Private Fuel Storage, LLC

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John D. Parkyn, Chairman of the Board

January 19, 2001

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

LICENSE APPLICATION AMENDMENT No. 20
DOCKET NO. 72-22/TAC NO. L22462
PRIVATE FUEL STORAGE FACILITY
PRIVATE FUEL STORAGE L.L.C.

This letter submits Amendment No. 20 to the Private Fuel Storage Facility (PFSF) License Application. This amendment updates PFSF Safety Analysis Report (SAR) Section 2.2.2, "Hazards from Air Crashes", based on recently acquired information. The U.S. Air Force recently provided information indicating that the number of F-16 flights in Skull Valley in fiscal years 1999 and 2000 was greater than the number of flights recorded in 1998, which had been used to evaluate the probability of an aircraft crash hazard at the PFSF site. This results in a somewhat higher F-16 aircraft crash impact probability, which has been reflected in the amended Section 2.2.2.2.1. The assessments of the crash impact hazards from military aircraft conducting operations within the restricted areas of the Utah Test and Training Range (UTTR) (SAR Section 2.2.2.2.2) and from general aviation aircraft (SAR Section 2.2.2.4) have also been revised. While these revisions impact the total PFSF aircraft hazard probability computed in SAR Section 2.2.2.5, the calculated cumulative air crash impact probability remains below 1 E-6 per year for the PFSF.

If you have any questions regarding this submittal, please contact me at 608-787-1236 or Mr. J. L. Donnell, Project Director, at 303-741-7009.

Sincerely,

John D. Parkyn, Chairman
Private Fuel Storage L.L.C.

JDP:JRJ
Enclosure

NMSS01 Public

PREFACE

PRIVATE FUEL STORAGE FACILITY

LICENSE APPLICATION

AMENDMENT 20

Enclosed are the following revisions to the Private Fuel Storage Facility License Application documents:

Safety Analysis Report – Revision 19

DOCUMENT CONTROL

PAGE	REVISION
Document Control Tab	
a	19
b	19
c	19
d	19
e	19
f	19
g	19
h	19
i	19
j	19
k	19
l	19
m	19
n	19
o	19
p	19
q	19
r	19
s	19
t	19
u	19
v	19
w	19
x	19
y	19
z	19
aa	19
Table of Contents Tab	
i	10
ii	0
iii	9
iv	13
Chapter 1 Tab	
1-i	0
1-ii	17
1.1-1	0
1.1-2	3
1.1-3	3
1.1-4	0
1.2-1	17
1.2-2	17

DOCUMENT CONTROL

PAGE	REVISION
1.3-1	17
1.3-2	17
1.3-3	17
1.3-4	0
1.4-1	17
1.4-2	4
1.5-1	17
1.5-2	0
1.6-1	17
1.6-2	0
1.7-1	17
1.7-2	17
Figure 1.1-1	3
Figure 1.1-2	2
Figure 1.2-1	3
Figure 1.3-1	12
Figure 1.3-2 (deleted)	17
Chapter 2 Tab	
2-i	19
2-ii	19
2-iii	12
2-iv	12
2-v	11
2-vi	11
2-vii	11
2-viii	12
2-ix	13
2-x	11
2-xi	11
2-xii	11
2-xiii	11
2-xiv	11
2.1-1	0
2.1-2	0
2.1-3	6
2.1-4	10
2.1-5	0
2.1-6	0
2.2-1	9
2.2-2	10
2.2-3	9
2.2-4	9
2.2-5	9

DOCUMENT CONTROL

PAGE	REVISION
2.2-6	19
2.2-7	16
2.2-8	16
2.2-9	19
2.2-10	19
2.2-11	19
2.2-12	19
2.2-13	19
2.2-14	19
2.2-15	19
2.2-16	19
2.2-17	19
2.2-18	19
2.2-19	19
2.2-20	19
2.2-21	19
2.2-22	19
2.2-23	19
2.2-24	19
2.2-25	19
2.2-26	19
2.3-1	0
2.3-2	0
2.3-3	0
2.3-4	0
2.3-5	0
2.3-6	0
2.3-7	0
2.3-8	0
2.3-9	0
2.3-10	0
2.3-11	0
2.3-12	12
2.3-13	12
2.3-14	12
2.3-15	12
2.3-16	12
2.3-17	12
2.3-18	12
2.3-19	12
2.3-20	12
2.3-21	12
2.3-22	12
2.4-1	0

DOCUMENT CONTROL

PAGE	REVISION
2.4-2	0
2.4-3	3
2.4-4	3
2.4-5	6
2.4-6	3
2.4-7	11
2.4-8	11
2.4-9	11
2.4-10	11
2.4-11	11
2.4-12	11
2.4-13	11
2.4-14	11
2.4-15	11
2.4-16	11
2.5-1	0
2.5-2	3
2.5-3	3
2.5-4	3
2.5-5	15
2.5-6	3
2.6-1	3
2.6-2	3
2.6-3	3
2.6-4	5
2.6-5	3
2.6-6	3
2.6-7	6
2.6-8	6
2.6-9	3
2.6-10	3
2.6-11	3
2.6-12	3
2.6-13	3
2.6-14	3
2.6-15	3
2.6-16	3
2.6-17	6
2.6-18	3
2.6-19	8
2.6-20	15
2.6-21	8
2.6-22	8
2.6-23	8

DOCUMENT CONTROL

PAGE	REVISION
2.6-24	8
2.6-25	8
2.6-26	8
2.6.26a	8
2.6.26b	8
2.6.26c	8
2.6.26d	8
2.6-27	9
2.6-28	9
2.6-29	15
2.6-30	9
2.6-31	11
2.6-32	13
2.6-33	13
2.6-34	13
2.6-35	13
2.6-36	13
2.6-36a	13
2.6-36b	13
2.6-36c	13
2.6-36d	13
2.6-36e	13
2.6-36f	13
2.6-37	13
2.6-38	9
2.6-39	11
2.6-40	11
2.6-41	11
2.6-42	11
2.6-43	11
2.6-44	11
2.6-44a	11
2.6-44b	11
2.6-44c	13
2.6-44d	13
2.6-45	9
2.6-46	13
2.6-47	13
2.6-48	9
2.6-49	13
2.6-50	17
2.6-51	11
2.6-52	9
2.6-53	9

DOCUMENT CONTROL

PAGE	REVISION
2.6-54	9
2.6-55	13
2.6-56	9
2.6-57	13
2.6-58	13
2.6-59	13
2.6-60	9
2.6-61	13
2.6-62	13
2.6-63	13
2.6-64	13
2.6-65	13
2.6-66	13
2.6-67	13
2.6-68	13
2.6-69	9
2.6-70	9
2.6-71	13
2.6-72	17
2.6-72a	17
2.6-72b	15
2.6-73	13
2.6-74	17
2.6-75	13
2.6-76	13
2.6-77	13
2.6-78	13
2.6-79	13
2.6-80	13
2.6-81	13
2.6-81a	13
2.6-81b	13
2.6-82	13
2.6-83	13
2.6-84	9
2.6-85	9
2.6-86	9
2.6-87	11
2.6-88	9
2.6-89	9
2.6-90	9
2.6-91	10
2.6-91a	11
2.6-91b	10

DOCUMENT CONTROL

PAGE	REVISION
2.6-92	9
2.6-93	9
2.6-94	9
2.6-95	9
2.6-96	9
2.6-97	9
2.6-98	13
2.6-99	11
2.6-100	11
2.6-100a	11
2.6-100b	11
2.6-101	9
2.6-102	9
2.6-103	9
2.6-104	9
2.6-105	9
2.6-106	9
2.6-107	9
2.6-108	13
2.6-109	13
2.6-110	9
2.6-111	13
2.6-112	13
2.6-113	11
2.6-114	11
2.6-115	11
2.6-116	9
2.7-1	11
2.7-2	5
2.8-1	11
2.8-2	11
2.8-3	11
2.8-4	11
2.8-5	11
2.8-6	19
2.8-7	12
2.8-8	19
2.8-9	12
2.8-10	17
2.8-11	17
2.8-12	15
2.8-13	15
2.8-14	11
Table 2.3-1	0

