The Boeing Company
Rocketdyne Propulsion & Power
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, CA 91309-7922

June 7, 2001
In reply refer to: 2001RC-2051

D. Sutherland
DOE Site Manager
U. S. Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, CA 94612-5208

Subject: NESHAPs Report for 2000

Dear Ms. Sutherland:

Enclosed is the National Emission Standards for Hazardous Air Pollutants (NESHAPs) Report for 2000 for the Department of Energy's (DOE) facility at the Santa Susana Field Laboratory (SSFL). The U.S. Environment Protection Agency (EPA) regulates airborne releases of radioactivity from DOE facilities under 40 CFR 61, Subpart H. This document reports the radiochemical analysis results of the effluent samples from all applicable emission sources. It also includes the off-site dose assessment results, which are compared against the EPA standards for compliance demonstration.

During 2000, the only applicable emission source at the DOE facility at SSFL was the operating exhaust stack at the Radioactive Materials Handling Facility (RMHF). Another potential point source mentioned in previous year's report, the 4024 portable ventilation system, was not in operation in 2000. The RMHF Pond, usually considered an area source when it is dry, contained water all year long, and, therefore, the sediment in the pond was not resuspended by wind for airborne releases.

Only trace amounts of radionuclides were released from the RMHF stack into the atmosphere in 2000. The calculated radiation exposure dose to the Maximally Exposed Individual (MEI) was performed using the EPA's CAP88PC computer model. The Effective Dose Equivalent from the RMHF exhaust during 2000 was 7.7×10^{-7} mrem (7.7×10^{-9} mSv) per year. The EPA limit for a DOE site is 10 mrem/yr, as specified in 40 CFR 61, Subpart H. This result indicates that the release from the RMHF is about 10 million times less than the regulatory limit.

This report includes the Certification Statement to be signed by M. E. Lee (or designee) for The Boeing Company, Rocketdyne Propulsion & Power and by you for the DOE Site Closure Office. The Certification Statements are required for the final report.

BOEING

If you have any questions or comments on this report, please contact Ning Liu at (818) 586-6262.

Sincerely,

M. E. Lee, Program Manager
DOE Site Closure

Enclosure: Radionuclide Air Emissions Annual Report

cc: S. Black, DOE/OAK

SHEA-093267

DOEAIR00

U. S. Department of Energy
Radionuclide Air Emissions Annual Report
(under Subpart H of 40 CFR Part 61)
Calendar Year 2000

Site Name: Santa Susana Field Laboratory
(Prepared on May 15, 2001)

Operations Office Information

Office:	Oakland Operations Office
Address:	1301 Clay Street, Room 700N Oakland, CA 94612-5208
Contact:	Steve Black
Phone:	(510) 637-1595

Site Information

Operator:	The Boeing Company Rocketdyne Propulsion & Power
Address:	6633 Canoga Avenue, MC T-038 P. O. Box 7922, Canoga Park, CA 91309-7922
Contact:	Ning Liu
Phone:	(818) 586-6262

Section I. Facility Information

Site Description

The Santa Susana Field Laboratory (SSFL) is located in a mountainous region between the residential areas of Simi Valley and San Fernando Valley at the boundary of Ventura and Los Angeles Counties in southern California (Figure 1). The site consists of approximately 2,850 acres (Figure 2), and the climate is generally dry, with variable winds.

The facility formerly served as a test site for very low-power experimental nuclear reactors and for developmental fuel fabrication, and fuel decladding. All the nuclear related research and development (R&D) operations in Area IV ceased in 1988, and the subsequent efforts have been directed toward decontamination and decommissioning (D&D) of the former nuclear facilities.

Source Description

Potential sources of release of radionuclides at SSFL include both point and area (non-point) sources. Figure 3 shows the locations of these sources. The Radioactive Materials Handling Facility (RMHF) is the only facility that has a radiological ventilation systems and is considered a potential point source. This facility is used for storage of waste packages waiting shipment to DOE waste disposal sites, evaporation of radioactively contaminated water generated in decontamination operations, and decontamination, size-reduction, and packaging in support of the decontamination operations. Ventilation from work areas in this facility is exhausted through HEPA filters and released from a stack.

Building 4024 had a portable HEPA filtered ventilation system to support the decontamination of the Hot Laboratory concrete blocks. The system has not been in operation since the decontamination work was completed in 1999. The ventilation system in Building 4059 was no longer needed after the phase I remediation was completed in 1998, and the two ventilation stacks were demolished in 2000. Therefore, Building 4024 and 4059 are no longer considered point release sources.

The RMHF Pond (Sump 614), a collection sump for rainfall runoff from the RMHF, is a potential area source, because radioactivity in the sediment may become airborne when the pond is dry and the sediment is exposed to air. Similarly, the RMHF North Slope is an identified area of low-level soil contamination, and radioactivity in the soil may be resuspended by wind if the soil surface is not covered by vegetation. During 2000, the RMHF sump was covered with water and the RMHF North Slope was covered with dense brush for the entire year. No radionuclides from these two areas were resuspended by wind for airborne releases.

The only applicable radiological emission source for the DOE facility at SSFL was the operating exhaust stack at the RMHF. Air samples from the ventilation stack were analyzed for specific radionuclides, and the results were used for the dose assessment in this report.

