearing and distance to a ground based navigation aid or by latitude and longitude coordinates. The route of flight is delineated on the flight plan filed with air traffic control. Changes to the route of flight may be requested from air traffic control while airborne.

IFR flight must be at or above an established minimum area altitude to ensure clearance from the terrain. This minimum altitude is based upon the terrain elevation and the proximity of rising terrain. As noted in the report, the Stansbury Mountains on the eastern portion of the Sevier B MOA extend through the vertical limit of the MOA and the Cedar Mountains on the west rise to 7,700' MSL. This high terrain would preclude IFR flight through a significant portion, if not all, of the Sevier B MOA.

The 388th FW aircraft are equipped with the LANTIRN system, which is composed of a targeting and a navigation pod. During night operations, the pilots will use the Imaging Infrared (IIR) capability of the navigation pod to assist them. The navigation pod projects an image of what is in front of the aircraft on the pilot's head up display[2] thereby increasing his positional and situational awareness.

4. If there were cloud cover in Skull Valley, how would the pilot maintain awareness of the location of the PFSF site, including the use of aircraft instruments such as the INS to do so?

As noted in answer 9(h) in the March 30, 2001 PFS RAI, pilots are trained to maintain situational awareness as to their location and the surrounding environment. As part of their mission preparation, pilots will select and annotate a route of flight on their map. Typically, the map will have heading, distance and time between turn points; location of emergency fields; any flight restrictions such as areas with a minimum altitude, no fly areas, etc.; location of simulated "enemy positions"; and other information as appropriate. These are discussed during the flight briefing prior to the mission as well.

Once airborne, pilots will use outside references, landmarks, roads, etc. and their onboard systems while referencing their maps to maintain their positional awareness. As a general rule, pilots will rely on outside references and reinforce them with onboard systems when cloud coverage and visibility allow. As weather or darkness begins to limit visual contact with outside references, pilots will begin to rely more on their onboard systems and less on external features. It is possible for pilots to fly in the clouds without any external references available. In this case, the pilot uses onboard systems to maintain basic aircraft control (altitude, attitude, heading, speed) and an combination of the onboard INS and external navigation aids such as TACAN and GPS to maintain positional awareness.

[2] RAI Response, March 30, 2001, page 8

One of the onboard instruments the pilot would use is the Horizontal Situation Indicator (HSI, see attached example).[3] This displays bearing and distance to the selected navigation or steering point and can be used to fly an exact course to the point. In the attached example, the selected navigation point is bearing 090^0 for 3 miles. Further, it shows that the airplane is to the right of the 103^0 course selected by the pilot. If the pilot wanted to correct back to the course, he would need to turn left. If the pilot were on course, then the large bar marked "Deviation from Selected Course" (in the drawing) would be centered and it would form a straight line with the "arrow point and tail" in the center of the display. Thus, pilots can maintain a precise course (also referred to as ground track) to the desired point.

5. If an F-16 experiences an problem or failure and the pilot determines that he must jettison the aircraft's stores, at what point does the pilot actually jettison them and would he ever consider the point at which the stores might hit the ground before jettisoning them?

The pilot's specific actions in the event of an engine problem or failure would depend in part on the circumstances under which the incident occurred. If the pilot was operating in the 3,000'-4000' AGL regime indicated by the 388th FW Vice Commander[4], and experienced an engine anomaly, the pilot could be reasonably expected to climb while trying to determine if in fact the engine was operating normally. If the pilot was concerned about the engine he would turn toward the nearest suitable airfield while carefully monitoring the situation and taking appropriate actions. Depending on the nature of the problem, the pilot may elect to jettison the external stores. Should the engine subsequently fail, the pilot would jettison the external stores if he had not already done so. In this case, because pilots maintain situational awareness, the pilot should already be aware of populated areas or significant structures such English Village or the PFSF.

Conversely, if the pilot was at the same 3,000-4,000' AGL and the engine suddenly failed with little or no warning, the pilot would execute the low altitude engine failure and airstart procedures described in the Report[5]. In the event of a low altitude engine failure, there is no written requirement in the pilot procedures to look for a clear area prior to jettisoning the external stores. However, during discussions of emergency procedures and in simulator training when low altitude engine failure procedures are practiced, many pilots indicate they will at least consider what's in the immediate area before jettisoning the stores. As has been noted in previous PFS submittals, pilots are taught to maintain general situation and positional awareness.

6. Why would F-16 pilots transiting Skull Valley through Sevier B MOA avoid entering the restricted air space adjacent to the MOA to the west while transiting the valley?

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[3] The HSI is powered by the emergency generator..

[4] Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Rev 4), page 5.

[5] Ibid, Tab E

Pilots transiting Skull Valley through Sevier B MOA would avoid entering the restricted air space adjacent to the MOA for several reasons. First, flights must be cleared into the restricted airspace by Clover Control. If they haven't received clearance, they won't enter the airspace. Second, the flight transiting Skull Valley may be scheduled for range space in the western portion of the South UTTR not the airspace adjacent to Skull Valley. Third, even if the flight transiting Skull Valley is scheduled for the airspace next to Skull Valley, their range time may not have started yet and another flight may be using the airspace.

7. When F-16s fly down Skull Valley in a formation and the formation was to use a turning point in the valley, how many of the aircraft in the formation would actually fly directly over the turning point?

As noted in the March 30, 2001 RAI response to question 4e, a typical formation for a two ship formation would be for the wingman to be approximately 9,000' line abreast from his leader. Thus, while both aircraft in the flight would be heading in the general direction of the turning point, only one (and possibly neither) would be pointed directly at the turning point. A typical four ship formation will be flown as an "off-set box". This is essentially two flights of two aircraft, with each flight in the line abreast formation. The second, or trailing, second flight (also known as an element) is normally a few miles behind the first flight and offset left or right. Thus, depending on the actual relative position of the aircraft in the flight, and where exactly the flight lead is pointed, there could be one or two aircraft in the flight pointed directly at the proposed PFSF even though everyone in the flight would be pointed in the general direction of the proposed PFSF. It is conceivable, although not likely, that none of the four aircraft would be pointed directly at the PFSF if it were selected as a turn point.

There is no "set" turn point in Skull Valley. There are some buildings and road intersections that can be used if desired. Many flights, however, do not have a turn point in Skull Valley itself; they will use their time in the Valley for administrative procedures, G awareness turns, etc. As such, when entering Skull Valley from the north, they'll use the mountain ranges for the lateral confines and visually point toward the narrow neck or gap at the southern end of the valley.[6] Their first turn point would be either in the neck of the valley or south of it.

8. How big is the S-shaped path (two adjacent 90 degree turns) flown by F-16 pilots doing G-awareness turns?

The G-awareness maneuver is not a precise maneuver and the airspace required will vary depending upon variables such as speed and G loading. As a rough estimate, the turning radius for G awareness turns at 400KCAS and 4-5 G's would be approximately 1nm. A typical delay from the end of the first turn until the beginning of the second turn would 5-10 seconds, although no minimum or maximum amount of delay is required by regulation.

