Contract No:

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

CALCULATION COVER SHEET

Project DWPF	Calculation No. S-CLC-S-00039	Project Number SR02.KH15627.038.WD206407B
Title Helicopter Crash Frequency for DWPF (U)	Functional Classification SC Discipline Safety	Page 1 of ~~11~~ 17 RS 6/5/02

___ Preliminary X Confirmed

Computer Program No.	Version Release No.
N/A	N/A

Purpose and Objective

The purpose of this calc-note is to document calculations that estimate the expected frequency of helicopter crashes into selected DWPF structures.

Summary of Conclusion

The largest (and therefore, most likely to be crashed into) building is the vitrification building. The expected frequency of a helicopter crashing into the vitrification building is 2.7×10^{-6} per year. The frequencies for the remainder of the structures analyzed are given in the table in the Results and Conclusions section.

Revision

Rev. No.	Revision Description	Author
0	Initial Issue	AG Sarrack
1	Revised Number of Overflights and Evaluated Additional Structures	CR Lux

Sign Off

Revision Number	Originator (Print) Sign/Date	Verification Method	Verifier (Print) Sign/Date	Manager (Print) Sign/Date
1	C. Ray Lux [redacted]	Individual Review of Calculation	C. H. Blanton [redacted]	William R. Mangiante [redacted]

Keywords:
Aircraft
Fire
Explosion
Wachenhut
Overflight

Facility Revie [redacted]

Sign/Date

[redacted]

ADC & Reviewing O [redacted]

Date: 4/26/02

ENGINEERING DOC. CONTROL–SRS
00663795

ORIGINAL

CALCULATION REVISION LOG

(FOR APPROVAL SIGNATURES AND DATES SEE COVER SHEET)

CLIENT/PROJECT DWPF

CALCULATION NO. S-CLC-S-00039

REVISION NO.	AFFECTED SHEET NOS.	DESCRIPTION OF REVISION	REASON FOR REVISION
0	Initial Issue	Initial Issue	Initial Issue
1	3-11	Revised Number of Overflights and Evaluated Additional Structures	Some structures had not been reviewed for helicopter crash frequency.

TABLE OF CONTENTS

1.0 OPEN ITEM

There are no open items.

2.0 INTRODUCTION

Revision 0 of this calc-note examined the helicopter crash frequency for the Vitrification Bldg. (221-S), Glass Waste Storage (250-S), Low Point Pump Pit (511-S), Water & Chemical Waste Treatment (980-S), Cold Feed Storage Bldg. (422-S), and Organic Waste Storage Tank (430-S) at DWPF. Since the issue of that calc-note several other structures have been identified that require analysis for helicopter crash frequency. This revision is being issued to include those structures in the analysis. The intent is to provide helicopter crash frequencies calculated using the same methodology that was used in the original issue. However, concern was expressed that the current helicopter overflight frequency might have changed, the number of overflights was updated as a part of this revision.

3.0 INPUT DATA AND ASSUMPTIONS

3.1 FACILITY INPUT DATA

Dimensions of DWPF Structures

Structure	Approx. Dimensions (L x W x H) (ft)	Source
Vitrification Building	360 x 117 x 82	W757161, W755108, W755109
GWSB	205 x 184 x 0	W755284
Low Point Pump Pit (LPPP)	115 x 65 x 0	W756446
LPPP SG Purge System	Same as LWF Prim. N_2 & Tank	W756446, W756450, D34905
LPPP Safety Class Interlocks	111 x 65 x 41	W756446, W756450
Water & Chemical Treatment	114 x 92 x 18	W757131
Cold Feed Storage	150 x 60 x 28	W756405
Organic Waste Storage Tank (OWST)	42 diameter x 24 high	F SAR Chapter 4 Table 4.4-2
OWST SG Purge System-Pad/Tank & Transfer Line	21 x 18 x 31 921' of 1' wide line	C-CC-S-0112, F SAR Chapter 4 Table 4.4-2, W761103
OWST Primary Inerting System	Same as OWSTSG Purge System	C-CC-S-0112, F SAR Chapter 4 Table 4.4-2, W761103
Sand Filter	196 $^1/_3$ x 124 $^1/_3$ x 2	W762485, W762686, T-ESR-S-00001
Fan House	98 x 132 x 32 $^1/_2$	W755242 W755245
Chemical Process Cell/Salt Process Cell (CPC/SPC) Safety Grade (SG) N_2 Purge System- Pad & Tanks (Since tanks, vaporizers, piping located on pad, conservatively use pad width in place of tank diameter)	56 x 30 x 0 122" diameter x 369" high	D34905
CPC Primary Purge System & 2 compressors	85 x 74 x 32 5 diameter x 10 high	W756405, P-PE-S-0023
SPC Primary Purge System & Pipe	30 x 35 x 12 6" diameter x 40'	Field Measured