DOCUMENT CONTROL

PAGE	REVISION
Table 2.3-2	0
Table 2.3-3	12
Table 2.3-4	12
Table 2.3-5	12
Table 2.3-6	0
Table 2.3-7	0
Table 2.3-8	1
Table 2.3-9	0
Table 2.3-10	0
Table 2.3-11	12
Table 2.6-1	6
Table 2.6-2	6
Table 2.6-3	6
Table 2.6-4 (1 of 14)	0
Table 2.6-4 (2 of 14)	0
Table 2.6-4 (3 of 14)	0
Table 2.6-4 (4 of 14)	0
Table 2.6-4 (5 of 14)	0
Table 2.6-4 (6 of 14)	0
Table 2.6-4 (7 of 14)	0
Table 2.6-4 (8 of 14)	0
Table 2.6-4 (9 of 14)	0
Table 2.6-4 (10 of 14)	0
Table 2.6-4 (11 of 14)	0
Table 2.6-4 (12 of 14)	0
Table 2.6-4 (13 of 14)	0
Table 2.6-4 (14 of 14)	0
Table 2.6-5	6
Table 2.6-6	13
Table 2.6-7	13
Table 2.6-8	13
Table 2.6-9	13
Table 2.6-10	13
Table 2.6-11	13
Table 2.6-12	11
Table 2.6-13	13
Figure 2.1-1	0
Figure 2.1-2 (1 of 2)	3
Figure 2.1-2 (2 of 2)	0
Figure 2.3-1	0
Figure 2.3-2	0
Figure 2.3-3	0
Figure 2.3-4	0
Figure 2.3-5	0

DOCUMENT CONTROL

PAGE	REVISION
Figure 2.3-6	0
Figure 2.4-1	3
Figure 2.4-2	3
Figure 2.4-3	3
Figure 2.4-4	3
Figure 2.4-5	3
Figure 2.5-1	3
Figure 2.6-1	0
Figure 2.6-2 (1 of 2)	8
Figure 2.6-2 (2 of 2)	0
Figure 2.6-3	0
Figure 2.6-4	0
Figure 2.6-5 (1 of 14)	8
Figure 2.6-5 (2 of 14)	8
Figure 2.6-5 (3 of 14)	8
Figure 2.6-5 (4 of 14)	8
Figure 2.6-5 (5 of 14)	8
Figure 2.6-5 (6 of 14)	8
Figure 2.6-5 (7 of 14)	8
Figure 2.6-5 (8 of 14)	8
Figure 2.6-5 (9 of 14)	8
Figure 2.6-5 (10 of 14)	8
Figure 2.6-5 (11 of 14)	8
Figure 2.6-5 (12 of 14)	8
Figure 2.6-5 (13 of 14)	8
Figure 2.6-5 (14 of 14)	8
Figure 2.6-6	0
Figure 2.6-7	0
Figure 2.6-8	0
Figure 2.6-9	0
Figure 2.6-10	0
Figure 2.6-11	0
Figure 2.6-12	0
Figure 2.6-13A	6
Figure 2.6-13B	6
Figure 2.6-13C	6
Figure 2.6-14A	6
Figure 2.6-14B	6
Figure 2.6-14C	6
Figure 2.6-15	0
Figure 2.6-16	0
Figure 2.6-17	6
Figure 2.6-18	6
Figure 2.6-19	8

DOCUMENT CONTROL

PAGE	REVISION
Figure 2.6-20 (1 of 2)	6
Figure 2.6-20 (2 of 2)	6
Figure 2.6-21	6
Figure 2.6-22	6
Figure 2.6-23	6
Figure 2.6-24	6
Figure 2.6-25	11
Figure 2.6-26	6
Figure 2.6-27	6
Figure 2.6-28	6
Figure 2.6-29	6
Figure 2.6-30 (1 of 6)	8
Figure 2.6-30 (2 of 6)	8
Figure 2.6-30 (3 of 6)	8
Figure 2.6-30 (4 of 6)	8
Figure 2.6-30 (5 of 6)	8
Figure 2.6-30 (6 of 6)	8
Figure 2.6-31	11
Appendix 2A Tab	
Reports	8
Appendix 2B Tab	
Survey	0
Appendix 2C Tab	
Analysis	0
Appendix 2D Tab	
Deleted	3
Appendix 2E Tab	
Analysis	0
Appendix 2F Tab	
Report	9

DOCUMENT CONTROL

PAGE	REVISION
Appendix 2G Tab	
Evaluation	10
Chapter 3 Tab	
3-i	9
3-ii	17
3-iii	17
3-iv	17
3-v	17
3-vi	0
3.1-1	17
3.1-2	17
3.1-3	17
3.1-4	17
3.1-5	17
3.1-6	0
3.2-1	0
3.2-2	17
3.2-3	17
3.2-4	1
3.2-5	9
3.2-5a	9
3.2-5b	9
3.2-6	0
3.2-7	17
3.2-8	9
3.2-8a	9
3.2-8b	9
3.2-9	7
3.2-10	5
3.2-11	5
3.2-12	17
3.2-13	17
3.2-14	9
3.2-14a	3
3.2-14b	3
3.2-15	17
3.2-16	17
3.2-17	0
3.2-18	1
3.2-19	17
3.2-20	17

DOCUMENT CONTROL

PAGE	REVISION
3.2-21	17
3.2-22	17
3.2-23	17
3.2-24	17
3.2-24a	12
3.2-24b	12
3.2-25	5
3.2-26	1
3.2-27	1
3.2-28	1
3.2-29	1
3.2-30	1
3.2-31	1
3.2-32	1
3.3-1	17
3.3-2	17
3.3-3	17
3.3-4	17
3.3-5	12
3.3-6	1
3.3-7	13
3.3-8	13
3.3-9	13
3.3-10	10
3.3-11	10
3.3-12	10
3.4-1	0
3.4-2	17
3.4-3	17
3.4-4	9
3.4-5	9
3.4-6	17
3.4-7	17
3.4-8	9
3.5-1	0
3.5-2	17
3.6-1	0
3.6-2	0
3.7-1	17
3.7-2	0
3.7-3	12
3.7-4	12
Table 3.1-1 (deleted)	12
Table 3.1-2 (deleted)	12

DOCUMENT CONTROL

PAGE	REVISION
Table 3.1-3 (1 of 2, deleted)	17
Table 3.1-3 (2 of 2) (deleted)	17
Table 3.2-1	12
Table 3.2-2	12
Table 3.2-3 (deleted)	17
Table 3.4-1	17
Table 3.6-1 (1 of 5)	17
Table 3.6-1 (2 of 5)	13
Table 3.6-1 (3 of 5)	17
Table 3.6-1 (4 of 5)	17
Table 3.6-1 (5 of 5)	17
Chapter 4 Tab	
4-i	4
4-ii	17
4-iii	10
4-iv	17
4-v	9
4-vi	17
4-vii	17
4-viii	17
4-ix	17
4-x	17
4.1-1	17
4.1-2	17
4.1-3	0
4.1-4	16
4.2-1	17
4.2-2	0
4.2-3	12
4.2-4	12
4.2-5	12
4.2-6	12
4.2-7	12
4.2-8	13
4.2-9	12
4.2-10	12
4.2-11	12
4.2-12	4
4.2-13	1
4.2-14	12
4.2-15	12
4.2-16	17
4.2-16a	7

DOCUMENT CONTROL

PAGE	REVISION
4.2-16b	12
4.2-16c	10
4.2-16d	7
4.2-17	8
4.2-18	12
4.2-19	12
4.2-20	12
4.2-20a	12
4.2-20b	12
4.2-21	4
4.2-22	17
4.2-23	17
4.2-24	17
4.2-25	17
4.2-26	17
4.2-27	17
4.2-28	17
4.2-29	17
4.2-30	17
4.2-31	17
4.2-32	17
4.2-33	17
4.2-34	17
4.3-1	9
4.3-2	9
4.3-3	12
4.3-4	13
4.3-5	13
4.3-6	9
4.3-7	10
4.3-8	13
4.3-9	13
4.3-10	10
4.3-11	10
4.3-12	16
4.3-13	10
4.3-14	16
4.3-15	16
4.3-16	10
4.3-17	10
4.3-18	10
4.3-19	16
4.3-20	13
4.3-21	13