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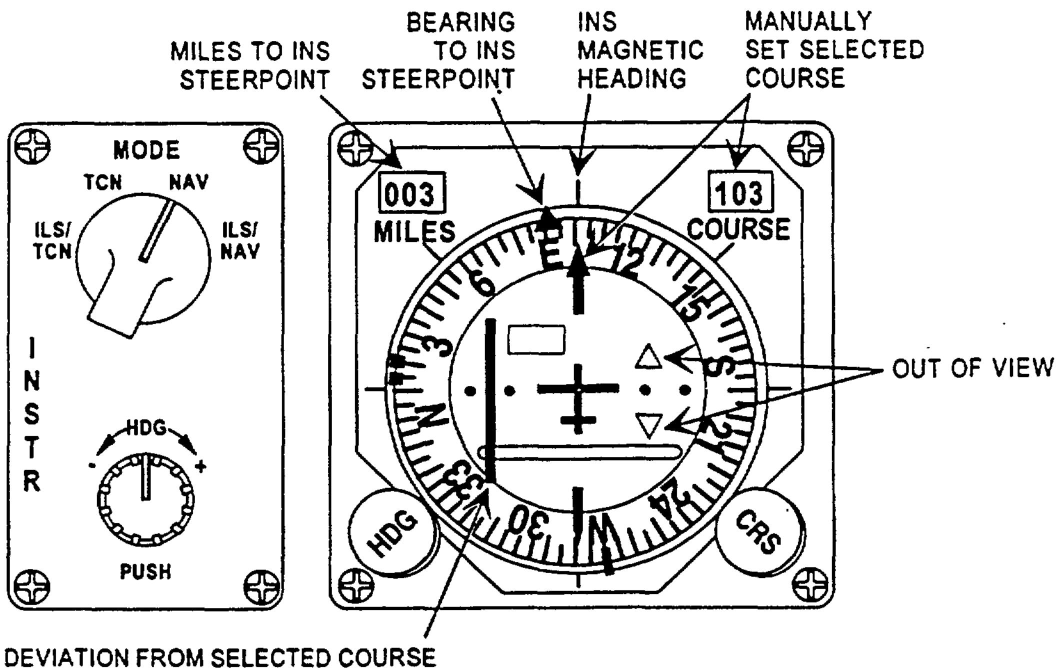
[6] RAI Response, March 30, 2001, page 11.

NAV Selected

When NAV is selected on the instrument mode select knob the following data displays on the HSI: INS magnetic heading, bearing to INS steerpoint, miles-to-go, course deviation, and course set from the selected INS steerpoint (Figure 17). The NAV mode does not change HUD symbology from the standard navigation displays.



NAV Mode HSI Display.

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May 31, 2001

REQUEST FOR ADDITIONAL INFORMATION ON AIRCRAFT HAZARDS—REMAINING REPONSE AND CLARIFICATION
DOCKET NO. 72-22 / TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

Reference 1: NRC Letter, Delligatti to Parkyn, Request for Additional Information, dated March 9, 2001.
Reference 2: PFS Letter, Donnell to Delligatti, Request for Additional Information on Aircraft Hazards—Partial Response, dated March 30, 2001.
Reference 3: April 18, 2001 teleconference between PFS and the NRC.

In Reference 1 the NRC submitted a request for additional information regarding the supplements to PFS's license application that PFS submitted under letters dated January 19 and 25, 2001 and other documents related to aircraft hazards. PFS answered the questions for which it had the information to do so on March 30, as submitted with Reference 2. PFS's responses to the remaining questions are enclosed.

On April 18, 2001, PFS and the NRC participated in a teleconference (Reference 3), in which the NRC requested clarification regarding the effect of a recent design change in the canister transfer building for the Private Fuel Storage Facility on PFS's general aviation aircraft hazard assessment. PFS's clarification is enclosed.

If you have any questions regarding this response, please contact me at 303-741-7009.

Sincerely

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REMAINING RESPONSES TO MARCH 9, 2001 NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING AIRCRAFT AND CRUISE MISSILE HAZARDS AT THE PRIVATE FUEL STORAGE FACILITY AND CLARIFICATION REGARDING IMPACT OF CANISTER BUILDING DESIGN CHANGES ON AIR CRASH HAZARD

EXECUTIVE SUMMARY

This document completes Private Fuel Storage's (PFS) responses to the NRC's requests for additional information of March 9, 2001 regarding aircraft and cruise missile hazards at the Private Fuel Storage Facility (PFSF).[1] On March 30, 2001, PFS answered those questions for which it had the necessary information to provide a response.[2] The remaining answers required obtaining information from the Air Force under the Freedom of Information Act (FOIA). The last of the Air Force responses to PFS's FOIA requests was received May 30, 2001.

The responses below provide, to the extent obtainable, the quantitative information requested by the NRC with respect to Skull Valley F-16 flights (including ordnance carried on such flights), fighter operations on the UTTR, and use of IR-420 for Fiscal Years (FY) 1999 and 2000. This new information confirms and shows the conservatism of PFS's hazard calculations in its January 19, 2001 Addendum[3] to its August 10, 2000 Air Crash Report.[4] The biggest quantitative change is a large reduction in the fraction of Skull Valley F-16 sorties that carry ordnance. This reduction greatly decreases the probability hazard calculated in PFS's Addendum for jettisoned ordnance, which reduces the cumulative hazard for both the base case[5] and the sensitivity analysis.[6]

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[1] March 9, 2001 Letter from Mark S. Delligatti, NRC Senior Project Manager, to John Donnell, PFS Project Director, Requests for Additional Information.

[2] March 30, 2001 Letter from John Donnell, PFS Project Director, to Mark S. Delligatti, NRC Senior Project Manager, Partial Response to Requests for Additional Information.

[3] Addendum to Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Jan. 19, 2001) (Addendum).

[4] Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Aug. 10, 2000) (Revision 4) (Report).

[5] The base case in the Addendum was based on 5,870 flights which was the approximate average of F-16 flights through Skull Valley for FY99 and FY00 (4250 +5757 divided by 2), increased by 17.4% to account for the increased numbers of F-16s to be stationed at Hill AFB. Addendum at pages 3-4. Averaging the new ordnance counts for FY 99 and FY 00 (as was done for Skull Valley flights in the base case) and adjusting the calculation for other new information concerning ordnance referred to above, reduces the probability hazard from jettisoned ordnance for the base case from 1.49×10^{-7} to 3.2×10^{-8}, which in turn reduces the cumulative hazard calculated in the Addendum for the expected, or base, case from $<5.34 \times 10^{-7}$ to $< 4.17 \times 10^{-7}$. See Response to NRC RAI 7(b) at pages 14-15, infra.

[6] PFS also performed a sensitivity analysis assuming that the FY00 F-16 Skull Valley sortie number of 5,757 would be the expected norm (as opposed to the approximate average of the FY99 and FY00 numbers), increased by 17.4% to account for the increased numbers of F-16s to be stationed at Hill AFB. Addendum at page 4, note 5. Using the ordnance count for FY 00 (as was done for Skull Valley flights in the sensitivity case) and adjusting the calculation for other new information concerning ordnance referred to above, reduces the probability hazard calculated in the Addendum for jettisoned ordnance from 1.72×10^{-7} to 3.318×10^{-8}, which in turn reduces the cumulative hazard calculated in the Addendum for the sensitivity case from $<6.04 \times 10^{-7}$ to $< 4.65 \times 10^{-7}$. See Response to NRC RAI 7(b) at page 15, infra.

PFS has made some other adjustments to its hazard calculation to account for new information that it received in the latest round of FOIA responses from the Air Force. First, PFS has learned that the ordnance counts that it has received from Hill AFB may not include ordnance carried on sorties flown by the 419th Fighter Wing stationed at Hill AFB. Therefore, PFS has chosen to conservatively assume that the ordnance counts provided by Hill AFB are for the 388th Fighter Wing only, and has proportionally increased those numbers to account for ordnance carried by the 419th Fighter Wing. See Response to NRC RAI 7 at pages 12-16, infra. This proportional increase for the 419th Fighter Wing is taken into account in the probability hazards calculated in the response to NRC RAI 7(b) at pages 14-16, infra, and summarized in notes 5 and 6 supra.