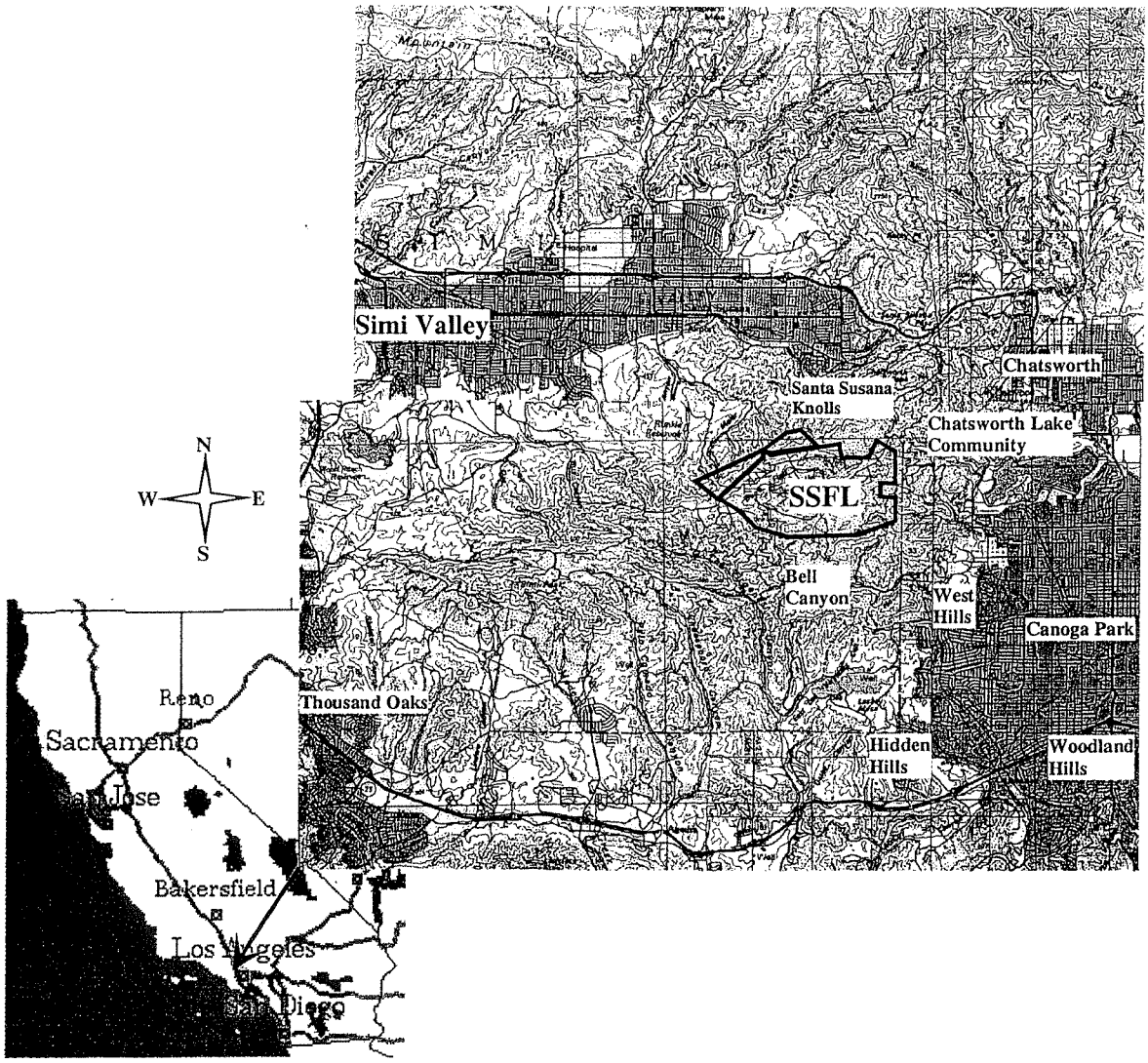

Figure 1. Location of Santa Susana Field Laboratory

Subdivisions			
Owner	**Jurisdiction**	**Acres**	**Subtotals**
Rocketdyne	Rocketdyne-Area IV	289.9	
	Rocketdyne	784.8	
	Rocketdyne (Undeveloped land)	1,324.6	2,399.3
Government	NASA (former AFP 57)	409.5	
	NASA (former AFP 64)	41.7	451.2
Total Acres			2,850.5

