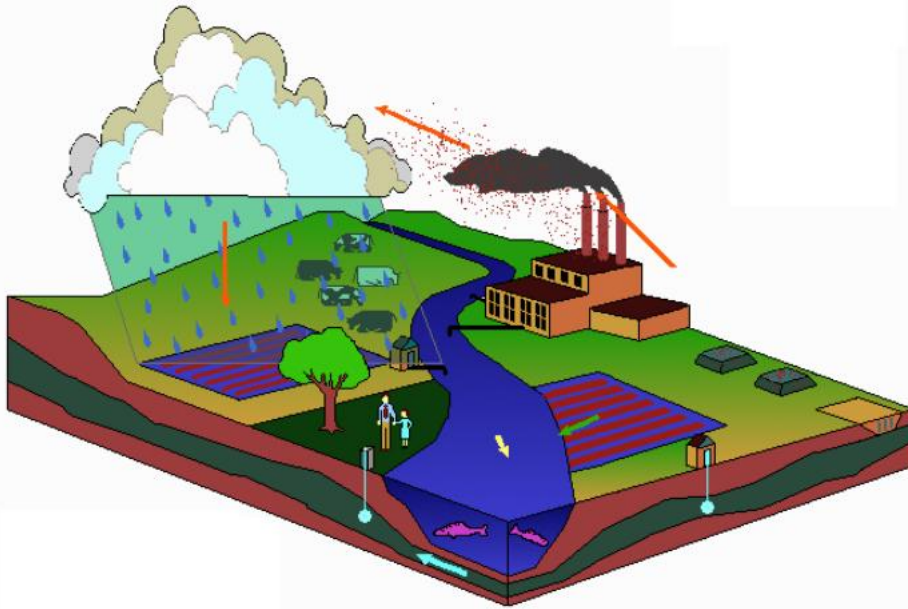


Code GENII-FRAMES ver. 2.0



GENII ver.2.0 is an environmental radiation dosimetry package which runs within the FRAMES Framework for Risk Analysis in Multimedia Environmental Systems.

Has been developed by the Pacific Northwest National Laboratory, for the Environmental Protection Agency (EPA), Office of Radiation and Indoor Air, with subsequent revisions for the US DOE and US NRC.

PURPOSE: to provide the capability to perform dose and risk assessments of environmental releases of radionuclides.

Code GENII-FRAMES ver. 2.0 (1)

The code was used to calculate effective doses due to release of chronic and acute releases of radioactive gases due to SPES operation.

In particular:

- 1) Chronic releases of radioactive air from ISOL bunkers
- 2) Acute release of all radioactive material in a volatile state and radioactive gases from the UC_x source at the End Of Bombardment (EOB)

Code GENII/FRAMES ver. 2.0 (2)