Further, the Air Force has not provided a specific number for F-16 flights transiting Skull Valley for FY 99 and FY 00 as it had done previously for FY 98. Based on its previous communications concerning Skull Valley F-16 flights for FY 98, PFS had used the total number of flight operations for the Sevier B MOA, under which Skull Valley lies, as the number of F-16 sorties transiting Skull Valley in FY 99 and FY 00 for its calculations in the Addendum. In its recent responses, Hill AFB has stated that it is not possible to determine the exact number of the F-16s transiting Skull Valley because no records are kept for Skull Valley, but that Skull Valley transits would be a subset of Sevier B usage and Sevier D usage (which is roughly about 5% of that for Sevier B). Based on the available information, PFS continues to believe that the best estimate for the number of F-16 flights transiting Skull Valley in FY99 and FY00 are the number of flight operations identified in the Sevier B MOA usage reports. However, PFS has done a sensitivity analysis to show that, conservatively setting Skull Valley transits to be equal to the sum of the Sevier B and Sevier D transits, the cumulative hazard would remain well below 1 x E-6.[7]

PFS has also provided the information on sortie and fighter hours for operations on the South UTTR and has provided available information concerning IR 420 as it relates to traffic to and from Michael Army Airfield on Dugway Proving Ground. The information on fighter operations on the South UTTR does not affect PFS's assessment in the Addendum that the probability hazard is < 1 x E-8 because those operations occur too far away from the PFSF to present a credible hazard. No precise flight counts are available for IR-420, but the available information regarding Michael Army Airfield shows that the traffic count used by PFS in its hazard calculation is conservative.

In this document PFS also answers several remaining questions concerning past cruise missile crashes on the UTTR. The Air Force has stated that no cruise missile crashes have occurred outside UTTR air boundaries and no information provided by the Air Force provides reason to doubt the Air Force's previous statements that all cruise missile impacts have occurred

[7] This sensitivity analysis assumes that the new expected norm for Skull Valley flights would be the sum of the FY00 flight operations for Sevier B and Sevier D or 5,757 + 240, adjusted upward by 17.4% for the additional F-16s to be stationed at Hill, or (5,997 x 1.174) or 7040. While PFS does not believe that this number is likely to be the norm, using it would increase the cumulative hazard from the base case value of < 4.17 x E-7 to < 4.90 x E-7, taking into account the other changes discussed in the text above. See Response to NRC RAI 7(b) at page 15, infra.

within at most half a mile of the intended ground track of the missile at the time of the crash and that the UTTR has never experienced a cruise missile flight termination system failure.

Finally, this document responds to the NRC's request for clarification made during a teleconference between PFS and the NRC on April 18, 2001 regarding the effect of recent design changes in the canister transfer building (CTB) on PFS's air crash hazard for general aviation. After the changes, the roof of the CTB would no longer be designed to withstand the design basis tornado missile Spectrum II automobile impact.[8] PFS had previously assessed that potential impacts of light general aviation aircraft would be bounded by the impact of the design basis tornado missile and thus would not pose a hazard to the CTB. Nevertheless, the area of the CTB roof is very small relative to the effective area of the PFSF as a whole. Therefore, even if it is assumed that the impact of a light general aviation aircraft on the roof might damage a spent fuel canister inside the CTB, the effect of the CTB roof design change on the general aviation hazard to the PFSF is negligible.

[8] The CTB roof, however, is designed to withstand other tornado-driven missiles in Spectrum II as necessary to meet NRC regulatory requirements.

REMAINING RESPONSES TO MARCH 9, 2001 NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING AIRCRAFT AND CRUISE MISSILE HAZARDS AT THE PRIVATE FUEL STORAGE FACILITY AND CLARIFICATION REGARDING IMPACT OF CANISTER BUILDING DESIGN CHANGES ON AIR CRASH HAZARD

I. REMAINING RESPONSES TO MARCH 9, 2001 NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING AIRCRAFT AND CRUISE MISSILE HAZARDS AT THE PRIVATE FUEL STORAGE FACILITY

AIRCRAFT DEPLOYMENT AND SORTIES

1. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from the additional F-16 aircraft and resulting sorties at Hill Air Force Base:

   (e) Provide data on the number of F-16 sorties flown through Skull Valley each year from FY 1998 to FY 2000 and the number of aircraft stationed at Hill AFB for the same years.

Response

PFS has previously obtained from the Air Force, and provided as part of its Report,[1] the number of F-16 sorties through Skull Valley for Fiscal Year (FY) 1998, which was 3,871.[2] Based on these previous communications, PFS used the total number of flight operations from the MOA usage reports for Sevier B, under which Skull Valley lies, as appropriate to determine the number of F-16 sorties transiting Skull Valley in subsequent years for the revised calculations in its January 19, 2001 Addendum to the Report.[3] The number of operations in

[1] Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Aug. 10, 2000) (Revision 4), page 5 (Report).

[2] That number was provided to Brig. Gen. Cole, USAF (Ret.), in a series of conversations with Colonel Charlie Bergman, Deputy Chief of Safety, USAF, and Lt. Col. Dan Phillips, Office of the Chief of Safety, in late 1998 and the first part of 1999. Subsequently, in response to a follow-up Freedom of Information Act (FOIA) request made in the summer of 1999 for the documentary support of the 3,871 number, Hill AFB referenced as support for this number and as being applicable for Skull Valley the Military Operating Area (MOA) usage report for Sevier A instead of Sevier B under which Skull Valley lies. 388th FW Wing Response to FOIA Request of July 24, 1999. (Sevier A is to the south and west of Sevier B and is also part of the route taken by those F-16s transiting Skull Valley on their way to the South UTTR). Although there is a slight difference in the number of operations for FY98 shown on the MOA usage report for Sevier A (3,871) and the report for Sevier B (3,878), PFS has used 3,871 as the applicable number (both for Skull Valley and Sevier B) because of the small differences between the two numbers and because PFS had previously been provided the 3,871 number directly in responses to its requests for F-16 flights transiting Skull Valley. Further, in subsequent years (FY99 and FY00) PFS has used the Sevier B MOA usage reports since Skull Valley lies under Sevier B and not Sevier A. (In FY99, the flight operations shown on the Sevier A and Sevier B MOA usage reports are identical and for FY00 there is a difference of one flight operation between the two MOAs.)

[3] Addendum to Aircraft Crash Impact Hazard at the Private Fuel Storage Facility (Jan. 19, 2001), page 1, note 1 (Addendum).

Sevier B for FY 1999 was 4,250 and the number for FY 2000 was 5,757 as reflected in the Addendum at page 1.

In its most recent FOIA inquiries, PFS specifically requested how many of the total number of flight operations for Sevier B for FY 1999 and FY 2000 represented F-16s transiting Skull Valley en route to the UTTR.[4] Also, to follow-up on claims made by Lieutenant Colonel Horstman, USAF (Ret), that F-16s transiting Skull Valley may fly above Sevier B airspace,[5] PFS at the same time requested the MOA usage reports for Sevier D (which lies above Sevier B) for FY 1999 and FY 2000 as well as how many of the total number of flights from the MOA usage reports for Sevier D represented F-16s transiting Skull Valley en route to the UTTR.[6] In its responses, however, Hill AFB stated that it was not possible to determine the exact number of the F-16s transiting Skull Valley because no records are kept for Skull Valley transitions as a subset of Sevier B and D MOA usage, but it did indicate that a majority of the flights are F-16s.[7]

Thus, the Air Force's recent responses for FY99 and FY00 flight information are less precise than those previously provided PFS for FY98 in which it identified a specific number of flights transiting Skull Valley (3,871). Further, the Air Force has now indicated that, in addition to F-16 Skull Valley flights going through Sevier B, the majority of flights going through Sevier D are also F-16s transiting Skull Valley. As reflected in the following Table, however, the number of total flights identified in the MOA usage reports for Sevier D are small compared to

[4] FOIA Request from James L. Cole, Jr., Brig. Gen. USAF (Ret.), to Mary Maynard, FOIA Manager Hill AFB (February 13, 2001) (Feb. 13 FOIA Request).

[5] E.g., Declaration of Lt. Colonel Hugh L. Horstman, Air Force (Retired) in Support of the State of Utah's Response to PFS's Motion for Summary Disposition of Contention Utah K and Confederated Tribes B (Jan. 30, 2001) ¶ 16.

[6] Feb. 13 FOIA Request. PFS also made the same request for Sevier D for FY98. FOIA Request from James L. Cole, Jr., Brig. Gen. USAF (Ret.), to Mary Maynard, FOIA Manager Hill AFB (February 12, 2001) (Feb. 12 FOIA Request).

