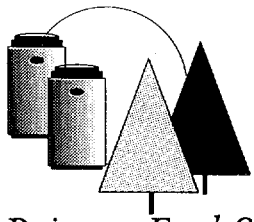

Private Fuel Storage, L.L.C.

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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.

NMSS01Public

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

Sincerely

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

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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

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[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.

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[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	1,496	8,694	6,915	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	17.3	1790.6	1870.3	1740.5	1176.4	1176.4
FY 2000	1770.3	378.8	2201.5	1751.1	1457.8	1457.6

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	590.1	126.3	733.8	583.7	485.9	485.9

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	633.9
6405	543.3	633.8	135.7
6406	605.3	662.0	788.4
6407	534.4	616.1	627.0
Sevier A	350.8	416.4	522.0
Sevier B	351.5	416.4	522.0
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

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[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-I6 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:

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

This is a decrease of 1.17×10^{-7} from the hazard of 1.49×10^{-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 $<5.34 \times 10^{-7}$ to $< 4.17 \times 10^{-7}$.

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 1.72×10^{-7} and the Cumulative Hazard was $< 6.04 \times E\text{-}7$.[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 (0.018×1.278, 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:

$P_0 = 6{,}759 \times 0.2879/10 \times 0.0230 \times 2.736 \times 10^{-8} \times 0.90 \times 0.3011 = 3.318 \times E\text{-}8$

This is a decrease of 1.39×10^{-7} from the probability of 1.72×10^{-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 6.04×10^{-7} to $< 4.65 \times 10^{-7}$.

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

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.

Response

According to the U.S. Air Force, no cruise missile crashes have occurred outside UTTR air boundaries.[33] As indicated in Table 1,[34] the crashes of 8 Oct 91, 29 Mar 94, 24 Jun 96, 23 Mar 00, and 27 Sep 00 occurred outside DoD (UTTR and Dugway Proving Ground) land boundaries. All other crashes in Table 1 occurred on DoD land. [35]

(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).

Response

As indicated in response to question 11(a), according to the U.S. Air Force, no cruise missile crashes have occurred outside UTTR air boundaries.

As previously indicated by the Air Force and reported by PFS (see Cruise Missile Report, p. 32), no cruise missile crashes on the UTTR have occurred more than half a mile from the intended ground track of the missile at the time of the crash.

(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

As indicated in response to question 11(a), according to the U.S. Air Force, no cruise missile crashes have occurred outside UTTR air boundaries. As indicated in response to question 11(b), no cruise missile crashes have occurred more than half a mile from their intended ground tracks at the time of the crash. Not all cruise missile crashes involve use of the flight

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[33] Conversation between RADM George Wagner, USN (Ret.) and Louie Alley, Freedom of Information Act Officer, Kirtland AFB (May 18, 2001).

[34] Risk Assessment of Cruise Missile Accidents Impacting Private Fuel Storage LLC Independent Spent Fuel Storage Installation, Rev 1 (Jan. 25, 2001), p. 33 ("Cruise Missile Report").

[35] Table 1 had indicated that the type of missile involved in the September 27 crash was unknown. The Air Force has now stated that the missile was an ALCM (AGM-86B). Freedom of Information Act Response from Kirtland AFB to RADM George Wagner, USN (Ret.) (Apr. 25, 2001).

termination system (FTS) (e.g., when a missile malfunction causes the missile to stop flying or to fly into the ground); thus, the "lateral limits" of the FTS are not applicable to all crashes. As indicated in the Cruise Missile Report (pp. 33-35), the lateral limit for cruise missile flight termination system performance ranges from approximately 0.4 nautical miles at altitudes less than 5,000 ft. above ground level (AGL) to approximately 1.6 nautical miles at 40,000 ft. AGL. The altitudes just before their crashes of the missiles that crashed on the UTTR are unknown, so PFS cannot state the precise performance limits that would have been applicable to those crashes had they involved use of the FTS. The Air Force has stated, however, that the UTTR has never experienced an FTS failure. Cruise Missile Report, p. 32. Since the missile crash locations were half a mile or closer to their intended ground tracks and even at low altitude the FTS performance limit is approximately 0.4 nautical miles lateral distance, the crash data provide no reason to believe that an FTS has failed to perform as designed on the UTTR.

After receiving PFS FOIA requests, the Air Force provided information on the September 27, 2000 crash which occurred while the missile was being flown manually by controllers aboard the ARIA after noting a malfunction. The crash occurred approximately 50 miles south of Wendover, NV, inside UTTR air boundaries. The ARIA and range chase aircraft had been continuously monitoring the missile flight and had noted for half an hour before the crash that the missile was not properly following its programmed ground track. The ARIA then took control of the missile manually and inadvertently issued a descent command to the missile. Approximately 30 seconds later, the ARIA issued a climb command to the missile, to which the missile began to respond, but the missile impacted the ground on government property before it completed its climb. At the time of the impact, the missile was flying along the course manually selected by the ARIA. Thus, the lateral distance between the ground track and the impact was zero.