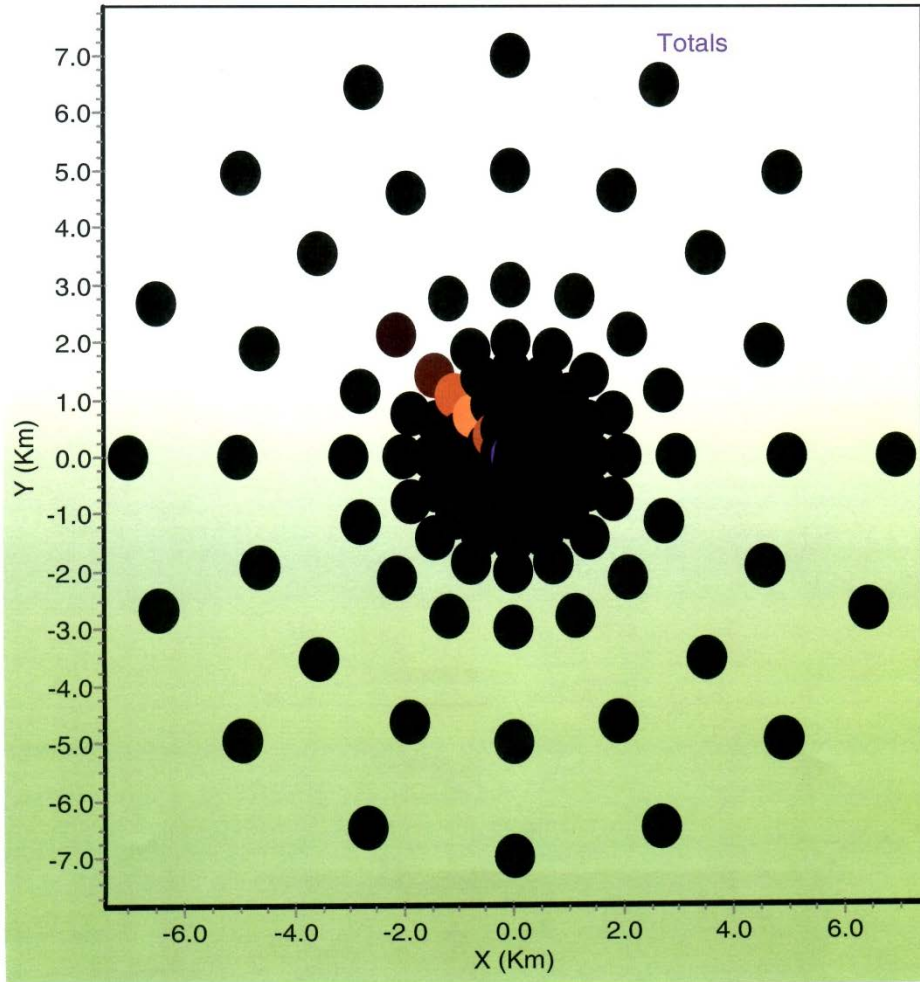
Chronic release of radioactive air products

- 1) 7 radionuclides considered: ^{41}Ar , ^7Be , ^{11}C , ^{14}C , ^3H , ^{13}N , ^{15}O , ^{35}S
- 2) Activity released up to 1.1×10^{13} Bq
- 3) Evaluation in a year of the effective dose received by all the ways of irradiation included the introduction of radioactive material in the body considering all possible ways
- 4) Two age groups of population considered: 7-12 and 17-70 years
- 5) Without and with plume rise (gas exit velocity 10 m/s)

Code GENII/FRAMES ver. 2.0 (3)

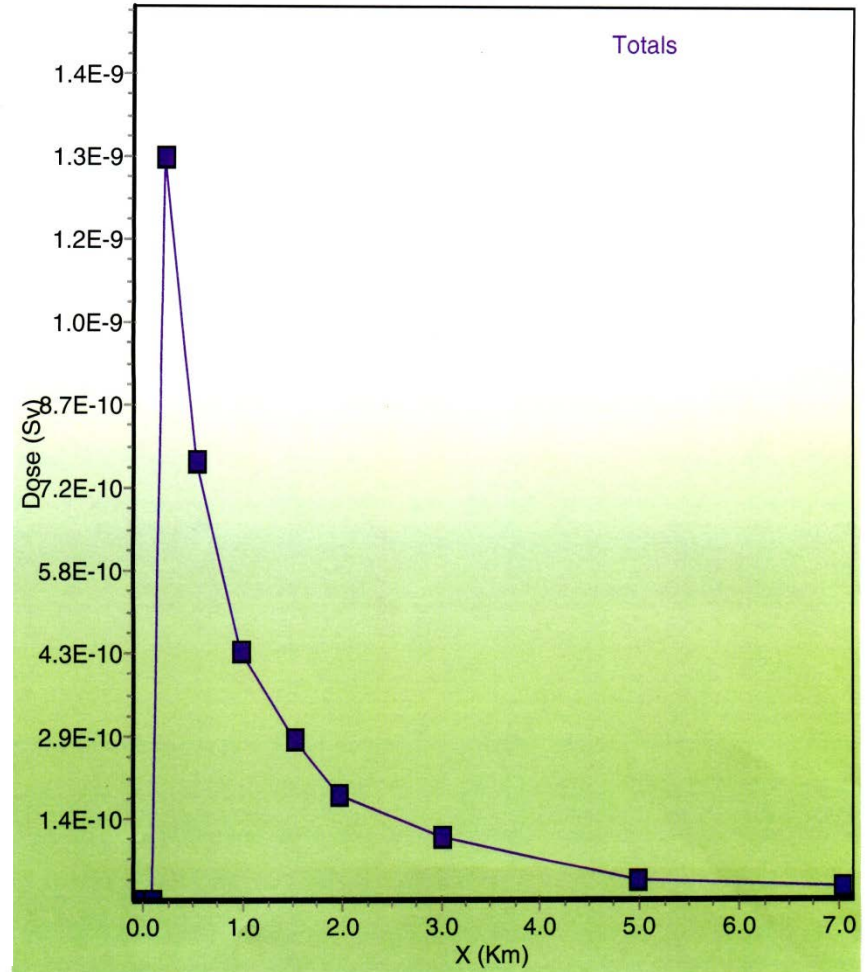
Chronic release of radioactive air products