DOCUMENT CONTROL

PAGE	REVISION
4.3-22	10
4.4-1	0
4.4-2	0
4.5-1	17
4.5-2	17
4.5-3	17
4.5-4	8
4.5-5	17
4.5-6	17
4.6-1	0
4.6-2	0
4.7-1	17
4.7-2	13
4.7-3	15
4.7-4	0
4.7-5	6
4.7-6	15
4.7-6a	13
4.7-6b	9
4.7-6c	9
4.7-6d	17
4.7-6e	18
4.7-6f	9
4.7-7	9
4.7-8	9
4.7-8a	13
4.7-8b	15
4.7-8c	9
4.7-8d	9
4.7-8e	17
4.7-8f	17
4.7-8g	15
4.7-8h	15
4.7-8i	15
4.7-8j	13
4.7-9	3
4.7-10	2
4.7-11	3
4.7-12	17
4.7-12a	17
4.7-12b	17
4.7-13	17
4.7-13a	13
4.7-13b	13

DOCUMENT CONTROL

PAGE	REVISION
4.7-13c	6
4.7-13d	6
4.7-13e	6
4.7-13f	6
4.7-13g	6
4.7-13h	6
4.7-13i	9
4.7-13j	6
4.7-14	0
4.7-15	12
4.7-16	0
4.7-17	12
4.7-18	0
4.7-19	12
4.7-20	12
4.7-21	12
4.7-22	12
4.7-23	17
4.7-24	17
4.7-25	17
4.7-26	17
4.8-1	17
4.8-2	17
4.8-3	16
4.8-4	9
4.8-5	6
4.8-6	15
4.8-7	6
4.8-8	17
4.8-9	13
4.8-10	16
Table 4.1-1 (1 of 7)	17
Table 4.1-1 (2 of 7)	17
Table 4.1-1 (3 of 7)	17
Table 4.1-1 (4 of 7)	17
Table 4.1-1 (5 of 7)	17
Table 4.1-1 (6 of 7)	0
Table 4.1-1 (7 of 7)	0
Table 4.2-1	7
Table 4.2-2	12
Table 4.2-3	12
Table 4.2-4 (deleted)	17
Table 4.2-5 (deleted)	17
Table 4.2-6 (deleted)	17

DOCUMENT CONTROL

PAGE	REVISION
Table 4.2-7	13
Table 4.2-8	9
Table 4.7-1	12
Table 4.7-2	4
Table 4.7-3 (deleted)	17
Figure 4.1-1	2
Figure 4.1-2	0
Figure 4.1-3	0
Figure 4.1-4	0
Figure 4.2-1	12
Figure 4.2-2 (1 of 3)	12
Figure 4.2-2 (2 of 3)	12
Figure 4.2-2 (3 of 3)	12
Figure 4.2-3	12
Figure 4.2-4 (deleted)	17
Figure 4.2-5 (1 of 4) (deleted)	17
Figure 4.2-5 (2 of 4) (deleted)	17
Figure 4.2-5 (3 of 4) (deleted)	17
Figure 4.2-5 (4 of 4) (deleted)	17
Figure 4.2-6 (deleted)	17
Figure 4.2-7	8
Figure 4.2-8	0
Figure 4.3-1	11
Figure 4.5-1 (1 of 2)	12
Figure 4.5-1 (2 of 2)	12
Figure 4.5-2 (deleted)	17
Figure 4.5-3 (1 of 2)	11
Figure 4.5-3 (2 of 2)	2
Figure 4.5-4	17
Figure 4.5-5	17
Figure 4.5-6 (1 of 4)	3
Figure 4.5-6 (2 of 4)	3
Figure 4.5-6 (3 of 4)	3
Figure 4.5-6 (4 of 4)	3
Figure 4.7-1 (1 of 3)	11
Figure 4.7-1 (2 of 3)	2
Figure 4.7-1 (3 of 3)	11
Figure 4.7-2	0
Figure 4.7-3 (deleted)	17
Figure 4.7-4	0
Figure 4.7-5	3
Figure 4.7-6	3
Figure 4.7-7	6
Figure 4.7-8	11

DOCUMENT CONTROL

PAGE	REVISION
Chapter 5 Tab	
5-i	0
5-ii	7
5-iii	0
5-iv	17
5-v	17
5-vi	0
5.1-1	17
5.1-2	0
5.1-3	3
5.1-4	2
5.1-5	17
5.1-6	17
5.1-7	13
5.1-8	17
5.1-9	17
5.1-10	13
5.2-1	17
5.2-2	17
5.2-3	17
5.2-4	17
5.2-5	17
5.2-6	17
5.3-1	0
5.3-2	0
5.4-1	0
5.4-2	0
5.5-1	1
5.5-2	0
5.6-1	0
5.6-2	0
5.7-1	17
5.7-2	0
Table 5.1-1 (1 of 2)	6
Table 5.1-1 (2 of 2)	6
Table 5.1-2 (1 of 2) (deleted)	17
Table 5.1-2 (2 of 2) (deleted)	17
Figure 5.1-1	1
Figure 5.1-2	0
Figure 5.1-3 (deleted)	17
Figure 5.1-4 (deleted)	17
Figure 5.1-5	0

DOCUMENT CONTROL

PAGE	REVISION
Chapter 6 Tab	
6-i	0
6-ii	0
6.1-1	17
6-1-2	13
6.2-1	1
6.2-2	0
6.3-1	0
6.3-2	0
6.4-1	17
6.4-2	7
6.4-3	7
6.4-4	7
6.5-1	13
6.5-2	0
6.6-1	17
6.6-2	0
Chapter 7 Tab	
7-i	17
7-ii	17
7-iii	17
7-iv	17
7-v	0
7-vi	0
7.1-1	0
7.1-2	0
7.1-3	0
7.1-4	0
7.1-5	17
7.1-6	0
7.1-7	0
7.1-8	13
7.1-9	3
7.1-10	3
7.1-11	3
7.1-12	3
7.2-1	17
7.2-2	17
7.2-3	17
7.2-4	17
7.2-5	17
7.2-6	17

DOCUMENT CONTROL

PAGE	REVISION
7.3-1	0
7.3-2	0
7.3-3	9
7.3-3a	13
7.3-3b	13
7.3-4	17
7.3-5	17
7.3-6	17
7.3-7	17
7.3-8	17
7.3-9	17
7.3-10	17
7.3-11	17
7.3-12	17
7.3-13	17
7.3-14	17
7.3-15	17
7.3-16	17
7.4-1	17
7.4-2	17
7.4-3	17
7.4-4	12
7.5-1	3
7.5-2	0
7.5-3	8
7.5-4	8
7.5-5	8
7.5-6	8
7.5-7	8
7.5-8	8
7.6-1	17
7.6-2	0
7.6-3	13
7.6-4	13
7.7-1	17
7.7-2	17
7.7-3	10
7.7-4	17
Table 7.3-1	10
Table 7.3-2 (deleted)	17
Table 7.3-3	10
Table 7.3-4 (deleted)	17
Table 7.3-5	10
Table 7.3-6	17

DOCUMENT CONTROL

PAGE	REVISION
Table 7.3-7	10
Table 7.3-8	17
Table 7.4-1 (1 of 4)	10
Table 7.4-1 (2 of 4)	10
Table 7.4-1 (3 of 4)	10
Table 7.4-1 (4 of 4)	10
Table 7.4-2 (1 of 4) (deleted)	17
Table 7.4-2 (2 of 4) (deleted)	17
Table 7.4-2 (3 of 4) (deleted)	17
Table 7.4-2 (4 of 4) (deleted)	17
Figure 7.3-1	0
Figure 7.3-2	17
Chapter 8 Tab	
8-i	0
8-ii	7
8-iii	16
8-iv	9
8-v	9
8-vi	13
8.1-1	9
8.1-2	17
8.1-3	0
8.1-4	17
8.1-5	17
8.1-6	17
8.1-7	7
8.1-8	17
8.1-9	17
8.1-10	17
8.1-11	0
8.1-12	17
8.1-13	17
8.1-14	17
8.1-15	17
8.1-16	17
8.1-17	13
8.1-18	17
8.1-19	7
8.1-20	7
8.2-1	9
8.2-2	3
8.2-3	17
8.2-4	17