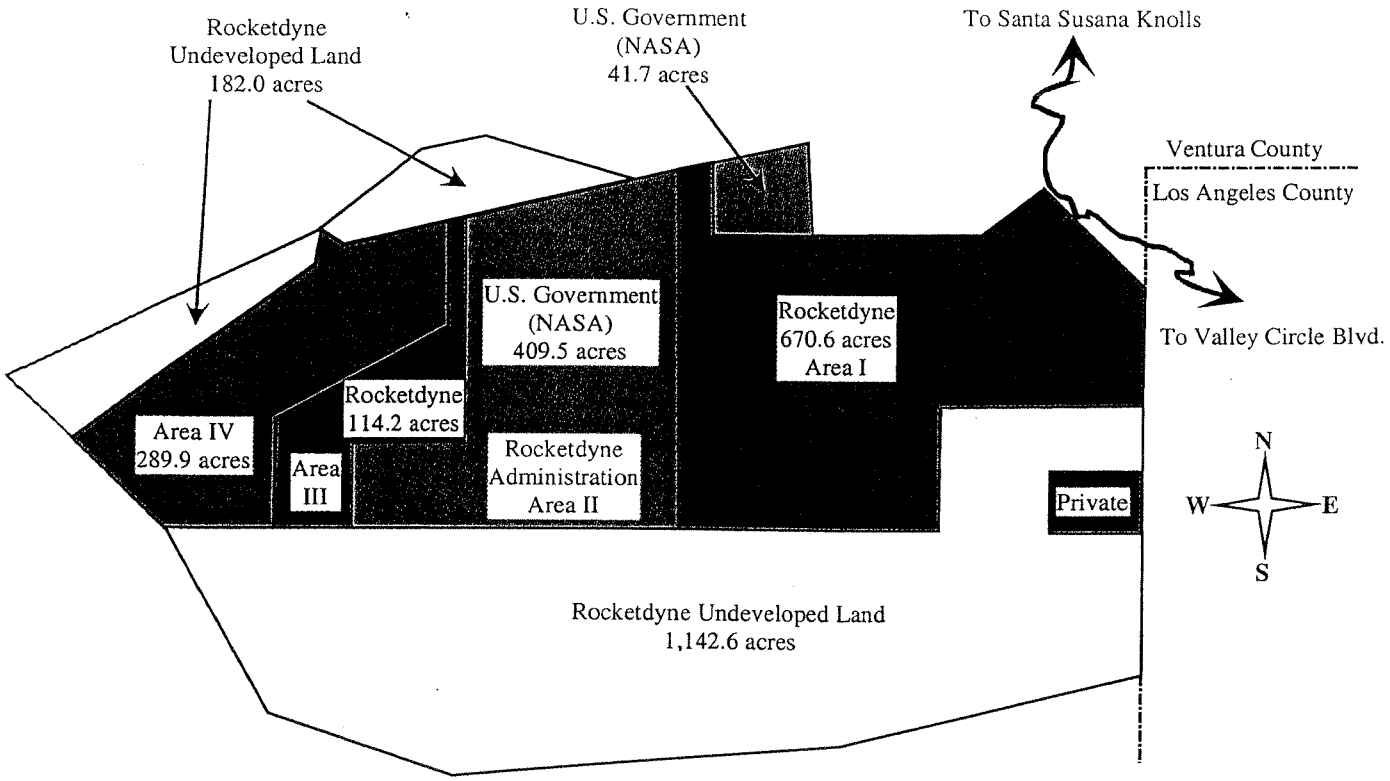

Figure 2. Santa Susana Field Laboratory Site Arrangement

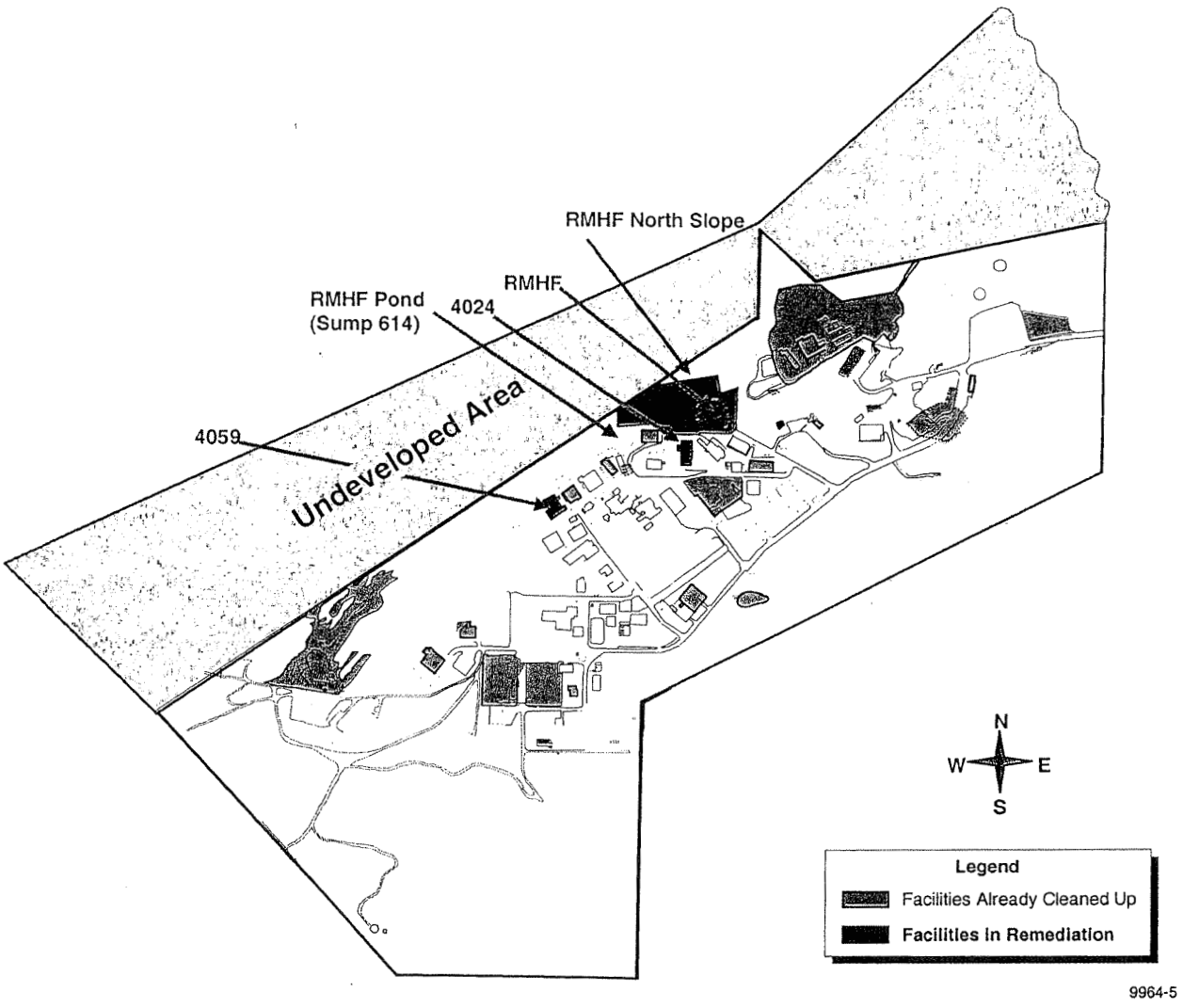

Figure 3. Potential Source Locations in Area IV at Santa Susana Field Laboratory

Section II. Air Emissions Data

Point Source

Point Source	Type Control	Efficiency	Distance to Nearest Receptor
RMHF	Pre- and HEPA filters	99.97+%	2320 m SSE

Point Source Radionuclides	Annual Release Quantity (Ci)	(Bq)
H-3	2.7E-05	1.0E+06
Cs-137	2.6E-07	9.5E+03
Ba-137M (Cs-137 daughter in equilibrium)	2.4E-07	9.0E+03
U-234	1.1E-08	4.1E+02
Pu-241	1.3E-06	5.0E+04

Area (Non-Point) Source

N/A

Section III. Dose Assessments

Description of Dose Model

Radiation doses to the Maximally Exposed Individual (MEI) as well as the population in the surrounding area resulting from the emissions of the DOE facility at SSFL during 2000 are calculated using the EPA's CAP88-PC version 2 computer code. Site specific meteorological data, such as wind speed, direction frequency, and stability, were developed by the NRC and Argonne National Laboratory and used for the atmospheric dispersion calculation in CAP88-PC. Other input data, such as release terms, stack height, and exhaust air velocity, were physically measured to represent the site-specific situation for dose calculations.

Dose calculations performed to demonstrate compliance with the NESHAPs standard are based on determining the maximum estimated dose to an offsite individual located at a residence, school, business, or office. For this purpose, the nearest such locations have been identified by review of maps, aerial photographs, and direct observation. The locations selected are in the nearest residential area of Simi Valley, the Brandeis-Bardin Institute, the Santa Monica Mountains Conservancy Sage Ranch office, the closest residence in Black Canyon, and the closest residence in Bell Canyon. The location with the highest estimated annual dose is considered the location of the Maximally Exposed Individual (MEI).

The RMHF stack is the only emission source in 2000. The Effective Dose Equivalent to the MEI resulting from the emission is compared against the NESHAPs standard for the demonstration of compliance. The dose was calculated using CAP88-PC with site-specific input data.