II. CLARIFICATION REGARDING IMPACT OF CANISTER BUILDING DESIGN CHANGES ON AIR CRASH HAZARD[36]

Question: PFS has changed the design of the PFSF canister transfer building (CTB) roof to improve constructabilty and reduce the overturning moment potentially resulting from a seismic event. Specifically, the minimum thickness of the roof is now 8 inches, supported by steel roof girders, rather than an all-concrete design with a 12-inch thick roof. What effect does the design change have on PFS's general aviation hazard calculation, given that PFS had excluded some general aviation aircraft from its impact probability calculation because their impacts were bounded by the design basis tornado missile for the building?

Response

In the Addendum to its aircraft crash impact hazard report, PFS estimated the general aviation traffic through Skull Valley and calculated a crash impact probability for general aviation aircraft at the PFS site.[37] PFS's approach was to calculate the number of general aircraft that would have to transit Skull Valley per year to result in a crash impact hazard of 1 E-7, 1 E-8, and 1 E-9. Addendum at 14. PFS then considered the calculated numbers of aircraft per year for each probability in light of the fact that F-16 pilots who flew through Skull Valley from Hill Air Force Base had observed no general aviation or only minimal general aviation in Skull Valley. Id.[38] Accordingly, PFS determined that the level of general aviation traffic through Skull Valley corresponded to the level of traffic that would result in a general aviation crash impact hazard at the PFSF of less than 1 E-8. Id. at 14-15.

In relating the general aviation crash impact hazard to the number of general aviation aircraft that transit Skull Valley per year, PFS accounted for the fact that 55 percent of the general aviation aircraft that transit Skull Valley would pose no crash impact hazard to the PFSF because their impact characteristics were bounded by the impact characteristics of the design basis tornado missile for the PFSF, including the CTB. Id. at 15. Therefore, design changes to the CTB are relevant to PFS's general aviation crash impact assessment only to the extent that potential impacts involving those 55 percent would no longer be bounded by the design basis tornado missile.

The design change to the CTB reduced the minimum thickness of the building roof to 8 inches.[39] This thickness is not sufficient to withstand the design basis tornado missile impact

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[36] This question was raised by the NRC Staff in an April 18, 2001 teleconference with PFS.

[37] Addendum § III.A.

[38] Clover Control, at Hill AFB, also reported having no records of general aviation traffic in Skull Valley. Report at 67 n.63.

[39] The design change to the CTB also increased the exterior dimensions slightly. See, e.g., PFSF SAR Fig. 4.7-8. The effect of this change was to increase the effective area of the PFSF site as a whole, see Report § III.A.3, by less than one percent for all aircraft hazards other than general aviation and by less than two percent for general aviation. Since the crash impact probability is directly proportional to the site effective area, id. at 6, the increase in CTB dimensions increased the aircraft hazard to the PFSF proportionately. PFS notes this effect here but, because of its negligible magnitude, has not incorporated it into the calculations performed elsewhere in this submittal.

(the Spectrum II automobile impact, see PFSF SAR at 3.2-8).[40] The remainder of the building, however, including the building walls up to the roof, is strong enough to withstand an impact by the Spectrum II automobile. Therefore, the only effect of the design change relevant to PFS's analysis is to make the roof of the CTB potentially susceptible to impacts involving those 55 percent of general aviation aircraft that are bounded by the design basis tornado missile.[41] Thus, the impact of the design change is to increase the general aviation crash impact hazard by the probability that one (or more) of the 55 percent of general aviation aircraft that are bounded by the design basis tornado missile would impact the CTB roof directly in an orientation conducive to maximum penetration.

PFS had assessed the probability of a general aviation aircraft impact causing a release of radioactive material at the PFSF to be less than 1 E-8. Addendum at 14-15. PFS accounts for potential impacts on the roof of the CTB by aircraft formerly bounded by the tornado missile as follows. The impact probability, P, for aircraft flying along an airway, as PFS modeled Skull Valley, is given by $P = N \times C \times A / w$, where N is the number of aircraft per year, C is the crash rate per mile, A is the site effective area, and w is the airway width. Addendum at 13. The number of general aviation aircraft, N, may separated into two groups, 1) those 55 percent of the aircraft bounded by the tornado missile, and 2) those 45 percent not bounded. Thus, the impact probability becomes:

$$P = 0.55\ N \times A / w + 0.45 \times N \times A / w$$

In the former case, in which all of the aircraft that were bounded by the tornado missile (the 55 percent) posed no hazard to the PFSF, the effective area of the site, A, for the bounded aircraft, was effectively zero, in that there was no area in which an impact of those aircraft could have resulted in a release of radioactive material. Thus, the probability was defined by:

$$P = 0.55\ N \times 0 / w + 0.45 \times N \times A / w, \text{ or}$$

$$P = 0.45 \times N \times A / w.$$

In the former case, P = 1 E-8, thus:

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[40] The CTB roof, however, is designed to withstand other tornado-driven missiles in Spectrum II as necessary to meet NRC requirements. PFSF SAR at 3.2-8.