DOCUMENT CONTROL

PAGE	REVISION
8.2-5	17
8.2-6	7
8.2-7	7
8.2-8	17
8.2-9	17
8.2-10	17
8.2-11	7
8.2-12	17
8.2-13	3
8.2-14	17
8.2-15	17
8.2-15a	17
8.2-15b	17
8.2-16	17
8.2-17	17
8.2-18	17
8.2-19	17
8.2-20	17
8.2-21	10
8.2-22	13
8.2-23	11
8.2-23a	17
8.2-23b	13
8.2-23c	17
8.2-23d	11
8.2-23e	11
8.2-23f	13
8.2-23g	13
8.2-23h	13
8.2-23i	14
8.2-23j	13
8.2-23k	14
8.2-23l	14
8.2-23m	14
8.2-23n	14
8.2-23o	14
8.2-23p	16
8.2-23q	16
8.2-23r	16
8.2-24	13
8.2-25	13
8.2-26	11
8.2-27	11
8.2-28	13

DOCUMENT CONTROL

PAGE	REVISION
8.2-29	17
8.2-29a	17
8.2-29b	17
8.2-29c	17
8.2-29d	11
8.2-29e	17
8.2-29f	18
8.2-29g	18
8.2-29g1	18
8.2-29g2	18
8.2-29h	11
8.2-29i	11
8.2-29j	11
8.2-29k	11
8.2-29l	11
8.2-29m	13
8.2-29n	17
8.2-29o	17
8.2-29p	13
8.2-29q	17
8.2-29r	11
8.2-30	17
8.2-31	17
8.2-32	13
8.2-32a	17
8.2-32b	17
8.2-32c	17
8.2-32d	17
8.2-32e	17
8.2-32f	16
8.2-32g	16
8.2-32h	16
8.2-33	17
8.2-34	17
8.2-35	17
8.2-36	17
8.2-37	17
8.2-38	17
8.2-39	17
8.2-40	17
8.2-41	17
8.2-42	17
8.2-43	13
8.2-44	17

DOCUMENT CONTROL

PAGE	REVISION
8.2-45	17
8.2-46	17
8.2-47	17
8.2-48	17
8.2-49	7
8.2-50	17
8.2-51	17
8.2-52	9
8.3-1	7
8.3-2	7
8.4-1	17
8.4-2	17
8.4-3	9
8.4-4	9
8.4-5	9
8.4-6	9
8.4-7	17
8.4-8	17
8.4-9	9
8.4-10	13
8.4-11	17
8.4-12	10
8.5-1	17
8.5-2	9
8.5-3	17
8.5-4	9
8.5-5	9
8.5-6	10
8.5-7	17
8.5-8	17
8.5-9	13
8.5-10	17
Table 8.1-1	17
Table 8.1-2	17
Table 8.2-1	17
Figure 8.2-1	15
Chapter 9 Tab	
9-i	0
9-ii	1
9-iii	4
9-iv	4
9-v	0
9-vi	0

DOCUMENT CONTROL

PAGE	REVISION
9.1-1	0
9.1-2	0
9.1-3	0
9.1-4	4
9.1-5	4
9.1-6	4
9.1-7	4
9.1-8	4
9.1-9	4
9.1-10	13
9.1-10a	13
9.1-10b	13
9.1-10c	13
9.1-10d	13
9.1-11	13
9.1-12	4
9.1-13	13
9.1-14	0
9.1-15	1
9.1-16	1
9.1-16a	1
9.1-16b	1
9.1-17	0
9.1-18	0
9.1-19	0
9.1-20	0
9.1-21	0
9.1-22	0
9.1-23	0
9.1-24	3
9.1-25	4
9.1-26	4
9.1-27	4
9.1-28	4
9.1-29	4
9.1-30	4
9.2-1	13
9.2-2	13
9.2-2a	1
9.2-2b	1
9.2-3	17
9.2-4	17
9.2-5	0
9.2-6	0

DOCUMENT CONTROL

PAGE	REVISION
9.2-7	1
9.2-8	1
9.2-8a	17
9.2-8b	1
9.3-1	4
9.3-2	4
9.3-3	13
9.3-4	4
9.3-5	4
9.3-6	4
9.3-7	4
9.3-8	4
9.4-1	3
9.4-2	4
9.4-2a	4
9.4-2b	4
9.4-3	3
9.4-4	3
9.4-5	3
9.4-6	3
9.4-7	3
9.4-8	3
9.5-1	0
9.5-2	13
9.5-3	0
9.5-4	0
9.6-1	0
9.6-2	0
9.7-1	0
9.7-2	0
9.7-3	0
9.7-4	0
Figure 9.1-1	4
Figure 9.1-2	4
Figure 9.1-3	12
Chapter 10 Tab	
10-i	13
10-ii	13
10.1-1	13
10.1-2	13

DOCUMENT CONTROL

PAGE	REVISION
Appendix 10A Tab	
Technical Specification Bases	13
Chapter 11 Tab	
11-i	0
11-ii	0
11.1-1	4
11.1-2	4
11.1-3	4
11.1-4	0
11.1-5	0
11.1-6	0
11.1-7	0
11.1-8	0
11.1-9	0
11.1-10	0
11.2-1	0
11.2-2	0

CHAPTER 2

SITE CHARACTERISTICS

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

by common carrier along Skull Valley Road, but the safe packaging of those shipments is strictly regulated by the Department of Transportation so as to prevent a release even in the event of an accident. Hazardous wastes shipped from Dugway Proving Ground do not include chemical agent but rather only chemically neutralized agent, which is far less hazardous and would not threaten the PFSF even if spilled on Skull Valley Road.

Unexploded ordnance would not pose a significant hazard to the PFSF in that 1) it is extremely unlikely that such ordnance would explode spontaneously or accidentally and 2) even if it did, the PFSF is far enough away that the material in the round would not pose a significant hazard. Unexploded ordnance is not likely to be found off Dugway Proving Ground close enough to pose a risk to the PFSF, in that the firing ranges at Dugway are all at least 15 miles away and Army records of where munitions were fired at Dugway give no indication that munitions were fired elsewhere.

The Dugway Proving Ground receives and ships conventional Army weapons approximately 95 times a year. Some of these shipments could travel the Skull Valley Road, which present the only credible potential for an explosion near the PFSF. An accident associated with the transportation of explosives along the Skull Valley Road would be a minimum of 1.9 miles from the Canister Transfer Building and 2 miles from the nearest cask storage pad. Based on the methodology of Regulatory Guide 1.91, the Skull Valley Road is located much further from the PFSF than the distances required to exceed 1 psi overpressure for detonation of explosives transported by highway, as discussed in Section 8.2.4.

The Tooele Army Depot facilities, where toxic gas munitions are stored and incinerated, are located west and south, respectively, of Tooele City. The North Tooele Army Depot is 17 miles east-northeast of the PFSF and the South Tooele Army Depot is 21 miles east-southeast of the PFSF. The Stansbury Mountains, with an elevation of approximately 8,000 feet, lie between the PFSF and the Tooele Army Depots. The activities and materials at the Tooele Army Depots will therefore present no credible hazard to the PFSF, because of their relative distance and the intervening Stansbury Mountains.

2.2.2 Hazards from Air Crashes

Aircraft flights in the vicinity of the PFSF take place to and from Michael Army Airfield on Dugway Proving Ground, on and around the Utah Test and Training Range (UTTR), and on federal airways J-56 and V-257. While there are no civilian airports within 25 miles of the PFSF, minimal general aviation traffic may also transit the region. The annual probability of an aircraft crashing into the PFSF has been conservatively calculated to be less than 5.34 E-7 per year and qualitative factors indicate that the true probability of an aircraft impacting the PFSF is significantly lower. (PFS August 2000) This is an extremely low probability, well below the 1 E-6 regulatory standard the NRC has promulgated for above ground facilities at geologic repositories (which are similar to ISFSIs) (61 Fed. Reg. 64,257, 64,261-62, 64,265-66 (1996)). Therefore, aircraft crashes do not present a credible hazard to the PFSF and the facility does not need to be designed to withstand the impact of an aircraft crash.