Compliance Assessment

Location of Maximally Exposed Individual (MEI):

Residence in Simi Valley, 2867 m NW of RMHF.

The Effective Dose Equivalent to the MEI from the RMHF exhaust during 2000:

7.7×10^{-7} mrem (7.7×10^{-9} mSv) per year.

The EPA limit for a DOE site is 10 mrem/yr, as specified in 40 CFR 61, Subpart H. This result indicates that the release from the RMHF is about 10 million times less than the regulatory limit.

Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See, 18 U.S.C. 1001).

M. E. Lee Date: 6/7/01
M. E. Lee
DOE Site Closure Program Manager
The Boeing Company
Rocketdyne Propulsion & Power

Michael Lee for Date: 6/7/01
D. Sutherland
DOE Site Closure Manager
Oakland Operations Office
U. S. Department of Energy

Supplemental Information

The collective Effective Dose Equivalent resulting from the DOE operations at SSFL is calculated for the population within 80 kilometers of the site. For 2000, this dose is estimated to be $2.2x10^{-04}$ person-rem ($2.2x10^{-06}$ person-Sv).

The population doses were calculated using CAP88-PC in the "POPULATION" mode. The site-specific population distribution is based on updated demographic data for 2000. The population distribution is presented in a structure utilizing 16 directions, coinciding with the wind directions, and 13 radial zones, with the distances chosen to represent the center-of-area for each zone. These zones include a total population of 10.2 million people within 80 km of the site.

No operations regulated by Subparts Q and T were conducted in 2000, nor were there any emissions of Rn-220 from sources containing U-232 and Th-232. There were no non-disposal/non-storage sources of Rn-222 emission.

Potential releases from the RMHF are so low that, even assuming absence of HEPA filters, estimated doses would be below the level requiring continuous monitoring as prescribed in 40CFR61.93(b). However, continuous monitoring is still being performed as a best management practice. The stack effluent at RMHF is continuously sampled, counted for gross alpha and beta activities weekly, and composited annually for detailed radiochemical analysis. In addition, a sample of the evaporator feedwater is sampled annually and analyzed for tritium; the measured tritium concentration is used to calculate the release. Ambient air is continuously sampled and analyzed on a weekly basis for gross alpha and beta activities. These samples are composited (separately by location) annually for detailed radiochemical analysis. Appendix B, Method 114, as described in 40 CFR 61, Subpart H, is implemented for this surveillance effort.

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Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
May 15, 2001 02:52 pm

Facility: RMHF
Address: SSFL, Top of Woolsey Canyon Road, Simi Hills
City: Chatsworth
State: CA Zip: 91311-

Source Category: DOE facility
Source Type: Stack
Emission Year: 2000

Comments: CAP88PC calculation for 2000 ASER and NESHAPs
Maximum Exposed Individual, RMHF Stack

Effective Dose Equivalent (mrem/year)
7.70E-07

At This Location: 2867 Meters Northwest

Dataset Name: RMHF00IND
Dataset Date: May 15, 2001 02:52 pm
Wind File: C:\CAP88PC2\WNDFILES\SSFLNRC.WND

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2867 Meters Northwest
Lifetime Fatal Cancer Risk: 8.64E-12

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Dose Equivalent (mrem/y)
GONADS	3.70E-07
BREAST	2.67E-07
R MAR	7.57E-07
LUNGS	1.50E-06
THYROID	2.76E-07
ENDOST	6.92E-06
RMNDR	5.02E-07
EFFEC	7.70E-07

RADIONUCLIDE EMISSIONS DURING THE YEAR 2000

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CS-137	D	1.00	2.6E-07	2.6E-07
BA-137M	D	1.00	2.4E-07	2.4E-07
H-3	*	0.00	2.7E-05	2.7E-05
PU-241	Y	1.00	1.3E-06	1.3E-06
U-234	Y	1.00	1.1E-08	1.1E-08

SITE INFORMATION

Temperature:	17 degrees C
Precipitation:	85 cm/y
Mixing Height:	366 m

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 40.
Diameter (m): 1.

Plume Rise
Momentum (m/s): 15.
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.020	0.000	0.000
Fraction From Assessment Area:	0.000	0.000	0.000
Fraction Imported:	0.980	1.000	1.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

2867

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D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
May 15, 2001 02:52 pm

Facility: RMHF
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Source Category: DOE facility
Source Type: Stack
Emission Year: 2000

Comments: CAP88PC calculation for 2000 ASER and NESHAPs
Maximum Exposed Individual, RMHF Stack

Dataset Name: RMHF00IND
Dataset Date: May 15, 2001 02:52 pm
Wind File: C:\CAP88PC2\WNDFILES\SSFLNRC.WND

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	3.70E-07
BREAST	2.67E-07
R MAR	7.57E-07
LUNGS	1.50E-06
THYROID	2.76E-07
ENDOST	6.92E-06
RMNDR	5.02E-07
EFFEC	7.70E-07

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	4.14E-09
INHALATION	5.27E-07
AIR IMMERSION	9.94E-14
GROUND SURFACE	2.39E-07
INTERNAL	5.31E-07
EXTERNAL	2.39E-07
TOTAL	7.70E-07

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
CS-137	9.24E-10
BA-137M	2.39E-07
H-3	2.49E-10
PU-241	4.39E-07
U-234	9.10E-08
TOTAL	7.70E-07

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.09E-12
BONE	2.91E-13
THYROID	1.22E-13
BREAST	1.02E-12
LUNG	2.57E-12
STOMACH	6.43E-13
BOWEL	3.19E-13
LIVER	1.39E-12
PANCREAS	4.20E-13
URINARY	2.65E-13
OTHER	5.13E-13
TOTAL	8.64E-12

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	2.62E-14
INHALATION	2.89E-12
AIR IMMERSION	2.38E-18
GROUND SURFACE	5.72E-12
INTERNAL	2.92E-12
EXTERNAL	5.72E-12
TOTAL	8.64E-12

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
CS-137	2.43E-14
BA-137M	5.72E-12
H-3	6.81E-15
PU-241	1.68E-12
U-234	1.21E-12
TOTAL	8.64E-12