Dimensions of DWPF Structures

Structure	Approx. Dimensions (L x W x H) (ft)	Source
Late Wash Facility (LWF)	115 x 65 x 0	W756446
LWF Primary Nitrogen System & Tank	111 x 65 x 41 122" diameter x 369" high	C-CC-S-0111, P-PE-S-0008, D34905
LWF Backup Nitrogen System	Same as LWF Prim. N_2 & Tank	C-CC-S-0111, P-PE-S-0008, D34905
Zone 1 Ventilation Stack & Ductwork	8 $^2/_3$ diameter x 147 high 9 diameter x 245 long (duct is 4'2" off ground)	W762455 W762483 W762482
FESV	66 $^1/_3$ x 24 x 0	W780850
Melter Off-Gas & Vapor Space Temperature Interlocks	30 x 30 x 26	W755109, W755114

3.2 ASSUMPTIONS

The assumptions used in this analysis are given below:

1. Helicopters will have a 45° angle of descent.

2. The direction of approach is directly at the broad side of each structure (maximizes effective target area).

4.0 ANALYTICAL METHODS AND CALCULATIONS

Calculation

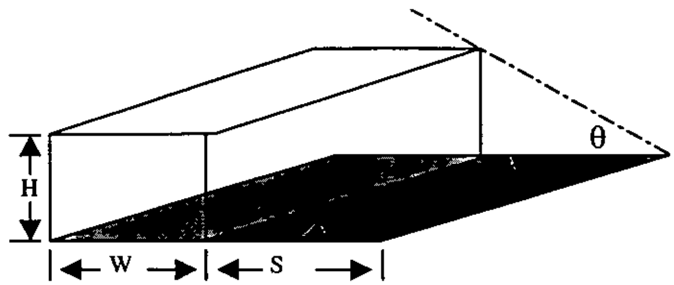
The frequency of a helicopter crash into a building (F_{bldg}) is directly related to the effective target area of the building (A_{bldg}) and the frequency of helicopter crashes in the area (F_{crash}), as described by the following equation:

$$F_{bldg} = A_{bldg} \times F_{crash}$$

Where F_{bldg} is the frequency of a helicopter crashing into a building (crashes/year)
A_{bldg} is the effective target area of the building (ft^2), and
F_{crash} is the frequency of a helicopter crashes over the area (crashes/year-ft^2)

Effective target area of building

The effective target area of each building is calculated by adding the building footprint A_{foot} (the area of land under the building) and the 45° shadow area, A_{shadow} (the area of land blocked by the building, as viewed from an aircraft approaching the broad side of the building, from a 45° angle with respect to the ground). This angle was judged to be conservative because it is thought that most helicopter crashes would result in a nearly vertical drop. (The steeper the drop is, the smaller the effective target area is.) The following sketch and equations describe the areas of interest.



Footprint Shadow Area

$A_{foot} = L \times W$

Where A_{foot} is the footprint of the building,
L is the Length of the building and
W is the Width of the building.

$A_{shadow} = L \times [H / \tan(\theta)]$

Where A_{shadow} is the "shadow area" cast by the building
L is the length of the building,
H is the height of the building, and
θ is the angle of approach (assumed to be 45°).

The effective target area is equal to the sum of the footprint and the shadow areas. Facility personnel provided the dimensions of the structures to be analyzed.

Probability of crash per unit area

The probability that a helicopter will crash at SRS (P_1) was determined in a previous analysis (Ref. 1) to be 1.8×10^{-13} crashes per overflight per ft^2.

Frequency of flights over the area

Aircraft operations at SRS are coordinated through the DOE Office of Safeguards, Security and Cyberspace by the SRS Aviation Manager. Regular helicopter operations, performed across the site by Wakenhut Services, Inc. (WSI), USDA-Forest Service-SR (USFS-SR), and South Carolina Electric and Gas (SCE&G), are addressed in this calculation. A small number of additional operations, performed by various agencies, are authorized on an infrequent basis. These activities are assumed to be insignificant in comparison to the evaluated operations and the associated contribution to facility impact frequency is not included.