2.2.2.1 Michael Army Airfield and Airway IR-420

Michael Army Airfield is located on the Dugway Proving Ground, 17 miles south-southwest of the PFSF. This military airfield has a 13,125 foot runway, and can accommodate all operative aircraft in the Department of Defense inventory, although the majority of the aircraft flying to and from Michael AAF are large cargo aircraft such as the C-5, C-17, and C-141. The airspace over the Dugway Proving Ground is restricted. Military airway IR-420 passes over the PFSF site area. The methods of NUREG-0800 Section 3.5.1.6 were used to estimate the probability of an aircraft impacting the PFSF from this airway, using the equation:

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

NUREG-0800 states the in-flight crash rate as 4 E-10 per mile, which is appropriate to apply to the types of aircraft flying to and from Michael AAF. (PFS August 2000) Information provided by the Dugway Proving Ground states that there are approximately 414 flights annually at this airfield. The effective area of the PFSF is 0.2116 mi^2, calculated using Department of Energy (DOE) formulas. (DOE 1996) The width of the airway is 10 nautical miles (nm), or 10nm x 1.15 mile/nm = 11.5 miles. The probability of an aircraft impacting the PFSF is therefore 3.0 E-9 per year. Because of the distance from the PFSF to Michael Army Airfield, takeoff and landing operations at Michael pose a negligible hazard to the PFSF.

Consideration was given to the plans for landing the X-33 aircraft at Michael Army Airfield. The X-33 is an unmanned half-scale demonstrator launch vehicle planned to test critical components for the next generation space transport system. The X-33 will not pose a hazard to the PFSF because, first, tests for the X-33 at Michael Army Airfield are scheduled to be completed by mid-2000, before the PFSF would be operational, and second, the X-33's flight plan does not take it over Skull Valley, let alone the PFSF.

2.2.2.2 Utah Test and Training Range

The UTTR is an Air Force training and testing range over which the airspace is restricted to military operations. It is divided into a North Area, located on the western shore of the Great Salt Lake, north of Interstate 80, and a South Area, located to the west of the Cedar Mountains, south of Interstate 80 and northwest of Dugway Proving Ground. (PFS August 2000) The airspace over the UTTR extends somewhat beyond the range's land boundaries and is divided into military operating areas (MOAs) and restricted areas. The MOAs on the UTTR are located on the edges of the range, adjacent to the restricted areas. The PFSF site is located over 18 statute miles east of the eastern land boundary of the UTTR South Area and 8.5 statute miles northeast of the northeastern boundary of Dugway Proving Ground. The site lies within the Sevier B MOA, two statute miles to the east of the edge of restricted airspace. (PFS August 2000)

Military aircraft flying in or around the UTTR South Area comprise three groups: 1) F-16 fighter aircraft flying from Hill Air Force Base (AFB), near Ogden, Utah, down Skull Valley en route to the range (Section 2.2.2.2.1); 2) aircraft conducting training in the restricted airspace on the range (Section 2.2.2.2.2); and 3) aircraft departing the range via the Moser Recovery to return to Hill AFB (Section 2.2.2.2.3). Aircraft flying in or around the UTTR North Area pose no credible hazard to the PFSF because of the distance from the facility.

2.2.2.2.1 F-16s Transiting Skull Valley

F-16 fighter aircraft fly north to south down Skull Valley, within Sevier B MOA, en route from Hill AFB to the UTTR South Area. The F-16s use the eastern side of Skull Valley as their predominant route of travel and typically pass approximately five miles to the east of the PFSF site. The U.S. Air Force has indicated that the F-16s typically fly between 3,000 and 4,000 ft. above ground level (AGL), with a minimum altitude of 1,000 ft AGL. Data from Hill Air Force Base (AFB) indicate that the number of F-16 flights transiting Skull Valley were 3,871, 4,250, and 5,757 in Fiscal Years (FY) 1998, 1999, and 2000, respectively. On the basis of its assessment of Air Force operational policies, PFS projects that the annual number of F-16 sorties transiting Skull Valley flown by aircraft now stationed at Hill AFB would be an average of the FY99 and FY00 numbers, or approximately 5,000. The Air Force has also stated that 12 additional F-16s will be authorized at Hill AFB in FY2001, which would increase the number of authorized F-16s at the base from 69 to 81, i.e., by 17.4 percent. Therefore, PFS has projected the future annual number of sorties from Hill AFB through Skull Valley to increase by 17.4%, from 5,000 to 5,870. (PFS August 2000) This represents an increase in the annual number of F-16 sorties through Skull Valley by a factor of 1.516 since FY1998.

Because the predominant route of travel for the F-16s is down the eastern side of Skull Valley, away from the PFSF; because the likely nature of an F-16 crash in Skull Valley would be such that a crashing aircraft would not pose a hazard to the PFSF unless it was pointed directly at the site at the time of the event leading to the crash; and because Air Force pilots are instructed to avoid ground facilities in the event of a mishap in which the pilot retained control of the direction of the aircraft, it is not credible that a crashing F-16 would impact the PFSF. Nevertheless, an impact probability was calculated, using the methodology of NUREG-0800, in which it was conservatively assumed that the F-16 flights are uniformly distributed within the Sevier B MOA airspace in the vicinity of the PFSF. (PFS August 2000)

To calculate the F-16 impact probability using the NUREG-0800 method, the Sevier B MOA airspace in the vicinity of the PFSF was treated as an airway with a width of 10 miles. Given the flight characteristics of the F-16, the PFSF has an effective area of 0.1337 mi^2, assuming a facility at full capacity with 4,000 spent fuel storage casks on site. The number of flights through the valley was taken to be 5,870 per year. The crash rate for the F-16 was calculated from Air Force data to be 2.736 E-8 per mile. It was also determined, from an extensive review of Air Force F-16 accident investigation reports, that over 90 percent of the F-16 crashes that would result from accident-initiating events that could occur in Skull Valley would leave the pilot in control of the aircraft after the event. Furthermore, because of the training Air Force pilots receive in responding to such in-flight events, the flight characteristics of the F-16, the absence of other built up areas in Skull Valley, and the small effort required for the pilot to avoid the PFSF site in the event of a crash caused by an accident-initiating event leaving him in control of the aircraft, the pilot would be able to direct the aircraft away from the PFSF at least 95 percent of the time in which such an event caused a crash in Skull Valley. Accordingly, 85.5 percent (90% x 95%) of the crashing F-16s would be able to avoid the PFSF and hence the calculated crash impact hazard to the PFSF would be reduced by this fraction. Thus, the annual crash impact probability for the F-16s in Skull Valley (assuming a fully loaded facility) was calculated to be 3.11 E-7. (PFS August 2000)

PFS also calculated the probability that ordnance jettisoned from a crashing F-16 in Skull Valley would impact the PFSF. (PFS August 2000) Some of the F-16 flights through Skull Valley carry ordnance (live or inert) and in the event of an incident leading to a crash in which the pilot would have time to respond before ejecting from the aircraft (e.g., an engine failure), one of the pilot's first actions would be to jettison any ordnance carried by the aircraft. PFS used an approach similar to that of NUREG-0800 to calculate the probability that such ordnance would impact the PFSF. The fraction of the 5,870 F-16s transiting Skull Valley per year that would be carrying ordnance was determined from Air Force data to be 11.8 percent. Thus the number of aircraft carrying ordnance through Skull Valley per year, N, would be 693. The crash rate for the F-16s, C, was taken to be 2.736 E-8 per mile, as above. Nonetheless, the pilot was assumed to jettison ordnance in only 90 percent of all crashes, the fraction of the crashes, e, assumed to be attributable to engine failure or some other event leaving him in control of the aircraft (in crashes attributable to other causes it was assumed that the pilot would eject quickly and would not jettison ordnance). Skull Valley was treated as an airway with a width, w, of 10 miles. As with the calculation for F-16s transiting Skull Valley, PFS conservatively assumed that the F-16s are uniformly distributed across the 10 miles, despite the fact that their predominant route of flight is down the eastern side of the valley and that, according to the Air Force, aircraft carrying live ordnance avoid flying over populated areas to the maximum extent possible. The area of the PFSF, from the perspective of a piece of ordnance jettisoned from an aircraft flying from north to south over the site, A, was taken to be the product of the width and the depth of the cask storage area (assuming a full facility with 4,000 casks) plus the product of the width and depth of the canister transfer building, in that the pieces of ordnance are small relative to an aircraft and impact the ground at a steep angle. Thus, the area of the PFSF was calculated to be 0.08763 mi^2. The probability that the ordnance would impact the PFSF is given by P = N x C x e x A/w, or:

$$P = 693 \times 2.736\text{ E-8} \times 0.90 \times 0.08763 / 10 = 1.49\text{ E-7}$$