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)
Direction	2867
N	1.3E-07
NNW	4.5E-07
NW	7.7E-07
WNW	4.4E-07
W	9.6E-08
WSW	1.7E-07
SW	2.0E-07
SSW	1.7E-07
S	1.4E-07
SSE	3.4E-07
SE	5.4E-07
ESE	3.2E-07
E	8.2E-08
ENE	1.0E-07
NE	1.2E-07
NNE	1.3E-07

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)
Direction	2867
N	1.6E-12
NNW	5.1E-12
NW	8.6E-12
WNW	5.0E-12
W	1.2E-12
WSW	1.9E-12
SW	2.2E-12
SSW	1.9E-12
S	1.7E-12
SSE	3.8E-12
SE	5.8E-12
ESE	3.5E-12
E	1.0E-12
ENE	1.2E-12
NE	1.4E-12
NNE	1.5E-12

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S Y N O P S I S R E P O R T

Non-Radon Population Assessment
May 15, 2001 02:47 pm

Facility: RMHF
Address: SSFL, Top of Woolsey Canyon Road, Simi Hills
City: Chatsworth
State: CA Zip: 91311-

Source Category: DOE facility
Source Type: Stack
Emission Year: 2000

Comments: CAP88PC calculation for 2000 ASER and NESHAPs
Population Dose, RMHF stack

Effective Dose Equivalent (mrem/year)
8.90E-07

At This Location: 2400 Meters Northwest

Dataset Name: RMHF00POP
Dataset Date: May 15, 2001 02:47 pm
Wind File: C:\CAP88PC2\WNDFILES\SSFLNRC.WND
Population File: C:\CAP88PC2\POPFILES\SSFL2000.POP

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 2400 Meters Northwest
Lifetime Fatal Cancer Risk: 1.01E-11

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)	Collective Population (person-rem/y)
GONADS	4.34E-07	9.42E-05
BREAST	3.16E-07	6.52E-05
R MAR	8.75E-07	2.13E-04
LUNGS	1.73E-06	4.36E-04
THYROID	3.26E-07	6.73E-05
ENDOST	7.92E-06	2.04E-03
RMNDR	5.83E-07	1.38E-04
EFFEC	8.90E-07	2.16E-04

FREQUENCY DISTRIBUTION OF LIFETIME FATAL CANCER RISKS

Risk Range	# of People	# of People in This Risk Range or Higher	Deaths/Year in This Risk Range	Deaths/Year in This Risk Range or Higher
1.0E+00 TO 1.0E-01	0	0	0.00E+00	0.00E+00
1.0E-01 TO 1.0E-02	0	0	0.00E+00	0.00E+00
1.0E-02 TO 1.0E-03	0	0	0.00E+00	0.00E+00
1.0E-03 TO 1.0E-04	0	0	0.00E+00	0.00E+00
1.0E-04 TO 1.0E-05	0	0	0.00E+00	0.00E+00
1.0E-05 TO 1.0E-06	0	0	0.00E+00	0.00E+00
LESS THAN 1.0E-06	10222462	10222462	3.18E-08	3.18E-08

RADIONUCLIDE EMISSIONS DURING THE YEAR 2000

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
CS-137	D	1.00	2.6E-07	2.6E-07
BA-137M	D	1.00	2.4E-07	2.4E-07
H-3	*	0.00	2.7E-05	2.7E-05
U-234	Y	1.00	1.1E-08	1.1E-08
PU-241	Y	1.00	1.3E-06	1.3E-06

SITE INFORMATION

Temperature:	17 degrees C
Precipitation:	85 cm/y
Mixing Height:	366 m

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 40.
Diameter (m): 1.

Plume Rise Momentum (m/s): 15.
(Exit Velocity)

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.020	0.000	0.000
Fraction From Assessment Area:	0.000	0.000	0.000
Fraction Imported:	0.980	1.000	1.000

Beef Cattle Density:	8.81E-02
Milk Cattle Density:	2.85E-02
Land Fraction Cultivated for Vegetable Crops:	1.18E-02

POPULATION DATA

	Distance (m)						
Direction	800	2400	4000	5600	7200	8800	11200
N	0	38	2055	7029	7689	5	14
NNW	0	0	3007	8597	6743	354	0
NW	0	562	6296	9532	10120	244	5
WNW	0	0	0	8175	7549	7392	1050
W	0	0	0	325	1129	193	12026
WSW	0	0	0	6	852	728	9539
SW	0	0	0	3554	3079	3041	11396
SSW	0	0	0	0	4166	5694	6453
S	0	305	3	0	1475	2306	3630
SSE	0	0	560	0	16	2991	4712
SE	0	188	832	1364	8154	9003	22249
ESE	0	201	0	2299	9422	13191	52287
E	0	0	0	1597	3483	5769	38595
ENE	0	0	0	280	387	2380	18881
NE	0	109	347	8915	2187	0	130
NNE	0	0	814	8261	2947	0	65

	Distance (m)					
Direction	14400	19200	25600	34400	48000	68000
N	0	202	1029	5024	434	873
NNW	0	1702	65	0	0	6131
NW	456	141	14242	748	255	346
WNW	13029	15438	804	30019	14607	35307
W	18841	13897	31911	46004	275199	540
WSW	20912	28943	12132	4209	18643	2
SW	13649	4018	925	108	0	0
SSW	1432	624	7206	0	0	0
S	681	5306	347	0	0	0
SSE	1007	4202	2979	0	13532	67961
SE	15379	5759	39912	493989	1110827	1461829
ESE	42581	90394	125998	465362	1623379	1719302
E	43909	133591	289752	263927	270781	283206
ENE	15185	45485	101785	6592	3517	74108
NE	63	15985	43962	69867	6882	208339
NNE	0	828	17371	11522	3341	2719

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D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Population Assessment
May 15, 2001 02:47 pm

Facility: RMHF
Address: SSFL, Top of Woolsey Canyon Road, Simi Hills
City: Chatsworth
State: CA Zip: 91311-

Source Category: DOE facility
Source Type: Stack
Emission Year: 2000

Comments: CAP88PC calculation for 2000 ASER and NESHAPs
Population Dose, RMHF stack

Dataset Name: RMHF00POP
Dataset Date: May 15, 2001 02:47 pm
Wind File: C:\CAP88PC2\WNDFILES\SSFLNRC.WND
Population File: C:\CAP88PC2\POPFILES\SSFL2000.POP