[41] As PFS noted in its Report at 71a n.74, spent fuel inside the CTB will be contained within and protected by a spent fuel shipping cask or a spent fuel storage cask 92 percent of the time that spent fuel is present in the building. Only while transfer operations are taking place and while the canister is inside the transfer cask will the canister not be protected by a shipping or storage cask. Nevertheless, PFS does not take credit for the protection provided by the shipping or storage casks here. This analysis assumes that any general aviation impact on the roof of the CTB might result in the breach of a spent fuel canister and the release of radioactive material. PFS also does not take into account the fact that an aircraft impact into the roof of the building might not affect a spent fuel canister inside at all. First, the roof is supported by an extensive network of steel beams and girders through which the aircraft would have to penetrate to affect a cask. Second, the building is much larger than a spent fuel canister. Third, there are small general aviation aircraft that still would not penetrate the roof because of their light weight and low speed. Furthermore, a glancing blow by a light aircraft might not penetrate the roof. Hence, not all of the 55 percent of general aviation aircraft bounded by the design basis tornado missile should necessarily be included in this calculation.

$1\ E\text{-}8 = 0.45 \times N \times A / w$

Under the present CTB design, however, the effective area for the 55 percent of general aviation aircraft that had been bounded by the tornado missile is not equal to zero, but rather is equal to the area of the roof of the CTB, A_r. This is because, for the purpose of this analysis, we assume that an impact of one of those aircraft on the roof of the building might cause a release of radioactive material. Therefore, the new general aviation crash impact probability, accounting for the new design of the CTB, is defined by:

$P = 0.45 \times N \times A / w + 0.55\ N \times A_r / w$

Taking $0.45 \times N \times A / w = 1\ E\text{-}8$ from above, $N / w = 1\ E\text{-}8 / (0.45 \times A)$. Thus,

$P = 1\ E\text{-}8 + 0.55/0.45 \times 1\ E\text{-}8 \times A_r / A$, or

$P = 1\ E\text{-}8\ (1 + 1.222 \times A_r / A)$.

The area of the CTB roof, A_r, is equal to 26,488 sq. ft., or 9.50 E-4 sq. mi. See PFSF SAR Fig. 4.7-8.[42] The effective area of the site, A, is equal to 0.1193 sq. mi. for general aviation aircraft.[43] Therefore, the new general aviation crash impact probability is equal to:

$P = 1\ E\text{-}8\ (1 + 1.222 \times 9.50\ E\text{-}4 / 0.1193)$, or,

since P defined the upper bound of the probability,

$P < 1.01\ E\text{-}8$.[44]

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[42] The effective area of the roof is the actual area of the roof of that part of the CTB that is protected by the building's tornado missile barrier (as noted above, the roof itself forms part of the barrier for certain Spectrum II missiles). The remainder of the roof, covering offices, store rooms, and the cask transporter aisle, on either side of the building, does not protect areas where spent fuel casks will be located; thus, it is not relevant to the general aviation hazard to the building. See PFSF SAR Fig. 4.7-8. In its assessment of crash impact hazards for other aircraft, PFS included a "skid area" and a "shadow area" in its site effective area calculation for the CTB to account for the possibilities that 1) an aircraft could impact the ground in front of the site and skid into it and 2) a crashing aircraft that would otherwise hit the ground behind the site could hit an elevated part of the site. Report § III.A.3. Here, because the only impact of concern is an impact directly on to the roof of the CTB, PFS does not need to include a "skid area" or "shadow area" in the effective area calculation for the roof. In fact, impacts that would occur in the hypothetical "skid area" and "shadow area" of the roof, if the same areas used for the CTB as a whole were used for the roof, would impact the side of the CTB.

[43] This is the newly calculated CTB effective area, reflecting the small changes to the building's dimensions that PFS recently made. The original effective area of the site for general aviation aircraft was 0.1173 sq. mi. Report at 69.

[44] The effect of the change in the dimensions of the CTB, see note 39 above, was to increase the site effective area for general aviation from 0.1173 to 0.1193, an increase of 1.7 percent. If that increase is combined with the effect of the change in the CTB roof thickness, the total effect of CTB design changes on the general aviation hazard to the PFSF is equal to 1.01 x 1.017 = 1.027 or an increase of 2.7 percent. Thus, PFS estimates the general aviation hazard to the PFSF to be less than 1.027 E-8, or, as a practical matter, still less than 1 E-8.

Therefore, the design change to the CTB has a negligible effect on the general aviation hazard to the PFSF.[45]

[45] As an aside, if the entire CTB were susceptible to impacts of light general aviation aircraft, then A_r would be replaced by the effective area of the entire CTB, 0.109 sq. mi. (this includes the CTB "skid area" and "shadow area," see note 42, above) and the general aviation impact hazard to the PFSF would increase from 1 E-8 to 1.1 E-8. Thus, the general aviation hazard assessment for the PFSF is not sensitive to design changes to the CTB.