In addition to the potential hazard posed by direct impacts of crashing aircraft and jettisoned ordnance, PFS also calculated the hazard to the PFSF posed by jettisoned live ordnance that might land near the facility and explode on impact, as well as the hazard posed by a potential explosion of live ordnance carried aboard a crashing aircraft that might impact the ground near the PFSF. (PFS August 2000) At the outset, aircraft transiting Skull Valley near the PFSF do not carry armed live ordnance. Furthermore, the U.S. Air Force has indicated that the likelihood that unarmed live ordnance would explode when impacting the ground after being jettisoned is "remote" and the Air Force has no records of such incidents in the last 10 years. Thus, it is highly unlikely that jettisoned live ordnance or live ordnance carried aboard a crashing aircraft that did not directly impact the PFSF would damage the facility. Nevertheless, to calculate a numerical hazard to the facility, PFS assumed that such ordnance would have a 1 percent chance of exploding and assessed that damage to the PFSF would result if an explosion occurred close enough that the blast overpressure would damage a storage cask or the Canister Transfer Building, without hitting either one. The explosive overpressure limit for a storage cask was taken to be 10 psi. The limit for the Canister Transfer Building was taken to be 1.5 psi. PFS assumed that the ordnance in question was a 2,000 lb. bomb, the largest single piece of ordnance carried by the F-16s that transit Skull Valley. The Air Force indicated that 193 F-16s transited Skull Valley in 1998 with live ordnance. PFS calculated the probability that an F-16 carrying live ordnance would crash and jettison the ordnance so as to impact near the PFSF, or crash near the PFSF without jettisoning the ordnance, following the same method it used to calculate the probability that an F-16 would crash and impact the facility. The results of PFS's final calculation showed that the annual probability that a storage cask or the Canister Transfer Building would be damaged by an explosion of live ordnance jettisoned from a crashing aircraft or carried aboard a crashing aircraft that impacted the ground near the PFSF was equal to 2.43 E-10. 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 data, and the stationing of the 12 additional F-16s at Hill AFB, the probability would increase by a factor of 1.516 to 3.68 E-10. This is exceedingly low and is insignificant relative to the other aircraft crash and jettisoned ordnance impact hazards calculated for the PFSF.

2.2.2.2.2 Aircraft Training on the UTTR

According to the Air Force, 8,284 sorties were flown over the UTTR South Area in 1998. (PFS August 2000) Those aircraft conducted a variety of activities, including air-to-air combat training, air-to-ground attack training, air-refueling training, and transportation to and from Michael Army Airfield (which is located beneath UTTR airspace). Hazards posed by aircraft flying to and from Michael Army Airfield are addressed in Section 2.2.2.1 above. Of the remaining aircraft, only fighter aircraft conducting air-to-air training represent a potential hazard to the PFSF, in that aircraft conducting air-to-ground attack training do so over targets that are located more than 20 miles from the PFSF site and aircraft conducting air refueling training do so on the far western side of the UTTR, over 50 miles from the site. The Air Force indicated 6,360 fighter sorties were flown on the UTTR South Area in 1998 and one-third, or approximately 2,120, involved fighter aircraft conducting air-to-air training.

The crash impact probability for fighter aircraft conducting air-to-air training on the UTTR was calculated as follows:

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

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

The total air-to-air training crash rate per square mile on the UTTR, C_a, was calculated from the total number of hours flown in air-to-air training on the UTTR South Area in 1998 (2,468), the crash rate per hour for fighter aircraft (the F-16) conducting the types of flight activity conducted within the portion of the restricted areas on the UTTR near the PFSF, the distribution of air operations over the sectors of the UTTR nearest the PFSF, and the ground areas of those sectors. PFS then updated its input data based on F-16 sortie information from Hill AFB for Fiscal Years 1999 and 2000, and a projected increase in the number of aircraft stationed at the base. (PFS August 2000) As with the F-16s transiting Skull Valley, 95 percent of the crashes on the UTTR attributable to engine failure or some other cause leaving the pilot in control of the aircraft were determined not to pose a hazard to the PFSF, in that the pilot would retain control of the aircraft and would be able to avoid the site. Based on Air Force data, 45 percent of all F-16 crashes occurring during combat training are attributable to engine failure; thus the factor R in the equation above was set equal to 0.573 (1-(45% x 95%)). The area from which an aircraft could credibly impact the PFSF in the event of a crash, A_c, was taken to be the portion of the UTTR within 5 miles of the PFSF and outside a three-mile buffer zone assumed to exist on the edge of the UTTR restricted areas. Based on Air Force F-16 mishap data, a crashing aircraft more than 5 miles from the PFSF would have to be under control of the pilot in order to glide and reach the site, and the pilot would guide any such aircraft away from the site, which is outside the land boundaries and the restricted airspace of the UTTR. The buffer zone represents the fact that aircraft do not fly within three miles of the edges of the restricted areas while conducting training on the UTTR. The site effective area, A, was determined as in Section 2.2.2.2.1 above for a facility at a full capacity of 4,000 storage casks. The footprint area, A_p, was calculated by assuming that a crashing aircraft could glide in any direction up to a distance equal to the product of its starting altitude above ground and its glide ratio. Accordingly, the aircraft conducting air-to-air training over the UTTR were divided into altitude bands and an impact probability calculated for each band. Aircraft too low to glide to the PFSF in the event of a mishap were calculated not to contribute to the crash impact hazard, in that they would have no chance of reaching the site. The maximum annual air crash impact probability for aircraft conducting air-to-air training on the UTTR South Area was determined to be significantly less than 1 E-8, based on the sum of impact probabilities of the altitude bands and consideration of the fact that practically no aircraft on the UTTR experiencing an in-flight mishap leading to a crash would be close enough to the PFSF site to impact it.

2.2.2.2.3 Aircraft Using the Moser Recovery

Most of the F-16s returning to Hill AFB from the UTTR South Area exit the northern edge of the range (away from the PFSF) in coordination with air traffic control. However, some aircraft returning to Hill from the UTTR South Area may use the Moser recovery route, which runs from the southwest to the northeast, approximately two miles from the PFSF site. (PFS August 2000) The Moser route is only used during marginal weather conditions or at night under specific wind conditions which require the use of Runway 32 at Hill AFB. Based on information from local air traffic controllers, conservatively estimated, the Moser recovery is used by less than five percent of the aircraft returning to Hill. According to the Air Force, 5,726 F-16 sorties were flown on the UTTR South Area in 1998, almost all of which flew from Hill AFB (not all aircraft transit Skull Valley en route to the South Area). Thus, fewer than 286 aircraft per year (5% x 5,726) were estimated to have used the Moser recovery on their return flights.

The annual crash impact probability for aircraft flying the Moser recovery was calculated using the NUREG-0800 method. The Moser recovery is defined as an airway with a width, w, of 10 nautical miles (11.5 statute miles) (equal to the width of military airway IR-420). The number of aircraft, N, was conservatively taken to be 286; the crash probability, C, is equal to 2.736 E-8 per mile; the effective area of the site is 0.1337 mi^2; and it is calculated that 85.5 percent of all crashes would be attributable to events leaving the pilot in control of the aircraft, in which the pilot could direct the aircraft away from the PFSF (see Section 2.2.2.2.1). Thus, the annual crash impact probability was conservatively 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 data, and the stationing of the 12 additional F-16s at Hill AFB (Section 2.2.2.2.1), the probability would increase by a factor of 1.516 to 2.00 E-8.