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)	Collective Population (person-rem/y)
GONADS	4.34E-07	9.42E-05
BREAST	3.16E-07	6.52E-05
R MAR	8.75E-07	2.13E-04
LUNGS	1.73E-06	4.36E-04
THYROID	3.26E-07	6.73E-05
ENDOST	7.92E-06	2.04E-03
RMNDR	5.83E-07	1.38E-04
EFFEC	8.90E-07	2.16E-04

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)	Collective Population (person-rem/y)
INGESTION	4.90E-09	1.01E-06
INHALATION	6.03E-07	1.57E-04
AIR IMMERSION	1.79E-13	7.59E-13
GROUND SURFACE	2.82E-07	5.77E-05
INTERNAL	6.08E-07	1.58E-04
EXTERNAL	2.82E-07	5.77E-05
TOTAL	8.90E-07	2.16E-04

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclides	Selected Individual (mrem/y)	Collective Population (person-rem/y)
CS-137	1.07E-09	2.52E-07
BA-137M	2.82E-07	5.77E-05
H-3	2.84E-10	1.18E-07
U-234	1.04E-07	2.71E-05
PU-241	5.03E-07	1.31E-04
TOTAL	8.90E-07	2.16E-04

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk	Total Collective Population Fatal Cancer Risk (Deaths/y)
LEUKEMIA	1.27E-12	4.03E-09
BONE	3.34E-13	1.19E-09
THYROID	1.44E-13	4.18E-10
BREAST	1.20E-12	3.48E-09
LUNG	2.98E-12	9.99E-09
STOMACH	7.60E-13	2.20E-09
BOWEL	3.77E-13	1.09E-09
LIVER	1.62E-12	5.32E-09
PANCREAS	4.96E-13	1.44E-09
URINARY	3.13E-13	9.07E-10
OTHER	6.07E-13	1.76E-09
TOTAL	1.01E-11	3.18E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk	Total Collective Population Fatal Cancer Risk (Deaths/y)
INGESTION	3.10E-14	9.20E-11
INHALATION	3.31E-12	1.22E-08
AIR IMMERSION	4.29E-18	2.56E-16
GROUND SURFACE	6.76E-12	1.95E-08
INTERNAL	3.34E-12	1.23E-08
EXTERNAL	6.76E-12	1.95E-08
TOTAL	1.01E-11	3.18E-08

PATHWAY GENETIC RISK SUMMARY
(Collective Population)

Pathway	Genetic Risk (person-rem/y)
INGESTION	1.13E-07
INHALATION	7.64E-07
AIR IMMERSION	7.47E-13
GROUND SURFACE	5.71E-05
INTERNAL	8.76E-07
EXTERNAL	5.71E-05
TOTAL	5.80E-05

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk	Total Collective Population Fatal Cancer Risk (Deaths/y)
CS-137	2.82E-14	9.36E-11
BA-137M	6.76E-12	1.95E-08
H-3	7.76E-15	4.56E-11
U-234	1.39E-12	5.10E-09
PU-241	1.92E-12	7.05E-09
TOTAL	1.01E-11	3.18E-08

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	800	2400	4000	5600	7200	8800	11200
N	0.0E+00	1.5E-07	1.0E-07	7.7E-08	6.6E-08	5.6E-08	4.5E-08
NNW	0.0E+00	0.0E+00	3.5E-07	2.7E-07	2.2E-07	1.9E-07	0.0E+00
NW	0.0E+00	8.9E-07	6.0E-07	4.5E-07	3.7E-07	3.1E-07	2.5E-07
WNW	0.0E+00	0.0E+00	0.0E+00	2.6E-07	2.2E-07	1.8E-07	1.4E-07
W	0.0E+00	0.0E+00	0.0E+00	6.5E-08	5.6E-08	4.9E-08	3.9E-08
WSW	0.0E+00	0.0E+00	0.0E+00	9.9E-08	8.2E-08	6.8E-08	5.3E-08
SW	0.0E+00	0.0E+00	0.0E+00	1.0E-07	8.5E-08	7.1E-08	5.6E-08
SSW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.8E-08	6.6E-08	5.2E-08
S	0.0E+00	1.7E-07	1.1E-07	0.0E+00	7.2E-08	6.1E-08	4.8E-08
SSE	0.0E+00	0.0E+00	2.6E-07	0.0E+00	1.6E-07	1.3E-07	1.0E-07
SE	0.0E+00	6.3E-07	4.0E-07	2.9E-07	2.4E-07	2.0E-07	1.6E-07
ESE	0.0E+00	3.7E-07	0.0E+00	1.8E-07	1.4E-07	1.2E-07	9.6E-08
E	0.0E+00	0.0E+00	0.0E+00	5.2E-08	4.5E-08	3.8E-08	3.1E-08
ENE	0.0E+00	0.0E+00	0.0E+00	6.1E-08	5.2E-08	4.5E-08	3.6E-08
NE	0.0E+00	1.4E-07	9.3E-08	7.1E-08	6.0E-08	0.0E+00	4.0E-08
NNE	0.0E+00	0.0E+00	9.7E-08	7.4E-08	6.3E-08	0.0E+00	4.3E-08

	Distance (m)					
Direction	14400	19200	25600	34400	48000	68000
N	0.0E+00	2.4E-08	1.6E-08	1.1E-08	6.4E-09	3.2E-09
NNW	0.0E+00	7.8E-08	5.3E-08	0.0E+00	0.0E+00	1.1E-08
NW	1.9E-07	1.3E-07	8.9E-08	6.1E-08	3.7E-08	1.9E-08
WNW	1.1E-07	7.7E-08	5.2E-08	3.5E-08	2.1E-08	1.1E-08
W	2.9E-08	2.1E-08	1.4E-08	9.3E-09	5.4E-09	2.6E-09
WSW	4.0E-08	2.8E-08	1.9E-08	1.3E-08	8.2E-09	4.4E-09
SW	4.3E-08	3.1E-08	2.2E-08	1.5E-08	0.0E+00	0.0E+00
SSW	3.9E-08	2.8E-08	1.9E-08	0.0E+00	0.0E+00	0.0E+00
S	3.6E-08	2.5E-08	1.7E-08	0.0E+00	0.0E+00	0.0E+00
SSE	7.8E-08	5.6E-08	3.8E-08	0.0E+00	1.7E-08	9.0E-09
SE	1.2E-07	8.5E-08	5.8E-08	4.1E-08	2.6E-08	1.4E-08
ESE	7.2E-08	5.2E-08	3.5E-08	2.4E-08	1.5E-08	8.2E-09
E	2.3E-08	1.6E-08	1.1E-08	7.3E-09	4.3E-09	2.0E-09
ENE	2.7E-08	1.9E-08	1.3E-08	8.6E-09	5.1E-09	2.5E-09
NE	3.1E-08	2.2E-08	1.5E-08	1.0E-08	6.0E-09	3.0E-09
NNE	0.0E+00	2.3E-08	1.5E-08	1.0E-08	6.2E-09	3.1E-09