[7] In its response to PFS's February 13 FOIA Request (which had requested the number of F-16s transiting Skull Valley enroute to the UTTR included in the total flight numbers for Sevier B and Sevier D for FY99 and FY00), Hill AFB responded as follows:

> No records are kept for Skull Valley transitions as a subset of the Sevier B and D MOA usage or as an entry or departure route to/from the range. Therefore, there is no way to determine the exact number of F-16s that transited Skull Valley.

March 28, 2001, FOIA Response from Hill AFB, Mary Maynard, FOIA Manager Hill AFB Utah. In its response to PFS's February 12 FOIA Request (which had requested information on the number of F-16s transiting Skull Valley enroute to the UTTR included in the total numbers for the Sevier D MOA usage reports), Hill AFB responded as follows:

> Sevier D Military Operations are not broken out by aircraft type, but the majority of operations for each year would have been for F-16 aircraft. . . . . No records are kept for Skull Valley transitions as a subset of the Sevier B and D MOA usage or as an entry or departure route to/from the range.

March 28, 2001 FOIA Response from Hill AFB, Mary Maynard, FOIA Manager, Hill AFB Utah.

Sevier B and constitute on average for FY98, FY99, and FY00 only approximately 5.7% of the flight operations identified in the Sevier B MOA usage reports.

	Sevier B	Sevier D
FY98	3,871	215
FY99	4,250	336
FY00	5,757	240

Further, as reflected in the Air Force FOIA responses, not all flight operations identified in the Sevier B and D MOA usage reports are F-16s transiting Skull Valley. Both Sevier B and Sevier D (which overlies Sevier B) are 145 miles long, extending more than 100 miles south of Skull Valley,[8] and various flight operations in these MOAs take place in the southern part of Seviers B and D far from Skull Valley. For example, cruise missiles and the chase aircraft that follow them as safety observers fly in the southern portions of the Sevier B MOA but do not overfly Skull Valley.[9]

Therefore, PFS continues to believe, as before, that the best estimate for the number of F-16 flights transiting Skull Valley in FY99 and FY00 (for which the Air Force did not provide a specific number as it had previously done for FY98) are the number of flight operations identified in the Sevier B MOA usage reports. This corresponds to the source of the Skull Valley F-16 number provided by the Air Force for FY98, discussed in note 2, supra, and takes into account that flight operations other than F-16s transiting Skull Valley occur in the large southern expanse of Seviers B and D.[10]

Hill AFB has also provided information on the number of aircraft assigned to the 388th FW (Chargeable Aircraft) for each of the past three fiscal years.[11] For those 3 years, the number was stable at 54. (An additional 12 aircraft were officially assigned to the wing in the third quarter (April) of FY 01 and the wing received funding for them at that time (although 6 of those aircraft were physically present at Hill AFB by the end of the third quarter (June) of FY 00)).[12] The best available information shows that 15 aircraft were assigned to the 419th FW (Reserve) at Hill for each of these years, giving a total of 69 F-16 aircraft at Hill for each year.

[8] See Salt Lake City Sectional Aeronautical Chart, National Oceanic and Atomspheric Administration (NOAA); Las Vegas Sectional Aeronautical Chart, NOAA.

[9] See Risk Assessment of Cruise Missile Accidents Impacting Private Fuel Storage LLC Independent Spent Fuel Storage Installation, Rev. 1 (Jan. 25, 2001), pages 26-27.

[10] PFS has, however, performed a sensitivity analysis showing that the cumulative hazard remains well below the regulatory limit of 1 x E-6 even assuming the number of F-16 flights through Skull Valley were equal to the sum of the flight operations for the Sevier B and D MOAs. See, page 14 infra.

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

[12] The wing's flying hour program and the additional pilots, maintenance personnel, funding and other resources necessary to support an increase in the flying hour program would not be made available until the aircraft were formally assigned to the wing (chargeable aircraft). See Response to Questions 1(c) and 1(d) (Mar. 30, 2001).

Therefore, the number of F-16 sorties flown through Skull Valley each year from FY98 to FY00 and the total number of aircraft stationed at Hill AFB for both the 388th and the 419th FW for the same years are as follows:

	Skull Valley Flights	Aircraft Assigned
FY 98	3,871	69
FY 99	4,250	69
FY 00	5,757	69

It should be noted, however, that the number of aircraft assigned does not totally reflect the true activity of the wing on the South UTTR as it fails to account for the aircraft which are assigned to the wing but are deployed and flying elsewhere both in the Unites States (e.g. training deployments such as Red Flag at Nellis AFB) and overseas to support contingency operations, such as Operation Southern Watch in Saudi Arabia.

(f) Provide a breakdown of the number of flights to the UTTR South area including number of hours spent in each discrete area of restricted air space in FY 1999 and FY 2000.

Response

The following analysis includes data for FY 1998, as presented in the Report, for comparison with the FY 1999 and FY 2000 data.

Data from Hill AFB shows the following F-16 sorties and flight hours in the UTTR South range for the year indicated.

	F-16 Sorties	F-16 Hours
FY 98	5,726	6,678.1
FY 99	7,232	8,671.3
FY 00	7,059	9,017.1

Hill AFB also provided data on the total number of operations flown in the following South UTTR restricted areas, but did not provide the associated flight hours for each area. These operation counts include aircraft of all types in each restricted area, hence are higher than the actual count of operations involving fighter aircraft or F-16s from Hill AFB in each area. For Restricted Areas 6402 and 6406, which have A and B sections, the smaller B sections have been combined with the larger A areas into a single area and the traffic counts have been consolidated using the higher counts for the A sections.[13]

[13] As explained in the Report, the B sections of these restricted areas "are too small to independently conduct training exercises without use of the large adjacent 'A' portions of the ranges. . . ." Report at 36-37, note 44. See also the discussion in the Report at 37-37a.

An operation is one aircraft entering or transiting the area. Since an F-16 or other aircraft might transit or use several areas in a single flight, a single sortie may be counted several times, each time in a different area, during its flight.

Total Operations

	6402	6405	6406	6407	Sevier A	Sevier B
FY 1998	909	5,995	6,679	5,897	3,871	3,871
FY 1999	3,314	6,469	6,757	6,288	4,250	4,250
FY 2000	6,991	8,694	6,915	6,862	5,756	5,757

As in the Report at page 36, PFS assumed that the proportion of the total number of hours spent in each area was proportional to the number of operations conducted in each area. Doing so, the following estimate of F-16 flight hours for each area was derived.

F-16 Flight Hours
(South UTTR)

	6402	6405	6406	6407	Sevier A	Sevier B
FY 1998	222.9	1470.3	1638.1	1446.3	949.4	951.1
FY 1999	917.3	1790.6	1870.3	1740.5	1176.4	1176.4
FY 2000	1537.6	1912.1	1520.9	1509.2	1266.0	1266.2

In the Report at page 34, based on information provided by the Vice Commander of the 388th Fighter Wing, the estimated number of air-to-air combat training hours was set at one third of the total range hours. Thus, the estimated F-16 air to air hours are:

F-16 Air to Air Hours[14]
(South UTTR)

	6402	6405	6406	6407	Sevier A	Sevier B
FY 1998	74.3	490.1	546.0	482.1	316.5	317.0
FY 1999	305.8	596.9	623.4	580.2	392.1	392.1
FY 2000	512.5	637.4	507.0	503.1	422.0	422.1

In Table 3 of the Report which follows page 32, flight hours for fighter aircraft in addition to the F-16 operating on the UTTR were provided in order to obtain an estimate of total air to air flight hours in each of the restricted areas. The hours for the other fighters are far overshadowed by F-16 hours provided above. However, for completeness and comparison to the Report, total air to air hours are presented below, which include hours for other fighter aircraft as well as the F-16:

Total Fighter Sorties and Flight Hours
(South UTTR)

	FY98 Sorties	Hours	Air to Air	FY99 Sorties	Hours	Air to Air	FY00 Sorties	Hours	Air to Air
F-16	5726	6678.1	2225.8	7232	8671.3	2890.4	7059	9017.1	3005.7
F-15	265	303.1	101.0	266	443.2	147.7	270	484.7	161.6
F-18	294	272.9	91.0	76	82.2	27.5	86	66.6	22.2
F-117			0.0	2	1	0.3	6	3.5	1.2
F-14			0.0	4	5.4	1.8	48	59.4	19.8
Mixed Fighters	75	149.9	50.0	8	4.5	1.5	31	55.8	18.6
Total	6360	7404	2467.8	7588	9207.8	3069.3	7500	9687	3229.0

Allocating these air to air hours to the range areas according to the number of operations in each as done above for F-16s yields the following:

[14] As noted in the Report on page 36, note 43, although military aircraft do not conduct combat training over Skull Valley, PFS includes operations in the MOAs when calculating the fraction of time spent in training in each area of the UTTR to account for the time spent by aircraft flying through the MOAs en route to the restricted area where the combat training takes place.