2.2.2.3 Aircraft Flying Federal Airways

Federal airway J-56 runs east-northeast to west-southwest at a distance (from the airway centerline) of 11.5 miles north of the PFSF. (PFS August 2000) Local air traffic controllers have indicated that fewer than 12 aircraft per day use the airway. The crash impact probability for aircraft on the airway was calculated for the PFSF using the method of NUREG-0800. Using the standard width for federal airways, J-56 is 8 nautical miles (9.2 statute miles) wide and the closest edge of J-56 is 6.9 miles from the PFSF. For facilities outside an airway, the effective width of the airway, w, is equal to the actual width plus twice the distance from the facility to the closest edge. Thus, J-56 has an effective width of 23 miles. The number of aircraft, N, is conservatively taken to be 12 per day, the crash rate, C, from NUREG-0800 is 4 E-10 per mile, and the effective area of the PFSF for commercial airliners (the most common aircraft on the airway) is 0.2615 mi^2, assuming a full facility with 4,000 casks. Accordingly, the maximum annual crash impact probability is 1.9 E-8. (PFS August 2000)

Federal airway V-257 runs north and south at a distance (from the airway centerline) of 19.5 miles east of the PFSF. (PFS August 2000) Local air traffic controllers have indicated that fewer than 12 aircraft per day use the airway. The crash impact probability for aircraft on the airway was calculated for the PFSF using the method of NUREG-0800. V-257 is 12 nautical miles (13.2 statute miles) wide and its closest edge is 12.6 miles from the PFSF. Thus, V-257 has an effective width of 39 miles. The number of aircraft, N, is conservatively taken to be 12 per day, the crash rate, C, is 4 E-10 per mile, and the effective area of the PFSF is 0.2615 mi^2. Accordingly, the annual crash impact probability is 1.2 E-8. (PFS August 2000)

2.2.2.4 General Aviation

There are no civilian airports within 25 miles of the PFSF, the PFSF is located in a sparsely populated area, and the PFSF is located inside a military operating area (MOA) in which flight by civilian aircraft is limited while the MOA is being used by the Air Force (and which is avoided by general aviation pilots because of the military flight activity that takes place there). Thus, the general aviation traffic over Skull Valley is negligible; in fact F-16 pilots who have flown from Hill AFB through Skull Valley indicate never having seen any, or having seen only minimal, general aviation traffic there. Therefore, it is highly unlikely that a general aviation aircraft would crash into the PFSF. (PFS August 2000) PFS estimates that the probability would be less than 1 E-8 per year.

First, a conservative upper bound for the crash impact probability for general aviation aircraft was calculated using National Transportation Safety Board (NTSB) crash data and the population of general aviation aircraft in the state of Utah. (PFS August 2000) The crash impact probability is equal to C_a x A, where C_a is the crash rate per square mile and A is the effective area of the PFSF. In 1995, the 182,600 general aviation aircraft in the United States suffered 412 fatal accidents. There are 1,218 general aviation aircraft in the state of Utah, which covers an area of 84,094 mi^2. FAA crash data indicate, however, that only 15 percent of all general aviation crashes occur during the cruise mode of flight, which, because there are no airports nearby, is the mode in which general aviation aircraft would be flying near the PFSF. Furthermore, business jets experience 7.85 percent of all general aviation fatal crashes and they can be excluded from this calculation, in that they fly mostly on federal airways. The effective area of the PFSF with respect to general aviation aircraft crashes is 0.1173 mi^2 (assuming a fully loaded facility with 4,000 casks). Accordingly, the annual crash impact probability for general aviation aircraft is 5.25 E-7. (PFS August 2000)

The crash impact hazard to the PFSF, however, would be reduced below the calculated impact probability, in that the spent fuel storage casks would be able to withstand the crash impact of most general aviation aircraft. Fifty-five percent of all general aviation aircraft are single-engine piston types weighing less than 3,500 lbs. (PFS August 2000) Such aircraft typically fly at speeds under 100 knots (114 mph). Therefore, the impact of such aircraft at the PFSF would be bounded by the design basis tornado missile impact for the PFSF, an automobile weighing 1800 kg (3,968 lbs.) moving at a speed of 126 mph. (p. 8.2-17) Thus, the impact of such light general aviation aircraft would not cause a radioactive release from a storage cask. Therefore, the calculated upper bound general aviation crash impact hazard to the PFSF can be reduced by 55 percent to 2.36 E-7 per year.

Based on the observations of F-16 pilots in Skull Valley, however, the general aviation traffic level there is significantly below the statewide average traffic level. Thus, the Skull Valley crash rate is significantly less than the statewide rate. The methodology of NUREG-0800, Section 3.5.1.6, can be used to correlate these observations with an associated hazard probability. (PFS August 2000)

The crash impact hazard posed by general aviation aircraft flying through Skull Valley is given, according to NUREG-0800, by P = N x C x A/W (see Section 2.2.2.1). The fatal crash rate, C, for fixed wing, powered general aviation aircraft in the cruise mode of flight, is 3.82 E-8 per mile. For Skull Valley, the corridor width, W, is 10 miles, and the PFSF effective area, A, remains 0.1173 mi^2. Therefore, if P is equal to 1 E-8, then N must be 22 general aviation aircraft per year transiting Skull Valley in the neighborhood of the PFSF. This number, however, includes single-engine piston general aviation aircraft weighing less than 3,500 lbs., which account for at least 55 percent of all general aviation aircraft and which pose no hazard to the PFSF. Refining this calculation to exclude those aircraft, the required number of aircraft transiting Skull Valley becomes 49 per year, or approximately one flight every 7 days. It is reasonable to assume that if general aviation aircraft were transiting Skull Valley on a weekly basis, they would be seen by the F-16 pilots (e.g, in FY98 there were approximately 11 F-16 flights per day), but in fact the F-16 pilots have never, or seldom, seen them. (PFS August 2000) Thus, PFS concludes that the general aviation crash impact hazard to the PFSF is less than 1 E-8.

Furthermore, the effective general aviation crash impact hazard posed by those aircraft whose impacts would not be bounded by the design basis tornado missile (i.e., the 45 percent of all general aviation impacts not excluded above) is shown to be even lower than 1 E-8 by PFS calculations demonstrating that such aircraft would not penetrate a spent fuel storage cask even in the remote event they were to impact the PFSF. PFS employed the methodology used by the Department of Energy to assess aircraft crash risks to hazardous facilities (DOE 1996; Davis et al. 1998) and determined that the engine of a general aviation aircraft, which would be the bounding component of a crashing aircraft, could not penetrate a storage cask. (PFS August 2000) General aviation aircraft other than jets may be modeled as having engines weighing between 230 and 800 lbs. and impacting at speeds between 67 and 280 miles per hour. (Kimura and Budnitz 1987) PFS calculations showed that an 800-lb. engine impacting at a speed of 280 miles per hour would have substantially less energy than that required to penetrate a spent fuel storage cask. Therefore, PFS's assessment of the crash impact hazard posed by general aviation aircraft whose impacts would not be bounded by the design basis tornado missile is conservative.

2.2.2.5 Cumulative Air Crash Impact Probability

The cumulative maximum air crash impact probability is given in the table below.

Aircraft Crash Impact Probabilities	
Aircraft	**Maximum Annual Probability**
Skull Valley F-16s	3.11 E-7
Aircraft Using the Moser Recovery	2.00 E-8
UTTR Aircraft	<1 E-8
Aircraft on Airway J-56	1.9 E-8
Aircraft on Airway V-257	1.2 E-8
General Aviation Aircraft	<1 E-8
Aircraft on Airway IR-420	3.0 E-9
Cumulative Crash Probability	<3.85 E-7
Jettisoned Military Ordnance	1.49 E-7
Cumulative Hazard	<5.34 E-7

The table shows that the cumulative air crash impact probability is less than 1 E-6 for the PFSF. Qualitative factors discussed below show further that the true impact probability is significantly less than the calculated probability. Thus, air crash impact does not pose a credible hazard to the PFSF and the PFSF does not need to be designed to withstand the effects of air crash impacts.

2.2.2.6 Projected Growth in Air Traffic

The Federal Aviation Administration projects that the number of commercial aviation flights in the United States will increase by approximately 66 percent between 1998 and 2025, that the number of general aviation flights will increase by approximately 14 percent over the same period, and that the number of military flights will not increase during this period. (FAA 1999) Furthermore, based on PFS assessment of Air Force operational policies, it is not expected that F-16s at Hill AFB will fly significantly more sorties per aircraft per year than were flown in FY00. (PFS August 2000) Because most of the air traffic near the PFSF site is military, the growth in commercial and general aviation projected by the FAA will have no material effect on the air crash impact probability calculated for the facility.