Wakenhut Services, Inc.

WSI conducts regular helicopter operations across SRS for purposes of site security. Operations, including security response, practice exercise, shipment escort, surveillance, and training, originate from the WSI heliport in B-Area.

A recent calc-note (Ref. 2) indicated that an average of 820 WSI flight hours were conducted per year during the period from 1996 through 2001. During 2001 and 2002, an average of 1373 missions were flown with an average duration of 0.6 hours per mission. WSI operating requirements and procedures do not restrict helicopter operation in the vicinity of SRS facilities. General operating practice does, however, discourage direct overflight of significant structures for all non-emergency response activities. Based on this information, Reference 2 concluded that the number of WSI helicopter flights expected to cross the effective area of an individual SRS facility housing nuclear material or safety related SSCs during a one year period is estimated to be no greater than 138 based on the product of 1) the number of missions conducted throughout the year (1373), 2) the probability that a mission crosses the specified area (0.5), 3) the number of passes across the specified area on a single mission (2), and 4) the probability that a specific flight enters the effective area of the facility where it does not normally fly (0.1).

Another recent discussion (Ref. 3) with WSI indicated that actual training and mission flights to the facility occur no more than every other day. Note that for these flights, WSI lands in perimeter areas that are 0.5-miles from any DWPF structure. If we assume that the helicopter passes near the facility on the way out and on the way back, this would be no more than 366 times a year that the helicopter is near the facility. Since WSI states that all of these flights are near DWPF, it is fairly likely that a structure could be overflown. The probability is estimated to be 0.5. Thus yielding no more than 183 overflights per year based on this information.

The two recent sets of information vary slightly yielding overflight counts of 138 and 183. As stated above, the 183 represents an upper bound on the number of flights. To maintain conservatism, this study will use **183** DWPF overflights by WSI.

USDA - Forest Service – Savannah River

USDA Forest Service-Savannah River (USFS-SR) conducts regular helicopter operations across SRS for purposes of wildfire detection/response, prescribed fire operations, and wildlife/forest health surveillance. Operations originate from the heliport adjacent to the USFS-SR facility in G-Area approximately 3.5 miles east of A-Area.

A recent study (Ref. 2) examined these operations to determine the number of overflights that would occur for a given facility. This study concluded that the total number of USFS-SR helicopter flights at SRS is expected to range from approximately 700 to 1200 per year. A bounding estimate of 1500 was considered to account for operational variability.

A hierarchy of procedure and policy governs USFS-SR helicopter operations. Primary guidance is provided by SR policy. Where no conflict occurs with SR policy, USFS-SR operations also comply with Federal Aviation Regulation (FAR). While neither SR policy nor FAR restrict general helicopter operations from facility overflight, general SR operating guidance discourages flight in populated areas of the site. This informal guidance, coupled with the fact that USFS-SR missions are not generally conducted in facility locations is considered sufficient to conclude that facility overflight by a USFS-SR helicopter is highly improbable. A conditional probability per flight of 0.01 is assigned.

The number of USFS-SR helicopter flights expected to cross during a one year period is estimated to be no greater than **6** based on the product of 1) the number of missions conducted throughout the year (1500), 2) the probability that a mission crosses the specified area (3/16), 3) the number of passes across the specified area on a single mission (2), and 4) the probability that a specific flight enters the effective area of the facility (0.01).

South Carolina Electric and Gas

SCE&G conducts limited helicopter operations across SRS for purposes of right-of-way inspection and clearance. Operations originate offsite with site access accomplished via electrical line pathways only. SCE&G helicopter operations are performed remote from SRS facilities. All flights enter SRS above electrical supply lines, follow the supply line to the associated substation, and then retrace the line to exit the site. Operations that cross the site or extend to primary SRS areas are not authorized.

A recent study (Ref. 2) examined the SCE&G operations to determine the number of overflights that would occur for a given facility. The study found that SCE&G operations are conducted four times per year, once for inspection of encroaching trees and three times for inspection of poles, wires and related equipment. Each operation requires no more than two days. Based on the nature of the task, Reference 2 estimated that inspection will involve flights in the vicinity of any primary site area no more than four times per year with no more that two transits per inspection for a total of 8 flights per year. As no SCE&G activities involve direct access to primary sites the study concluded that facility overflight by a SCE&G helicopter is highly improbable and a conditional probability per flight of 0.01 was assigned.