Total Fighter Air-to-Air Hours
(South UTTR)

Operations	FY 98 Air to Air	FY 99 Air to Air	FY 00 Air to Air
6402	82.4	324.7	550.9
6405	543.3	633.8	685.1
6406	605.3	662.0	544.9
6407	534.4	616.1	540.8
Sevier A	350.8	416.4	453.6
Sevier B	351.5	416.4	453.7
Total	2467.8	3069.3	3229.0

(g) Discuss whether the number of hours spent in air-to-air and air-to-ground combat training on the UTTR South area increases proportionally with the total number of F-16 sorties flown through Skull Valley.

Response

The numbers of UTTR South Area flying hours for both F-16 and fighter aircraft generally (discussed in question 1(f)), the number of Skull Valley F-16 sorties (discussed in question 1(e)), and the number of South UTTR fighter sorties in each of the last three years are shown below:

Year	UTTR South Fighter Hours	UTTR South Fighter Sorties	UTTR South F-16 Hours	UTTR South F-16 Sorties	Skull Valley F-16 Sorties
FY 98	7,404.0	6,360	6,678.1	5,726	3,871
FY 99	9,207.6	7,588	8,671.3	7,232	4,250
FY 00	9,687.1	7,500	9,017.1	7,059	5,757

As may be seen, UTTR South hours by all fighters and by F-16s alone do not correlate well with Skull Valley sorties. In FY99, Skull Valley sorties experienced a 9.8% increase over FY 98, yet UTTR South total fighter hours increased 24.4% and F-16 hours increased 29.8%. Skull Valley sorties experienced a 35.5% increase in FY 00 over FY 99, yet UTTR South total fighter hours increased only 5.2% and F-16 hours increased only 4.0% and over FY 99.

Based on the earlier information, PFS had forecast that flight hours on the UTTR South would increase proportionally with increases in Skull Valley F-16 transits. Addendum, page 6. That turns out to have been a conservative assumption, as in fact the new data shows that UTTR flight hours have not kept up with the Skull Valley sortie count. From FY 98 to FY 00, Skull

Valley sorties have increase by 48.7% yet total fighter hours in the South UTTR have only increased 30.8% and F-16 hours have only increased 35.0%.[15]

[15] PFS has assessed, however, that the crash hazard posed to the Private Fuel Storage Facility from operations on the South UTTR would be less than 1 x E-8 independent of the number of sorties conducted or hours flown there. See Addendum § II, in particular the "Third Major Conservatism in the UTTR Calculation", pages 9-11.

2. Provide the following items which are related to the effect on the aircraft crash probability at PFSF from aircraft sorties flown in IR-420:

(a) Specify the number of flights through IR-420 in FY 2000.

Response

Neither the Air Force[16] nor the Army[17] was able to provide any information on IR-420 traffic for FY 2000. Nevertheless, Michael Army Airfield has stated that 89 percent of "flight operations" at Michael are conducted by aircraft originating from Hill AFB.[18] The remaining 11 percent of the flights that utilize the airspace or land at Michael originate from "mostly military airfields within 200 to 350 nautical miles" of Michael.[19] Further, the "majority" of all types of aircraft that use the Michael airspace or land at Michael are F-16 jet fighters that use Michael for "recurring training" on approaches and landings required by Air Force Standards.[20]

In telephone conversations with Base Operations personnel at Michael Army Airfield and at Clover Control, PFS confirmed that the great majority of the 89% of the flight operations that are associated with aircraft that originate from Hill AFB are F-16s conducting training at Michael and that most of the other aircraft that fly to and from Michael are military and civilian cargo types, such as the C-5, C-141, C-130, the Boeing 727 and smaller aircraft, such as the C-21 and C-12. Further, PFS was advised that the F-16s that use Michael Army Airfield often proceed directly from the ranges on the UTTR to Michael for practice approaches and landings, without using IR-420 or flying to Michael across Skull Valley in the direction of the PFSF. Furthermore, any F-16s that would fly directly from Hill to Michael would already be accounted for in PFS's assessment of the risk from F-16 flights through Skull Valley (to fly directly from Hill to Michael and cross near the PFSF an aircraft would have to enter Sevier B MOA, which traffic is

[16] The Air Force FOIA Response stated that the Air Force does not have any records that would provide this information. May 8, 2001, FOIA Response from Hill AFB, Mary Maynard FOIA Manager, Hill AFB.

[17] The Army FOIA Response specifically said that it does not track this information. April 10, 2001, FOIA Response from Dugway Proving Ground (Michael AAF), Teresa Shinton, FOIA Manager, Dugway Proving Ground, Utah.

[18] November 15, 1999, FOIA Response to State of Utah from Dugway Proving Ground (Michael AAF), Lt. Col. Gaylen Whatcott, Command Judge Advocate. This and other MAAF FOIA responses deal only with the "flight operations" in their airport traffic area (i.e., within a 5-mile radius and up to and including 2,999 ft. above ground level), which are defined to include takeoffs, approaches, landings, and flights through the airport traffic area. See U.S. Department of Transportation Order 7210.3R, February 24, 2000, Chapter 9 – Operational Count Data. Thus, a flight to Michael AAF by a single aircraft could represent more than one "flight operation." For example, if as part of recurring training requirements an F-16 pilot does a low approach and a go-around, that counts as two flight operations. If a pilot were to do three low approaches and go-arounds prior to departing MAAF and returning to Hill, that would be total of six flight operations.

[19] In its FOIA response to the State (note 18, supra), MAAF states that representative airfields included Nellis AFB, Nevada; Boise, Idaho; Mountain Home AFB, Idaho; NAS Fallon, Nevada; Ellsworth AFB, South Dakota; McConnell AFB, Kansas; Yuma MCAS, Arizona; Aberdeen Proving Ground, Maryland; Yuma Proving Ground, Arizona, Salt Lake International Airport, Wendover, assorted civilian airports throughout the Wasatch. Approximately 2% of the 11 % originate from the East Coast.

[20] MAAF Response to State FOIA Request, note 18, supra.

accounted for in PFS's analysis of Skull Valley F-16 traffic). Therefore, the great majority of the 89 percent of the flight operations at Michael, which are conducted by F-16s, may be disregarded for the purpose of calculating the IR-420 hazard to the PFSF.[21]

Michael AAF has stated that 1,929 flight operations were conducted at Michael in FY00.[22] Based on the above information, approximately 1,717 of these operations would be associated with aircraft originating from Hill, the large majority of which would be F-16s already accounted for in PFS's calculations. The remaining 212 would be associated with various airfields around the country and could approach Michael from any direction. Some small proportion of the 1,717 operations originating from Hill would be non-F-16 traffic not otherwise accounted for in PFS's F-16 calculations, that could pass near the PFSF and should be counted as potential IR-420 traffic, while a large proportion of the 212 flights from around the country would likely not pass near the site since they could approach Michael from any direction and should not be counted. Since the large portion of flights from around the country that would not fly near the proposed PFSF site should more than offset the non-F-16 operations associated with flights that originate from Hill that might pass near the PFSF, PFS believes that a reasonable, conservative estimate to use for FY00 for purposes of the IR-420 calculation would be the 212 flight operations associated with the 11% of the aircraft not originating at Hill. This total estimate is significantly less than the 414 flights for IR-420 assumed in PFS's Aircraft Crash Report.