Data from the file: C:\FRAMES\SPESB.HIF



Ring 5, Sector 14, Location (-0.7 km, 0.7 km)

Data from the file: C:\FRAMES\SPESB.HIF

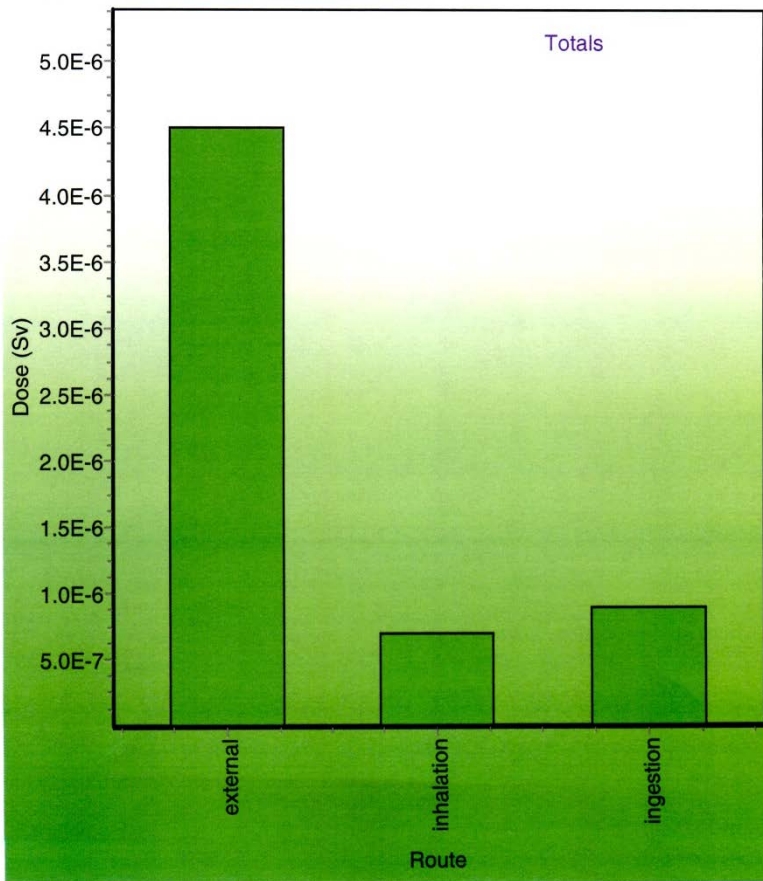


Current max. 1.3×10^{-9} Sv

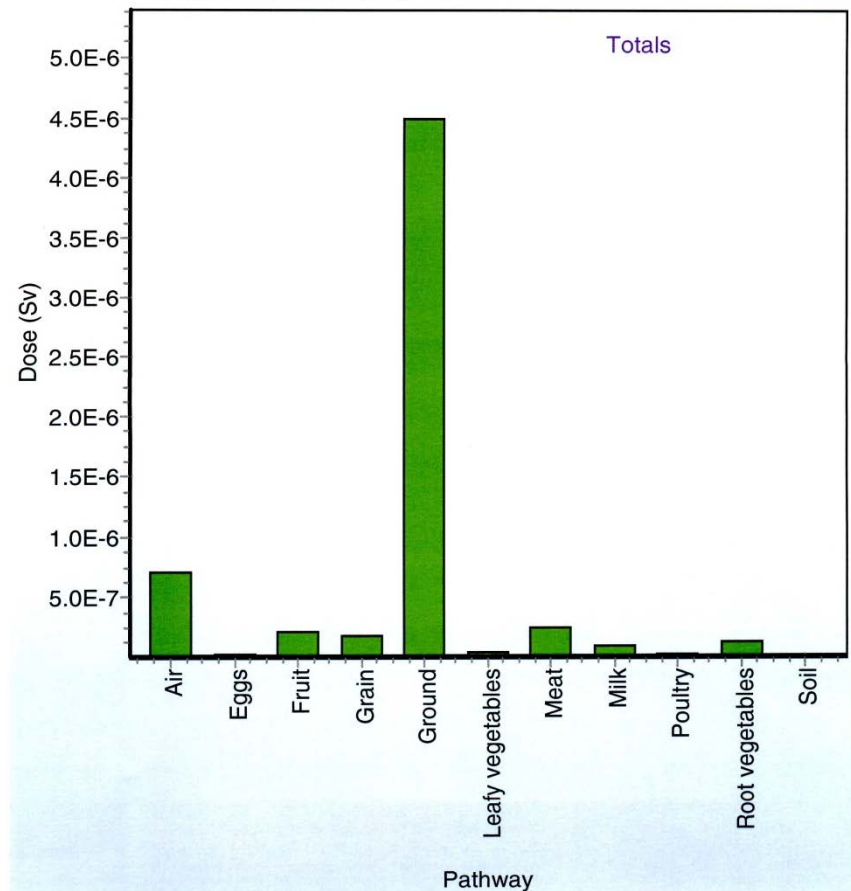
Code GENII/FRAMES ver. 2.0 (4)

Chronic release of radioactive air products

Data from the file: C:\FRAMES\SPESB.HIF



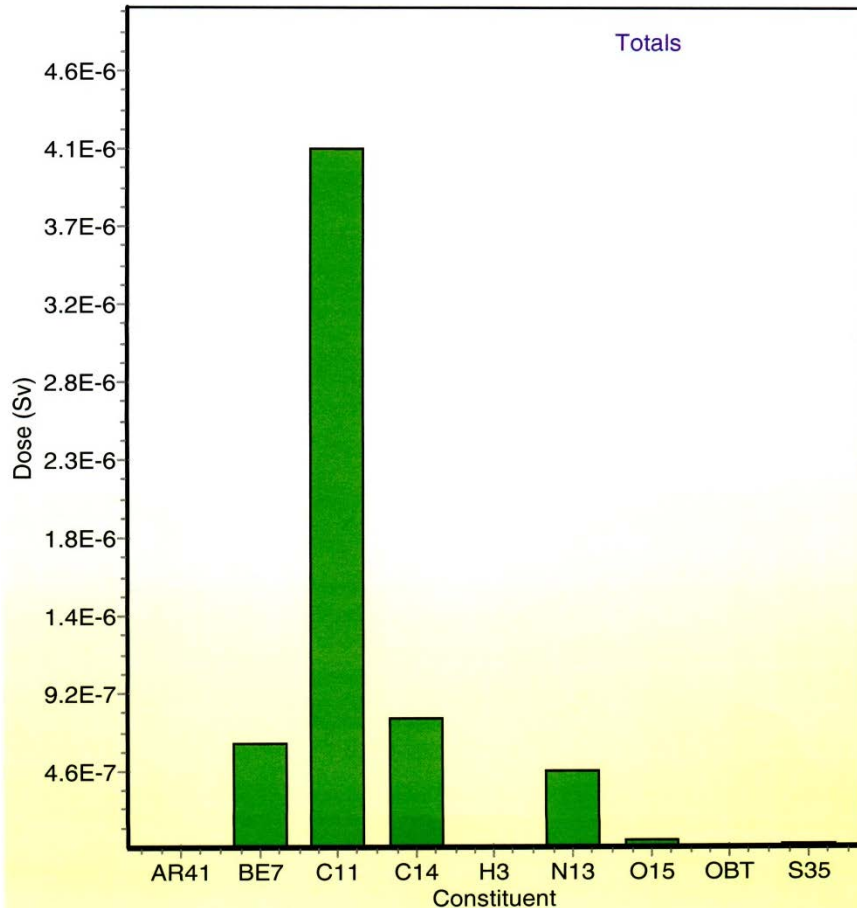
Data from the file: C:\FRAMES\SPESB.HIF



Code GENII/FRAMES ver. 2.0 (5)

Chronic release of radioactive air products

Data from the file: C:\FRAMES\SPESB.HIF



Max. effective dose at 700 m from the release point: **1.1 μSv** , for the group 7-12 years old, mainly due to external exposure to the plume (0.79 μSv (0.14 μSv for inhalation and 0.16 μSv for ingestion).