The number of SCE&G helicopter flights expected to cross the DWPF is estimated to be no greater than **1** based on the product of 1) the number of missions conducted in the vicinity of each primary area throughout the year (4), 2) the number of passes across the specified area on a single mission (2), and 3) the probability that a specific flight enters the effective area of the facility (0.01).

Total DWPF Overflight Estimate

The total number of helicopter flights expected to cross DWPF structures during a one-year period is estimated, from the sum of current WSI (183), USFS-SR (6), and SCE&G (1) operations, to be 190. It is assumed, for purposes of this calculation, that the number of helicopter flights conducted as part of future operations will not exceed that of current operations by greater than 10%. Therefore, the total number of helicopter flights expected to cross the effective area of DWPF structures of concern during a one year period is estimated to be no greater than **210**.

Crash frequency per unit area

The frequency of crashes (per unit area) while flying over DWPF is equal to the product of the frequency of DWPF overflights (F_{flight}) and the probability of crashing (P_1) per overflight per unit area:

$$F_{crash} = F_{flight} \times P_1$$

For DWPF, this is equal to 210 (overflights per year) times 1.8×10^{-13} (crashes per overflight per ft^2), which amounts to a crash frequency of 3.8×10^{-11} (accidents per year per ft^2 target area).

5.0 RESULTS AND CONCLUSIONS

Referring back to the original equation for frequency of helicopter crashes into a building:

$$F_{bldg} = A_{bldg} \times F_{crash}$$

Substituting the calculated frequency of crashes during DWPF overflights (F_{flight}), the frequency of helicopter crashes into DWPF structures depends on the effective target area of each structure. The following table summarizes the effective target area and the resulting frequency that a helicopter crash into that facility can be expected.

Helicopter Crash Frequency for Selected DWPF Structures

Structure	Footprint (ft^2)	Shadow Area (ft^2)	Target Area (ft^2)	Helicopter Crash Frequency (per year)
Vitrification Building	42120	29520	71640	2.7 E-06
GWSB	37720	0	37720	1.4 E-06
Low Point Pump Pit (LPPP)	7475	0	7475	2.8 E-07
LPPP SG Purge System	7296	4864	12160	4.6 E-07
LPPP Safety Class Interlocks	7215	4551	11766	4.5 E-07
Water & Chemical Treatment	10488	2052	12540	4.8 E-07
Cold Feed Storage	9000	4200	13200	5.0 E-07
Organic Waste Storage Tank (OWST)	1385	1008	2393	9.1 E-08
OWST SG Purge System-Pad/Tank & Transfer Line	378 921 1299	651 0 651	1029 921 1950	7.4 E-08
OWST Primary Inerting System	1299	651	1950	7.4 E-08
Sand Filter	24411	393	24804	9.4 E-07
Fan House	12936	4290	17226	6.5 E-07
Chemical Process Cell/Salt Process Cell (CPC/SPC) Safety Grade (SG) N_2 Purge System- Pad & Tanks (Since tanks, vaporizers, piping located on pad, conservatively use pad width in place of tank diameter)	1680 0 1680	0 1720 1720	1680 1720 3400	1.3 E-07
CPC Primary Purge System & 2 compressors	6290 40 6330	2720 100 2820	9010 140 9150	3.5 E-07
SPC Primary Purge System & Pipe	1050 20 1070	420 NA 420	1470 20 1490	5.7 E-08
Late Wash Facility (LWF)	7475	NA	7475	2.8 E-07
LWF Primary Nitrogen System & Tank	7215 81 7296	4551 313 4864	11766 394 12160	4.6 E-07
LWF Backup Nitrogen System	7296	4864	12160	4.6 E-07
Zone 1 Ventilation Stack & Ductwork	59 2205 2264	1274 3226 4500	1333 5431 6764	2.6 E-07
FESV	1592	NA	1592	6.0 E-08
Melter Off-Gas & Vapor Space Temperature Interlocks	900	780	1680	6.4 E-08

6.0 REFERENCES

1 M. R. Corum, *Evaluation of the Accident Probability Associated with Waste Management Helicopter Overflights*, WSRC-TR-92-495, Westinghouse Savannah River Company, Savannah River Technology Center, Aiken, SC (December 14, 1992).

2 C. H. Blanton. *Aircraft Impact Frequencies for SRS Facilities (U)*, Calc-note S-CLC-G-00278, Westinghouse Safety Management Solutions, Aiken, SC (April, 2002).

3 Discussion (April 23, 2002) by the author with Jackie Knight concerning information obtained by her from personal communication with WSI personnel.