(b) Identify and describe any routes other than Skull Valley and IR-420 by which aircraft enter the UTTR South area and provide the associated traffic rates in relation to the known air traffic rate for Skull Valley.

Response

There are five standard flight plans by which pilots routinely enter the South UTTR from Hill AFB without flying through the Sevier B MOA.[23] Four of these flight plans go from Hill AFB to a point near the western shore of Stansbury Bay of the Great Salt Lake north of I-80.[24] The two most commonly used of these four flight plans then proceed to R-6406 (in the South UTTR) without going through the Sevier B MOA. The other two flight plans are used when flights will be conducting aerial refueling. From the point near the western shore of Stansbury Bay[25] the flights proceed west for approximately 52 statute miles to the Bonneville TACAN.[26]

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[21] To be precise, route IR-420 ends at the northern end of Sevier B MOA, about 16 miles north of the PFSF. PFS has used "IR-420" as a surrogate to account for traffic other than F-16s that fly to and from Michael AAF and pass in the vicinity of the PFSF site, assuming for the purpose of analysis that the traffic would fly along an extension of IR-420 toward Michael AAF. While the nomenclature may not be technically precise, PFS will continue to use the term "IR-420" to represent such traffic.

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

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

[24] See Map at Tab A of the Report. This point is defined as the 250° radial for 40 NM from the Hill AFB TACAN. It is annotated on the flight plans as HIF 250040.

[25] 250- radial for 40 NM from the Hill AFB TACAN.

After passing the Bonneville TACAN flights proceed southwest for approximately 50 NM to the aerial refueling track on the western side of the UTTR. When they have completed the aerial refueling, flights proceed in an eastward direction to R-6406. The fifth flight plan is normally only used by especially qualified pilots flying an aircraft maintenance check flight referred to as a Functional Check Flight (FCF). On this route, pilots fly from Hill AFB to R-6404 (in the North UTTR) and then into R-6406. FCFs represent a small percentage of flights flown from Hill AFB.

(c) Specify whether all of the aircraft going to Michael Army Air Field through IR-420 are transport aircraft.

Response

The U.S. Air Force and the U.S. Army do not keep precise records of the types of aircraft that use IR-420. See notes 16 and 17 supra. As noted in response to question 2(a) above, the Michael AAF operations that are conducted by aircraft other than F-16s are conducted by largely military and civilian cargo types such as the C-5, C-141, C-130, the Boeing 727 and smaller aircraft, such as the C-21 and C-12. Therefore, while not all of the non-F-16 flights to and from Michael are transport aircraft, most of them are and it is reasonable to take the approach PFS used in calculating the hazard to the PFSF from Michael Army Airfield flights. See Report Chap. VI.

Footnote continued from previous page

[26] Salt Lake Sectional Aeronautical Chart, National Oceanic and Atmospheric Administration.

AIRCRAFT ORDNANCE

7. Provide the following items which are related to the effect on the aircraft crash probability at the proposed PFSF from aircraft ordnance:

(a) Provide a breakdown of the live and inert ordnance (e.g., numbers of each type such as MK84, CBU, etc.) carried by F-16 aircraft while transiting through Skull Valley in FY 2000, including the number of flights that carried each type.

Response

In FY 2000, the following ordnance was carried by F-16 aircraft from the 388th Fighter Wing at Hill AFB. Records were not kept on the route of flight of the aircraft carrying these munitions.

- 14 Live Mk-84 (2000 pound bomb), normally two per aircraft and includes laser guided bombs of this weight class. 7 sorties.
- 43 Inert Mk-84 (2000 pound bomb), normally two per aircraft and includes laser guided bombs of this weight class. 21 sorties.
- 224 Live Mk-82 (500 pound bomb), normally four or six per aircraft and including laser guided bombs of this weight class. 56 sorties.
- 182 Inert Mk-82 (500 pound bomb), normally four or six per aircraft and including laser guided bombs of this weight class. 44 sorties.[27]

While Hill AFB does not keep records of routes of flight of the F-16s carrying ordnance to the South UTTR, PFS divided such aircraft between Skull Valley flights and flights directly

[27] PFS requested from Hill AFB "[t]he number of F-16 sorties for FY 1999 and the number of F-16 sorties for FY 2000 that flew through Skull Valley with live and full scale intert ordnance." March 2, 2001, FOIA Request from Brig. Gen. James L. Cole, Jr., USAF (Ret.), to Mary Maynard, FOIA Manager Hill AFB. PFS received a response from Hill concerning the 388th Fighter Wing which it attributed as being a complete response to its request since it had received no indication to the contrary. Only upon further inquiries to the Hill FOIA office and the Vice Commander for the 388th did PFS learn that, even though the 419th Fighter Wing had no separate ordnance records, the above ordnance counts may not include ordnance carried on sorties flown by the 419th Fighter Wing on the South UTTR. Therefore, PFS has chosen to conservatively assume that the above ordnance counts do not include 419th FW sorties and to account for ordnance carried by the 419th FW separately. Based on Col. Fly's general knowledge of the practices of the 419th FW, PFS has accounted for its usage by assuming that it would fly sorties on the South UTTR with ordnance at the same rate and using the same munitions, on a per aircraft basis, as the 388th FW, which the Vice Commander of the 388th FW has concurred would be a reasonable assumption. Thus, PFS accounts for the use of ordnance by F-16s at Hill AFB by multiplying the usage of the 388th FW by a factor equal to the sum of the aircraft assigned to the 388th and the 419th, divided by the number of aircraft assigned to the 388th FW. For the three years for which PFS has obtained ordnance counts (FY98 to FY00), the 388th FW had 54 aircraft assigned and the 419th FW had 15 assigned. See pages 3-4, supra. Therefore, to incorporate the proportional increase attributable to the 419th FW, one would multiply the ordnance usage by the 388th FW by (54 + 15)/54, or 1.278.

into the UTTR South Area on the basis of the total F-16 sorties flown on the South UTTR and the F-16 sorties flying through Skull Valley. Report at pages 81-82.[28] For FY 98, PFS determined that 68 percent of the sorties carrying ordnance to the South UTTR transited Skull Valley. See Report at page 82. For FY 00, the total F-16 sorties on the South UTTR was 7,059 while the number of F-16 sorties transiting Skull Valley was 5,757. Therefore, following the same approach as used in the Report, approximately 82 percent of the above 388th Fighter Wing sorties carrying ordnance to the South UTTR in FY 00 would be expected to have transited Skull Valley. Similarly, 82 percent of the 419th Fighter Wing sorties carrying ordnance (see note 27 supra) would be expected to have transited Skull Valley.

(b) Specify whether the same types and proportional mix of ordnance were used in both FY 2000 and FY 1998.

Response

The ordnance carried in FY 98 by the 388th FW is listed in Table 4 on page 81 of the Report, Revision 4, August 10, 2000. The table below compares the two sets of data.[29]

Ordnance	Sorties FY98	Sorties FY00	Number of Munitions FY 98	Number of Munitions FY 00
Mk-84 Live*	111	7	156	14
Mk-84 Inert*	38	21	89	43
Mk-82 Live*	166	56	544	224
Mk-82 Inert*	355	44	1,029	182
AGM-65 Maverick	4	0	4	0
CBU-87 1000 pound cluster bomb	4	0	16	0
Totals	678	128	1,838	463

*Includes laser guided bombs of this weight class.