Max. effective dose at 700 m from the release point: **1 μSv** , for the group 12-70 years old.

WITH PLUME RISE: Max. effective dose at 1100 m from the release point: **0.13 μSv** for the group 7-12 years old and **0.10 μSv** for the group 12-70 years old.

Code GENII/FRAMES ver. 2.0 (6)

Chronic release of radioactive air products

LARAMED-TEMP

Protons of 70 MeV, 200 μ A on ^{85}Rb for ^{82}Sr production (p,4n) reaction.

Irradiation profile given by BEST Company.

No plume rise

Max. effective dose at 700 m from the release point: **1.4 μSv** , for the group 7-12 years old, mainly due to external exposure to the plume.

Max. effective dose at 700 m from the release point: **1.3 μSv** , for the group 12-70 years old.

WITH PLUME RISE: Max. effective dose at 1100 m from the release point: **0.19 μSv** for the group 12-70 years old.

MAX. TOTAL EFFECTIVE DOSE IN A YEAR, DUE TO THE RELEASE OF THE RADIOACTIVE AIR GASES PRODUCED FROM BUNKER AIR ACTIVATION, GROUP 7-12 YEARS OLD **2.5 μSv**

HotSpot ver. 3.02 (Livermore U.S.A.)

Radionuclides production in air in ISOL bunker 1 due to the interaction of 40 MeV protons, 200 μ A on UCx SPES tgt;

Radionuclides production taken into account: ^{41}Ar , ^7Be , ^{11}C , ^{14}C , ^3H , ^{13}N , ^{15}O , ^{35}S

Chronic continuous annual release, total:

1.1×10^{13} Bq

Radionuclides mixture

CEDEOnlyFile.mix - Blocco note	
File Modifica Formato Visualizza ?	
40 MeV protons-200 microA on UCx tgt	
Mixture Scale Factor	: 1.0000E+00
Nuclide [01] : H-3 1.2320E+01 y	
Halflife	(Years): 1.2320E+01
Inhalation 50-yr CEDE	(Sv/Bq): 0.0000E+00
Submersion	(Sv-m3)/(Bq-sec): 0.0000E+00
Ground Shine	(Sv-m2)/(Bq-sec): 0.0000E+00
Total Activity Released	(Bq): 7.8000E+07
Airborne Fraction	: 1.0000E+00
Respirable Fraction	: 1.0000E+00
Respirable Deposition Velocity (cm/sec)	: 3.0000E-01
Non-resp. Deposition Velocity (cm/sec)	: 8.0000E+00
Nuclide [02] : Be-7 F 53.3d	
Halflife	(Years): 1.4603E-01
Inhalation 50-yr CEDE	(Sv/Bq): 3.7600E-11
Submersion	(Sv-m3)/(Bq-sec): 2.2100E-15
Ground Shine	(Sv-m2)/(Bq-sec): 4.7600E-17
Total Activity Released	(Bq): 3.6000E+09
Airborne Fraction	: 1.0000E+00
Respirable Fraction	: 1.0000E+00
Respirable Deposition Velocity (cm/sec)	: 3.0000E-01
Non-resp. Deposition Velocity (cm/sec)	: 8.0000E+00
Nuclide [03] : C-11 F 20.38m	
Halflife	(Years): 3.8775E-05
Inhalation 50-yr CEDE	(Sv/Bq): 1.0800E-11
Submersion	(Sv-m3)/(Bq-sec): 4.5600E-14
Ground Shine	(Sv-m2)/(Bq-sec): 1.0000E-15
Total Activity Released	(Bq): 3.9000E+12
Airborne Fraction	: 1.0000E+00
Respirable Fraction	: 1.0000E+00
Respirable Deposition Velocity (cm/sec)	: 3.0000E-01
Non-resp. Deposition Velocity (cm/sec)	: 8.0000E+00
Nuclide [04] : C-14 F 5730y	
Halflife	(Years): 5.7300E+03
Inhalation 50-yr CEDE	(Sv/Bq): 2.0300E-10
Submersion	(Sv-m3)/(Bq-sec): 2.6000E-18
Ground Shine	(Sv-m2)/(Bq-sec): 1.2800E-20
Total Activity Released	(Bq): 1.6000E+08
Airborne Fraction	: 1.0000E+00
Respirable Fraction	: 1.0000E+00
Respirable Deposition Velocity (cm/sec)	: 3.0000E-01
Non-resp. Deposition Velocity (cm/sec)	: 8.0000E+00
Nuclide [05] : N-13 9.9650E+00 m	
Halflife	(Years): 1.8959E-05
Inhalation 50-yr CEDE	(Sv/Bq): 0.0000E+00
Submersion	(Sv-m3)/(Bq-sec): 4.5700E-14
Ground Shine	(Sv-m2)/(Bq-sec): 1.0300E-15
Total Activity Released	(Bq): 3.2000E+12