COLLECTIVE EFFECTIVE DOSE EQUIVALENT (person rem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	800	2400	4000	5600	7200	8800	11200
N	0.0E+00	5.8E-09	2.1E-07	5.4E-07	5.1E-07	2.8E-10	6.3E-10
NNW	0.0E+00	0.0E+00	1.1E-06	2.3E-06	1.5E-06	6.6E-08	0.0E+00
NW	0.0E+00	5.0E-07	3.8E-06	4.3E-06	3.8E-06	7.7E-08	1.2E-09
WNW	0.0E+00	0.0E+00	0.0E+00	2.1E-06	1.6E-06	1.4E-06	1.5E-07
W	0.0E+00	0.0E+00	0.0E+00	2.1E-08	6.4E-08	9.4E-09	4.7E-07
WSW	0.0E+00	0.0E+00	0.0E+00	5.9E-10	6.9E-08	5.0E-08	5.1E-07
SW	0.0E+00	0.0E+00	0.0E+00	3.6E-07	2.6E-07	2.2E-07	6.4E-07
SSW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.2E-07	3.7E-07	3.3E-07
S	0.0E+00	5.1E-08	3.4E-10	0.0E+00	1.1E-07	1.4E-07	1.7E-07
SSE	0.0E+00	0.0E+00	1.5E-07	0.0E+00	2.5E-09	3.9E-07	4.9E-07
SE	0.0E+00	1.2E-07	3.3E-07	4.0E-07	1.9E-06	1.8E-06	3.5E-06
ESE	0.0E+00	7.4E-08	0.0E+00	4.0E-07	1.4E-06	1.6E-06	5.0E-06
E	0.0E+00	0.0E+00	0.0E+00	8.3E-08	1.6E-07	2.2E-07	1.2E-06
ENE	0.0E+00	0.0E+00	0.0E+00	1.7E-08	2.0E-08	1.1E-07	6.7E-07
NE	0.0E+00	1.6E-08	3.2E-08	6.3E-07	1.3E-07	0.0E+00	5.3E-09
NNE	0.0E+00	0.0E+00	7.9E-08	6.1E-07	1.9E-07	0.0E+00	2.8E-09

	Distance (m)					
Direction	14400	19200	25600	34400	48000	68000
N	0.0E+00	4.8E-09	1.7E-08	5.4E-08	2.8E-09	2.8E-09
NNW	0.0E+00	1.3E-07	3.4E-09	0.0E+00	0.0E+00	6.7E-08
NW	8.5E-08	1.9E-08	1.3E-06	4.5E-08	9.5E-09	6.5E-09
WNW	1.4E-06	1.2E-06	4.2E-08	1.1E-06	3.1E-07	3.8E-07
W	5.6E-07	2.9E-07	4.4E-07	4.3E-07	1.5E-06	1.4E-09
WSW	8.4E-07	8.2E-07	2.3E-07	5.6E-08	1.5E-07	8.8E-12
SW	5.9E-07	1.2E-07	2.0E-08	1.7E-09	0.0E+00	0.0E+00
SSW	5.6E-08	1.8E-08	1.4E-07	0.0E+00	0.0E+00	0.0E+00
S	2.5E-08	1.4E-07	6.0E-09	0.0E+00	0.0E+00	0.0E+00
SSE	7.9E-08	2.3E-07	1.1E-07	0.0E+00	2.2E-07	6.1E-07
SE	1.8E-06	4.9E-07	2.3E-06	2.0E-05	2.9E-05	2.1E-05
ESE	3.1E-06	4.7E-06	4.4E-06	1.1E-05	2.5E-05	1.4E-05
E	1.0E-06	2.2E-06	3.2E-06	1.9E-06	1.2E-06	5.8E-07
ENE	4.1E-07	8.6E-07	1.3E-06	5.7E-08	1.8E-08	1.9E-07
NE	1.9E-09	3.5E-07	6.5E-07	7.0E-07	4.1E-08	6.3E-07
NNE	0.0E+00	1.9E-08	2.7E-07	1.2E-07	2.1E-08	8.5E-09

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	800	2400	4000	5600	7200	8800	11200
N	0.0E+00	1.9E-12	1.2E-12	8.8E-13	7.2E-13	6.1E-13	4.8E-13
NNW	0.0E+00	0.0E+00	3.9E-12	2.9E-12	2.3E-12	1.9E-12	0.0E+00
NW	0.0E+00	1.0E-11	6.6E-12	4.8E-12	3.9E-12	3.3E-12	2.5E-12
WNW	0.0E+00	0.0E+00	0.0E+00	2.8E-12	2.3E-12	1.9E-12	1.5E-12
W	0.0E+00	0.0E+00	0.0E+00	7.5E-13	6.2E-13	5.3E-13	4.2E-13
WSW	0.0E+00	0.0E+00	0.0E+00	1.1E-12	8.6E-13	7.1E-13	5.5E-13
SW	0.0E+00	0.0E+00	0.0E+00	1.1E-12	9.1E-13	7.6E-13	6.0E-13
SSW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.4E-13	7.0E-13	5.5E-13
S	0.0E+00	1.9E-12	1.3E-12	0.0E+00	7.7E-13	6.4E-13	5.0E-13
SSE	0.0E+00	0.0E+00	2.8E-12	0.0E+00	1.6E-12	1.4E-12	1.1E-12
SE	0.0E+00	6.9E-12	4.2E-12	3.1E-12	2.5E-12	2.0E-12	1.6E-12
ESE	0.0E+00	4.1E-12	0.0E+00	1.9E-12	1.5E-12	1.3E-12	9.8E-13
E	0.0E+00	0.0E+00	0.0E+00	6.0E-13	5.0E-13	4.2E-13	3.3E-13
ENE	0.0E+00	0.0E+00	0.0E+00	7.0E-13	5.8E-13	4.8E-13	3.8E-13
NE	0.0E+00	1.7E-12	1.1E-12	8.0E-13	6.5E-13	0.0E+00	4.3E-13
NNE	0.0E+00	0.0E+00	1.1E-12	8.4E-13	6.9E-13	0.0E+00	4.6E-13