The proportion of sorties carrying bombs in FY 98 that carried the heavier Mk-84 bombs is 22% (111 Mk-84 live sorties + 38 Mk-84 inert sorties divided by 678 total sorties). This is the same proportion as in FY 00 (7 Mk-84 live sorties + 21 Mk-84 inert sorties divided by 128 total sorties).

[28] PFS was advised by Hill AFB that virtually all the sorties carrying ordnance were conducted on the South UTTR as opposed to the North UTTR. Report at page 81. Accordingly, in the Report PFS assumed that all sorties carrying ordnance were conducted on the South UTTR, id., and assumes the same here with respect to FY 00.

[29] In addition, in FY 98, there were 800 sorties carrying 7,205 BDU-33 25-pound training bombs. These small bombs are not generally jettisonable from the F-16 and pose no independent threat to the proposed PFSF. Accordingly, they were not used in PFS's previous calculations in determining the potential hazard to the PFSF from jettisoned ordnance. Because these training bombs were neither mentioned in the April 1, 2001 FOIA response for FY 2000 nor used in PFS's earlier calculations, they have been left out of the following comparisons.

In terms of the number of munitions, the proportion of the heavier Mk-84s used in FY 98 is 13% (156 Mk-84 live munitions + 89 Mk-84 inert munitions divided by 1,838 total munitions) as compared with 12 % in FY 00 (14 Mk-84 live munitions + 43 Mk-84 inert munitions divided by 463 total munitions).

As may be easily noted, the number of 388th FW sorties carrying munitions has been reduced precipitously, from 678 in FY 98 to 128 in FY 00 (an 81% reduction). The number of munitions carried also reduced sharply, from 1,838 in FY 98 to 463 in FY 00 (a 75% reduction). Notably, this has occurred even as the number of sorties has risen to higher levels.

The impact of these revised numbers on the overall probabilities of striking the PFSF is significant. As calculated in the January 19, 2001 Addendum to the Report, the probability of jettisoned ordnance striking the PFSF was 1.49×10^{-7}, taking into account an increased number of sorties flown from Hill AFB for FY99 and FY00.[30]

Using the newly released numbers, the number of F-16 sorties on the South UTTR in FY00 was 7,059, the number of F-16 sorties using Sevier B was 5,757, and the number of sorties carrying jettisonable ordnance was 128. Following the calculations of the original Report, page 82, the fraction of sorties carrying jettisonable ordnance on the South UTTR for FY00 is 128/7,059, or 0.018, comparable to the fraction of 0.118 for FY98 in the Report (both fractions accounting for 388th FW sorties only).

The Air Force also provided information for FY99 ordnance which reflects that the percentage of sorties carrying ordnance in FY00 is virtually the same as for FY99. In FY99, the number of 388th FW F-16 sorties carrying ordnance on the South UTTR was 151 and the applicable fraction of sorties carrying ordnance, comparable to that calculated in the Report, was therefore 0.021 (151/7,232 South UTTR sorties). Using an average for FY99 and FY00, as was done for the base case in the Addendum for the number of Skull Valley F-16 flights, results in an average fraction of sorties carrying jettisonable ordnance on the South UTTR for FY99 and FY00, comparable to that in the Report, of 0.020 (again both fractions accounting for 388th FW sorties only).

If the average fraction of sorties carrying jettisonable ordnance on the South UTTR for FY99 and FY00 is increased proportionally to include the 419th FW, the fraction is increased to 0.02556 (0.020 x 1.278 (see note 27, supra)). Using this fraction, and holding the other factors constant,[31] the probability of striking the PFSF with jettisoned ordnance for the 5,870 flights PFS

[30] This probability does not account for the usage of ordnance by the 419th FW. To incorporate that effect, one would multiply the above probability by the factor of 1.278 derived in note 27, supra, which would increase the probability of jettisoned ordnance as calculated in the Addendum to 1.91 x E-7 and the cumulative hazard to less than 5.76 E-7. PFS's calculations in the text above of the effects of ordnance usage for FY99 to FY00 and beyond, however, do include the effects of ordnance usage by the 419th FW.

[31] The other factors held constant are the width of the PFSF equal to 1,520 ft (0.2879 mi.), the effective width of the valley equal to 10 mi., the crash rate of 2.736×10^{-8} per mile, the fraction of crashes precipitated by non-catastrophic engine failure of 0.90, and the depth of the cask storage area of 1,590 ft. (0.3011 mi.). See Report at page 82.

projected as its base case for Skull Valley and used in PFS's calculation for jettisoned ordnance in the Addendum is calculated as:

P_0 = 5,870 x 0.2879/10 x .002556 x 2.736 x 10^{-8} x 0.90 x 0.3011 = 3.20 x E-8

This is a decrease of 1.17 x 10^{-7} from the hazard of 1.49 x 10^{-7} calculated in the Addendum for jettisoned ordnance, which would reduce the Cumulative Hazard calculated in the Addendum for the expected, or base, case from <5.34 x 10^{-7} to < 4.17 x 10^{-7}.

As stated, the base case in the Addendum was based on 5,870 flights which was the approximate average of F-16 flights through Skull Valley for FY99 and FY00 (4,250 +5757 divided by 2), increased by 17.4% to account for the increased numbers of F-16s to be stationed at Hill AFB. Addendum at pages 3-4. PFS also performed a sensitivity analysis assuming that the FY00 F-16 Skull Valley sortie number of 5,757 would be the expected norm (as opposed to the approximate average of the FY99 and FY00 numbers). Id. at page 4, note 5. Adjusting this number upward by 17.4% to account for the additional F-16s, the Skull Valley sortie number under this assumption would be 6,759. Id. The jettisoned ordnance calculation in the Addendum for this sensitivity study was 1.72 x 10^{-7} and the Cumulative Hazard was < 6.04 x E-7.[32] Id. at 5, note 6; id. at 19. Using the FY00 fraction of aircraft carrying ordnance of 0.018 calculated above, adjusted upward proportionally to 0.0230 to include the 419th FW (0.018 x 1.278, see note 27, supra), results in a significant reduction in both the hazard for jettisoned ordnance and the Cumulative Hazard. For the new FY00 data, the hazard from jettisoned ordnance for this sensitivity analysis would be:

P_0 = 6,759 x 0.2879/10 x 0.0230 x 2.736 x 10^{-8} x 0.90 x 0.3011 = 3.318 x E-8

This is a decrease of 1.39 x 10^{-7} from the probability of 1.72 x 10^{-7} for jettisoned ordnance calculated in the Addendum for this sensitivity analysis, which would reduce the Cumulative Hazard calculated in the Addendum for the sensitivity analysis from 6.04 x 10^{-7} to < 4.65 x 10^{-7}.

Finally, PFS has performed a second sensitivity analysis assuming that the new expected norm for Skull Valley flights should be the sum of the FY00 flight operations for Sevier B and Sevier D MOAs or 5,757 + 240, adjusted upward by 17.4%, or (5,997 x 1.174) or 7,040. While PFS does not believe that this number is likely to be the norm, using it would increase the F-16 Skull Valley crash impact hazard from the base case (5,870 transits) value of 3.11 x E-7 to 3.73 x E-7, (2) the Moser Recovery crash impact from the base case (5,870 transits) value of 2.0 x E-8 to 2.4 x E-8, and (3) jettisoned ordnance from a base case value (based on the proportion of flights carrying ordnance that could be jettisoned in FY00) from 3.20 x E-8 to 3.90 x E-8, for an increase in the base case of 0.73 x E-7 from < 4.17 x E-7 to < 4.90 x E-7. Compare Addendum at page 19.

[32] Again these hazard probabilities do not account for jettisoned ordnance related to the 419th FW, which would increase the hazard for jettisoned calculated in the Addendum for this sensitivity analysis to 2.20 x E-8 and the Cumulative Hazard for the sensitivity analysis to less than 6.52 E-7.