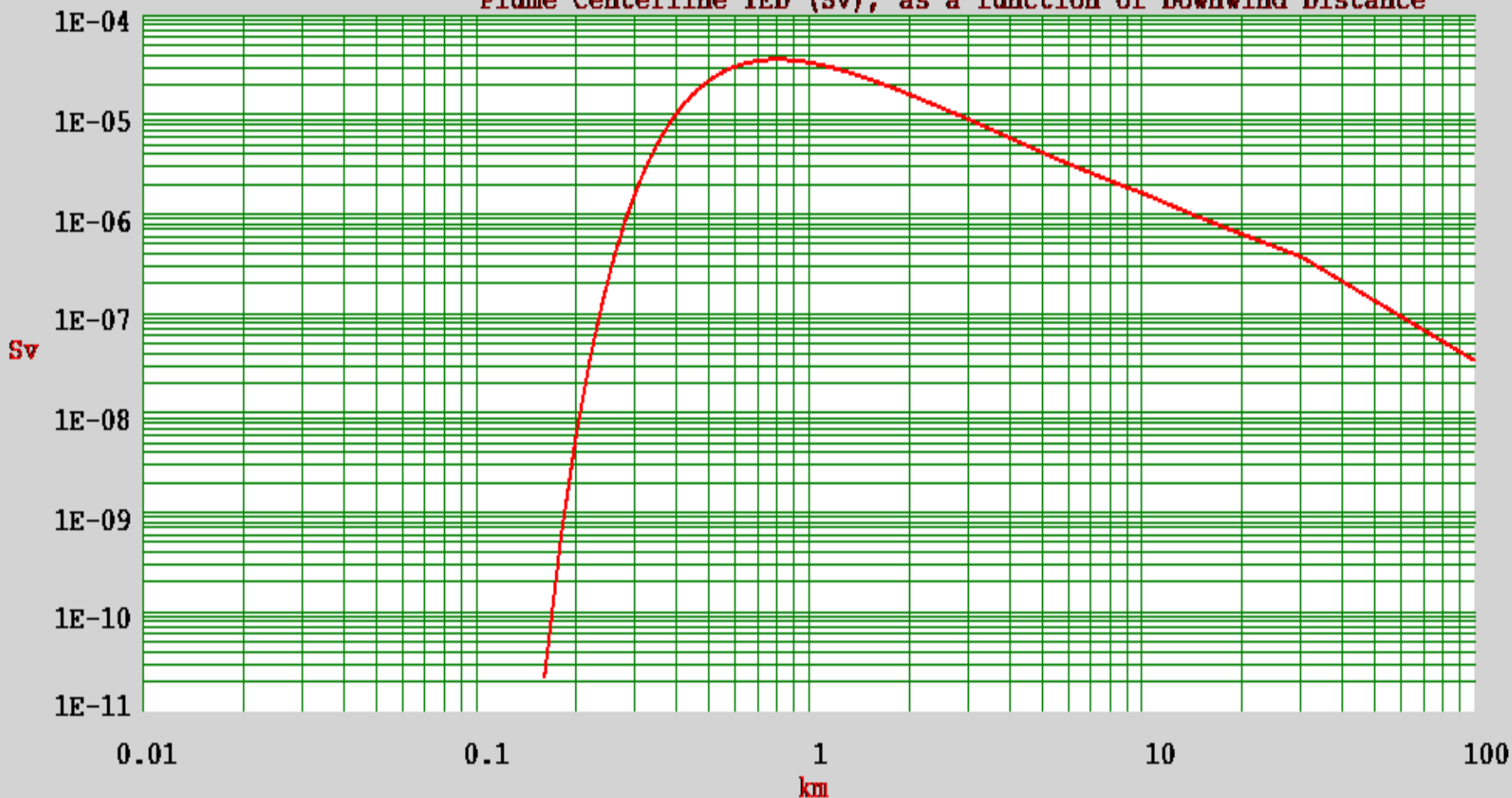
HotSpot Version 3.0.2 General Plume
lug 22, 2015 04:34