	Distance (m)					
Direction	14400	19200	25600	34400	48000	68000
N	0.0E+00	2.5E-13	1.7E-13	1.2E-13	6.9E-14	3.5E-14
NNW	0.0E+00	8.1E-13	5.5E-13	0.0E+00	0.0E+00	1.2E-13
NW	1.9E-12	1.4E-12	9.2E-13	6.3E-13	3.8E-13	2.0E-13
WNW	1.1E-12	7.9E-13	5.3E-13	3.6E-13	2.2E-13	1.1E-13
W	3.1E-13	2.2E-13	1.5E-13	9.9E-14	5.8E-14	2.8E-14
WSW	4.2E-13	3.0E-13	2.0E-13	1.4E-13	8.7E-14	4.8E-14
SW	4.6E-13	3.3E-13	2.3E-13	1.6E-13	0.0E+00	0.0E+00
SSW	4.1E-13	3.0E-13	2.0E-13	0.0E+00	0.0E+00	0.0E+00
S	3.8E-13	2.7E-13	1.8E-13	0.0E+00	0.0E+00	0.0E+00
SSE	8.0E-13	5.7E-13	3.9E-13	0.0E+00	1.7E-13	9.4E-14
SE	1.2E-12	8.7E-13	6.0E-13	4.2E-13	2.7E-13	1.5E-13
ESE	7.4E-13	5.3E-13	3.6E-13	2.5E-13	1.6E-13	8.6E-14
E	2.5E-13	1.7E-13	1.2E-13	7.9E-14	4.6E-14	2.3E-14
ENE	2.9E-13	2.0E-13	1.4E-13	9.2E-14	5.5E-14	2.8E-14
NE	3.2E-13	2.3E-13	1.6E-13	1.1E-13	6.4E-14	3.3E-14
NNE	0.0E+00	2.4E-13	1.6E-13	1.1E-13	6.7E-14	3.4E-14

COLLECTIVE FATAL CANCER RATE (deaths/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	800	2400	4000	5600	7200	8800	11200
N	0.0E+00	1.0E-12	3.4E-11	8.7E-11	7.9E-11	4.3E-14	9.4E-14
NNW	0.0E+00	0.0E+00	1.7E-10	3.5E-10	2.2E-10	9.7E-12	0.0E+00
NW	0.0E+00	8.0E-11	5.8E-10	6.5E-10	5.6E-10	1.1E-11	1.8E-13
WNW	0.0E+00	0.0E+00	0.0E+00	3.3E-10	2.4E-10	2.0E-10	2.2E-11
W	0.0E+00	0.0E+00	0.0E+00	3.4E-12	9.9E-12	1.4E-12	7.1E-11
WSW	0.0E+00	0.0E+00	0.0E+00	9.0E-14	1.0E-11	7.3E-12	7.4E-11
SW	0.0E+00	0.0E+00	0.0E+00	5.7E-11	4.0E-11	3.3E-11	9.6E-11
SSW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.9E-11	5.6E-11	5.0E-11
S	0.0E+00	8.4E-12	5.3E-14	0.0E+00	1.6E-11	2.1E-11	2.6E-11
SSE	0.0E+00	0.0E+00	2.2E-11	0.0E+00	3.7E-13	5.7E-11	7.0E-11
SE	0.0E+00	1.8E-11	5.0E-11	5.9E-11	2.8E-10	2.6E-10	5.0E-10
ESE	0.0E+00	1.2E-11	0.0E+00	6.1E-11	2.0E-10	2.3E-10	7.2E-10
E	0.0E+00	0.0E+00	0.0E+00	1.4E-11	2.5E-11	3.4E-11	1.8E-10
ENE	0.0E+00	0.0E+00	0.0E+00	2.8E-12	3.1E-12	1.6E-11	1.0E-10
NE	0.0E+00	2.6E-12	5.3E-12	1.0E-10	2.0E-11	0.0E+00	7.9E-13
NNE	0.0E+00	0.0E+00	1.3E-11	9.8E-11	2.9E-11	0.0E+00	4.2E-13

	Distance (m)					
Direction	14400	19200	25600	34400	48000	68000
N	0.0E+00	7.2E-13	2.5E-12	8.2E-12	4.2E-13	4.3E-13
NNW	0.0E+00	1.9E-11	5.0E-13	0.0E+00	0.0E+00	1.0E-11
NW	1.2E-11	2.7E-12	1.9E-10	6.6E-12	1.4E-12	9.7E-13
WNW	2.1E-10	1.7E-10	6.1E-12	1.5E-10	4.5E-11	5.6E-11
W	8.3E-11	4.3E-11	6.6E-11	6.4E-11	2.3E-10	2.1E-13
WSW	1.2E-10	1.2E-10	3.4E-11	8.2E-12	2.3E-11	1.4E-15
SW	8.8E-11	1.9E-11	3.0E-12	2.5E-13	0.0E+00	0.0E+00
SSW	8.4E-12	2.6E-12	2.1E-11	0.0E+00	0.0E+00	0.0E+00
S	3.6E-12	2.0E-11	8.8E-13	0.0E+00	0.0E+00	0.0E+00
SSE	1.1E-11	3.4E-11	1.7E-11	0.0E+00	3.3E-11	9.0E-11
SE	2.6E-10	7.1E-11	3.4E-10	2.9E-09	4.2E-09	3.1E-09
ESE	4.5E-10	6.7E-10	6.5E-10	1.6E-09	3.6E-09	2.1E-09
E	1.5E-10	3.3E-10	4.8E-10	2.9E-10	1.8E-10	9.0E-11
ENE	6.1E-11	1.3E-10	2.0E-10	8.6E-12	2.7E-12	2.9E-11
NE	2.9E-13	5.2E-11	9.7E-11	1.0E-10	6.2E-12	9.7E-11
NNE	0.0E+00	2.8E-12	4.0E-11	1.8E-11	3.1E-12	1.3E-12