In sum, the Cumulative Hazard for the base case using the new data for jettisonable ordnance would be $< 4.17 \times E\text{-}7$ and for the two sensitivity cases the Cumulative Hazard would be $< 4.65 \times E\text{-}7$ and $< 4.90 \times E\text{-}7$ respectively. Thus, the base case and both sensitivity analyses remain well below the regulatory limit of $1 \times E\text{-}6$.

SECTION I.11 INTENTIONALLY REMOVED

SECTION II INTENTIONALLY REMOVED

TAB II

LOCATION IN REVISED ADDENDUM TO CLARIFICATIONS REQUESTED IN JULY 5, 2001 TELECONFERENCE BETWEEN NRC STAFF AND PFS

NRC COMMENT 1: PFS should provide information concerning long range future traffic density for military aircraft in the environs of the PFSF.

PFS RESPONSE: PFS's response is found at Section I.C of the Revised Addendum.

NRC COMMENT 2: PFS should clarify and justify its use of an arc with a radius of 5 miles to define the "cut-out" area (A_c) in its calculation of the UTTR hazard in the current revision of the Safety Analysis Report.

PFS RESPONSE: The reason and justification for PFS's use of an arc with a radius of 5 miles to define the "cut-out" area (A_c) for the UTTR hazard calculation is set forth in Section II of the Revised Addendum.

NRC COMMENT 3: PFS should clarify the use of the statement in its May 15 Clarification no. 5 that "many pilots indicate that they will at least consider what's in the immediate area before jettisoning stores." Does PFS take credit for such avoidance in its calculation of jettisoned impact ordnance or is it a conservatism in the calculation?

PFS RESPONSE: As set forth in the last paragraph to Section VI.A of the Revised Addendum, PFS's calculation of the hazard from jettisoned ordnance takes no credit for expected avoidance action by pilots in jettisoning stores.

NRC COMMENT 4: PFS should clarify and justify the overpressure used to evaluate the susceptibility of the PFSF to the overpressure created by the explosion of the ordnance.

PFS RESPONSE: PFS addresses this issue in Section VI.B.2.a of the Revised Addendum.

NRC COMMENT 5: PFS should clarify how it addressed the possibility of multiple bomb explosions (from an aircraft carrying more than one bomb) near the PFSF.

PFS RESPONSE: PFS addresses this issue in Section VI.B.2.b of the Revised Addendum.

NRC COMMENT 6: PFS should provide clarification on the effect of taking into account accidents encountered in a Sevier D type setting in its analysis for the Sevier B accident category in Tab H to the Report .

PFS RESPONSE: PFS has done this analysis (which shows a negligible effect) in. Section I.D.2 of the Revised Addendum.

NRC COMMENT 7: PFS should clarify and reconcile its statement in the May 31 Response that the walls of the Canister Transfer Building would be resistant to the impact of the Spectrum II automobile design basis tornado missile up to the level of the roof of the building with the statement in the PFSF SAR (page 3.2.8-3.2.8a) that the building walls are only required to be designed to withstand the impact of the Spectrum II automobile up to a height of 30 feet above ground.

PFS RESPONSE: PFS addresses this issue in last paragraph in Section V.A of the Revised Addendum.

NRC COMMENT 7: There appears to by a typographical error in the May 31 Response, RAI no. 1(f) concerning F-16 flight hours in the South UTTR with respect to Range 6402 for FY99. .

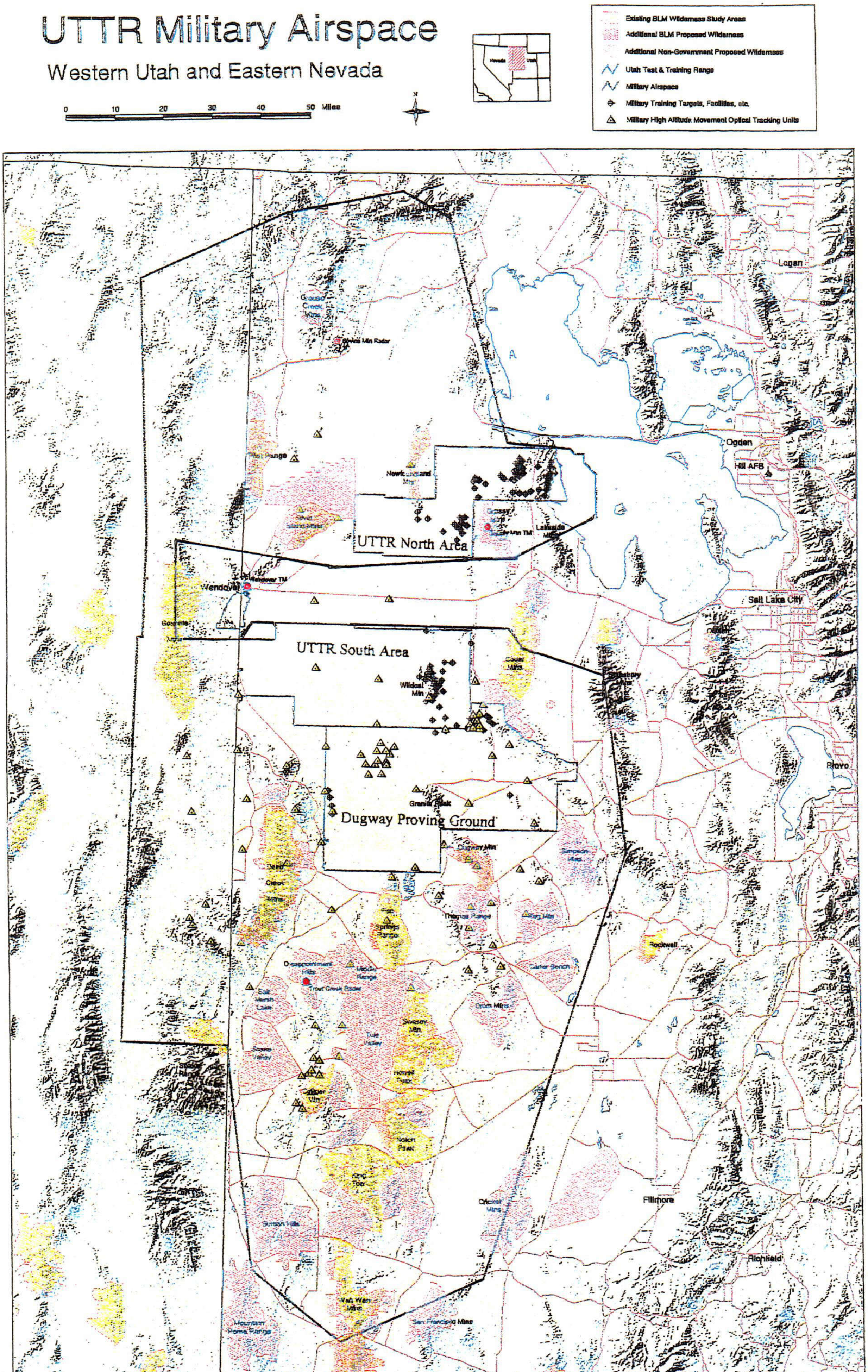
PFS RESPONSE: PFS has corrected the error in the May 31 Response attached at Tab HH. Also, in reviewing the data PFS recognized that the columns for the flight hours for the various ranges for FY00 were miscopied, which PFS has also corrected in the May 31 Response at Tab HH. The pages with changes have a revision date in their header and the changes are identified by a bar in the right hand margin of the page.

NRC COMMENT 8: PFS should supply a map showing the outline of both the UTTR land boundaries and the UTTR airspace boundaries.

PFS RESPONSE: Attached to this tab is a map which shows the outline of both the land boundaries and the air boundaries of the UTTR. Similar maps for the North and South UTTR can be found in Figures 14 and 15 to the Risk Assessment of Cruise Missile Accidents Impacting Private Fuel Storage LLC Independent Spent Fuel Storage Installation, Rev. 1 (Jan. 25, 2001). (These maps just show the general UTTR airspace without dividing that airspace into the various restricted areas and MOAs.)

UTTR Military Airspace

Western Utah and Eastern Nevada



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