Source Term : EOBSPES5.mix (Mixture Scale Factor = 1.0000E+00)
eob5
Physical Stack Height : 16.0 m
Stack Exit Velocity : 10.00 m/s
Stack Diameter : 15.0 m
Stack Effluent Temp. : 20.0 deg C
Air Temperature : 20.0 deg C
Effective Release Height : 16 m
Wind Speed (h=10 m) : 1.50 m/s
Wind Speed (h=H-eff) : 1.94 m/s
Stability Class : F
Receptor Height : 1.5 m
Inversion Layer Height : None
Sample Time : 10.000 min
Breathing Rate : 2.61E-04 m3/sec
Distance Coordinates : All distances are on the Plume Centerline

Maximum Dose Distance : 0.80 km
Maximum TED : 3.62E-05 Sv
Inner Contour Dose : 0.010 Sv
Middle Contour Dose : 5.00E-05 Sv
Outer Contour Dose : 1.00E-05 Sv
Exceeds Inner Dose Out To : Not Exceeded
Exceeds Middle Dose Out To : Not Exceeded
Exceeds Outer Dose Out To : 2.8 km

Include Plume Passage Inhalation and Submersion
Exposure Window:(Start: 0.00 days; Duration: 365.00 days) [100% stay time].

DISTANCE	T E D	RESPIRABLE TIME-INTEGRATED AIR CONCENTRATION	ARRIVAL TIME
km	(Sv)	(Bq-sec)/m3	(hour:min)
0.030	0.0E+00	0.0E+00	<00:01
0.100	0.0E+00	3.0E-09	<00:01
0.200	6.5E-09	6.0E+04	00:01
0.300	1.6E-06	1.3E+07	00:02
0.400	1.0E-05	7.3E+07	00:03
0.500	2.2E-05	1.5E+08	00:04
0.600	3.1E-05	2.0E+08	00:05
0.700	3.5E-05	2.2E+08	00:06
0.800	3.6E-05	2.2E+08	00:06
0.900	3.6E-05	2.1E+08	00:07
1.000	3.4E-05	2.0E+08	00:08
2.000	1.6E-05	8.2E+07	00:17
4.000	5.9E-06	2.3E+07	00:34
6.000	3.2E-06	1.1E+07	00:51
8.000	2.2E-06	6.1E+06	01:08
10.000	1.6E-06	4.1E+06	01:25
20.000	6.3E-07	1.2E+06	02:51
40.000	2.1E-07	3.3E+05	05:43



Source Material :EOBSPES5.mix

Eff. Release Height :16 m

Wind Speed (h=10 m) :1.50 m/s

u (h=16 m)