2.2.2.7 Conservatism in the PFSF Air Crash Impact Probabilities

While the calculated cumulative hazard for the PFSF is less than 5.34 E-7, qualitative factors indicate that the true probability of an aircraft or jettisoned ordnance impacting the site is significantly lower. (PFS August 2000) With respect to the F-16s transiting down Skull Valley en route to the UTTR South Area (and jettisoned military ordnance), these factors include the fact that, according to the U.S. Air Force, the predominant route of choice for the F-16s is the east side of the Valley, approximately five miles from the site. Thus, the uniform distribution assumed in calculations in Section 2.2.2.2.1 is conservative, especially considering the fact that the only aircraft that pose a real hazard to the site are those that are pointed directly toward it at the time of the incident leading to a crash. In addition, the Skull Valley F-16 calculations assume that F-16s will crash at the 10-year average rate rather than the more recent and lower 5-year average rate.

Furthermore, the calculated cumulative hazard is conservative in three other major respects. First, the calculated probability is for a fully loaded, 4,000 cask facility, which would be the case for only a short period in the life of the PFSF. The average area of the PFSF site, and hence the average annual probability that an aircraft or jettisoned ordnance would impact the site, is 55 percent of that of the full facility. Thus, the average annual impact probability is roughly 3 E-7.

Second, no credit was taken for the resistance to the effects of an air crash impact provided by the concrete storage casks in which the spent fuel canisters will be located (other than resistance to impacts of light general aviation aircraft). The cask construction is robust enough that a significant fraction of the potential air crash impacts at the PFSF would not cause a release of radioactivity. (Davis et al. 1998) The casks could withstand the direct impact of a jet fighter or commercial airliner at a speed of over 370 knots, which is significantly greater than typical air crash impact velocities, and the casks could withstand the impact of all general aviation aircraft that might overfly the PFSF. (PFS August 2000) This resistance of the casks to penetration further reduces significantly the calculated risk to the PFSF from aircraft crashes or jettisoned ordnance.

Third, PFS's assessment of the hazard posed by jettisoned ordnance is also conservative. The Air Force has indicated that the inert (i.e., dummy) variants of most of the munitions carried by F-16s transiting Skull Valley would not penetrate a spent fuel storage cask if they were to be jettisoned and impact a cask. (PFS August 2000) This assessment would also apply to any jettisoned live (but unarmed) munitions of the same types which did not explode on impact. The Air Force has stated that the likelihood that such ordnance would explode is remote.

2.2.3 The Use of Ordnance on the UTTR

As discussed in Section 2.2.2.2, military aircraft conduct air-to-ground attack training using air-delivered ordnance on the UTTR South Area. Military aircraft also conduct weapons testing, including the testing of cruise missiles. (PFS August 2000) As shown in the following paragraphs, the use of air-delivered ordnance on the UTTR does not pose a significant hazard to the PFSF (the hazard posed by jettisoned ordnance in Skull Valley was calculated in Section 2.2.2.2.1 above). The PFSF site is located 18 miles to the east of the easternmost land boundary of the range. Based on the following paragraphs it is concluded that weapons use on the UTTR does not pose a credible hazard to the PFSF and the facility does not need to be designed to withstand a weapon impact.

Weapons use on the UTTR is strictly controlled and the UTTR has never experienced an unanticipated munitions release outside of designated launch/release areas. Aircraft flying over Skull Valley are not permitted to have their armament switches in a release capable mode, and all switches are "safe" until the aircraft are inside DOD land boundaries. Master Arm switches are not actually armed until the aircraft are on the ranges within the UTTR where the bombs are to be dropped. Furthermore, the targets on the UTTR are all over 20 miles from the PFSF site and there are no run-in headings for weapons delivery over the Skull Valley area.

Hung Ordnance

The probability of "hung ordnance" (i.e., the failure of ordnance to release from an aircraft when delivery is attempted) and an unintentional release of the ordnance in

Skull Valley are exceedingly low. First, most aircraft do not even carry live ordnance but instead carry training ordnance such as Bomb Dummy Units (BDU) or inert filled or empty MK82 500 lb bombs. According to the U.S. Air Force, only approximately 15% of the 8,711 UTTR sorties flown in Fiscal Year 1998 actually carried live ordnance. Training bombs, by contrast, pose no explosive hazard to the PFSF and the dead weight of the BDUs pose no risk to the facility as well. BDU-33's have ballistic characteristics similar to MK 82 bombs but carry only a small smoke charge for marking purposes. They weigh only 25 pounds and are often the weapon of choice for training missions. Second the probability that any ordnance will "hang" is very low. Michael AAF is the designated primary airfield for aircraft landing with live hung ordnance that has failed to release. There were only five hung ordnance aircraft diversions/recoveries into Michael AAF during 1998. Since only approximately 15% of the aircraft sorties carry live ordnance, a total of only five hung ordnance recoveries in 1998 for a total of about 2,000 sorties (approximately 15% of the 13,367 over the UTTR) produces a probability for failing to release of approximately one in 400. Moreover, a failure to release does not mean there will be an inadvertent release or an inadvertent release and explosion. As indicated above, the Air Force has never had an unintentional release of ordnance outside the launch/drop/shoot boxes on the UTTR. All of these are obviously within the UTTR and in fact are over 20 statute miles from the PFSF site.

Finally, the probability of "hung ordnance" striking the PFSF is not credible because aircraft carrying hung ordnance do not fly over Skull Valley. In the event of hung ordnance, the first priority is to maintain aircraft control and then assess the situation and take appropriate action. Pilots contact Clover Control Air Traffic Control Facility and advise them of the situation. When hung ordnance is encountered, the pilot has the option of either jettisoning the rack and munitions on the range, if able, or recovering to base. Michael AAF is the designated primary recovery base for hung ordnance, although Hill AFB is available as well. Pilots request clearance to Michael

AAF for hung ordnance recovery/landing. Pilots maintain a stable flight path and remain in Visual Meteorological Conditions by avoiding clouds. Clover Control provides assistance as required and ensures Michael AAF is prepared to receive the aircraft to include fire fighting equipment and medical personnel standing by. The pilot maneuvers the aircraft to the northwest, approximately 20 statute miles from the proposed PFSF site, and proceeds to Michael AAF, avoiding rapid or steep turns and abrupt climbs or descents. Test facilities or any populated areas are avoided. A long straight-in approach with a shallow rate of descent is established to a full stop landing on runway 12 (to the southeast). Runway 12 is 13,125 ft long and 200 ft wide with a barrier cable at the end. After landing, Dugway Proving Ground Explosive Ordnance Disposal personnel inspect and safe the ordnance.

The UTTR record of no unintended release of live ordnance outside of designated launch/release areas and the procedure for landing aircraft with hung ordnance, which avoids populated areas and approaches Michael Army Airfield from the northwest, away from the PFSF, assures that hung ordnance will not impact the PFSF. Consequently, hung ordnance striking the PFSF is not a credible event.

Cruise Missiles

Missile launches are generally confined to the northern and western portions of the UTTR and are at least 30 statute miles away from the PFSF site. Run-ins, drops, and launches are normally done from north to south or east to west and are thus directed away from the PFSF site. Cruise missile targets on the UTTR are located at least 18 miles from the PFSF. Cruise missiles and other weapon systems that have a capability of exceeding range boundaries are required to have a Flight Termination System (FTS) installed prior to testing on the UTTR. The FTSs are designed to promptly destruct the weapons and terminate the weapons' flight paths in the event of an anomaly. Before a bomber launches a test cruise missile, the Mission Control Center verifies that the missile's remote control systems are working properly. At all times throughout the flight the cruise missile FTS must detect a signal that in effect permits the missile to keep flying (FTS discussed in USAF Accident Investigation Board Report, 12/10/97). If the missile does not detect the signal for a preset time, the FTS activates. Safety Officers can also activate the FTS, if required, at any time. The Range Safety Officer at Mission Control and the Airborne Range Instrumentation Aircraft are also both capable of terminating missile flight almost immediately. The UTTR has never experienced an FTS failure. Consequently, a cruise missile striking the PFSF is not a credible event.

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