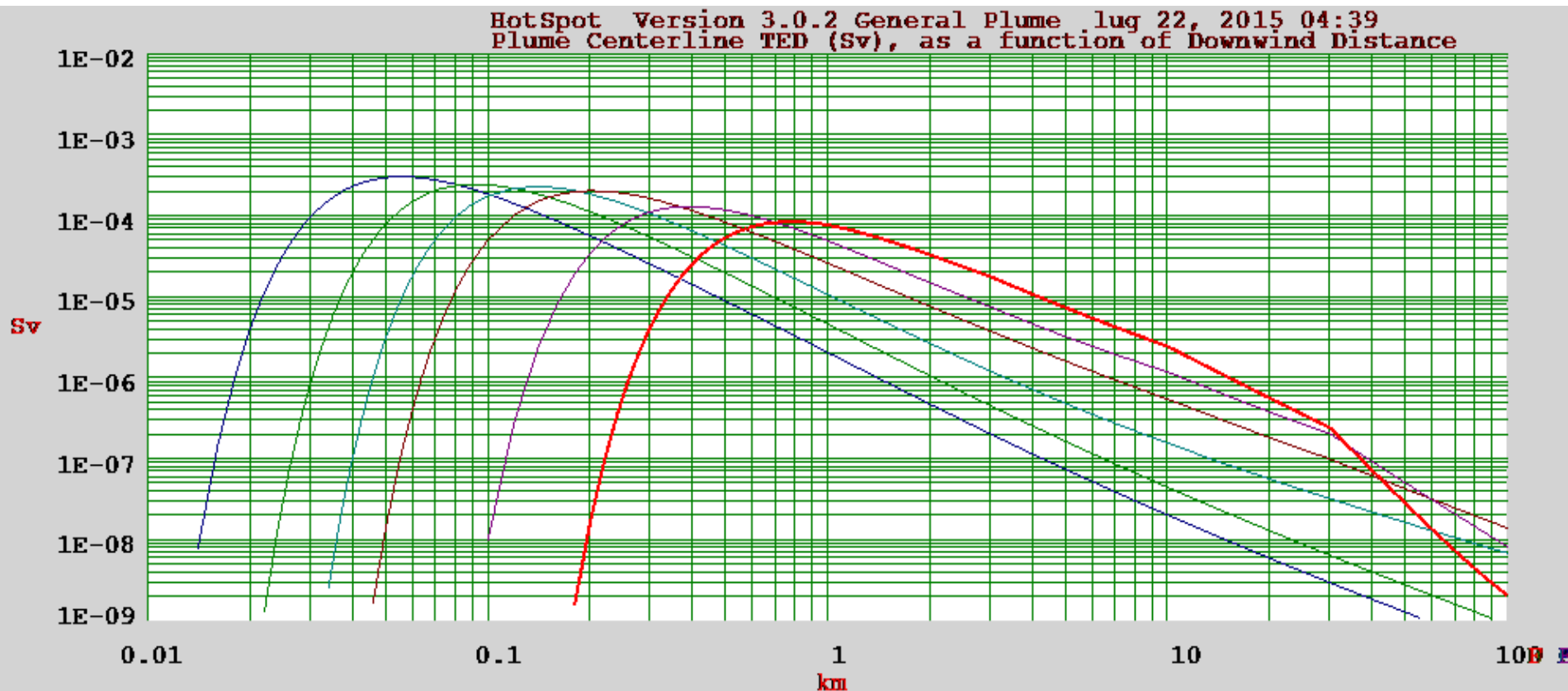
:1.94 m/s

Stability Class :F (Sample Time: 10.00 min)

Receptor Height :1.5 m

Inversion Layer Height :None

Different results based on class stability



Source Material :EOBSPES5.mix

Eff. Release Height :16 m

Wind Speed (h=10 m) :1.50 m/s

u (h=16 m)

:0.72 m/s

Stability Class :A - F (Sample Time: 10.00 min)

Receptor Height :1.5 m

Inversion Layer Height :None

Confronto HotSpot – GENII/FRAMES

Air Activation Release

1. HotSpot

Max. Effective dose: 36 μSv at 800 m,
100% presence outside

Different Model used (Pasquille/Gifford)
Class stability F (Moderately stable)

2. GENII/FRAMES

Max. Effective dose: 1 μSv at 700 m

100% presence outside

Different Model used (Brigg's Open Country)

Class stability F

Fraction of time spent indoors 0.7

Fraction of time spent outdoors 0.3

Days/y exposed to contaminated ground

Code GENII/FRAMES

Acute Plume at the End Of Bombardment di SPES (1)

- 1) 110 radionuclides, without any filtration are released in air for 1 hour
- 2) Activity released up to 1×10^{13} Bq
- 3) Evaluation of the effective dose received from the plume in 1 hour
- 4) Evaluation in a year of the effective dose received by all the ways of irradiation included the introduction of radioactive material in the body considering all possible ways
- 5) Age of population considered: 17-70 years

Code GENII/FRAMES

Acute Plume at the End Of Bombardment di SPES (2)

i. Max. effective dose received

hour acute release = 5 mSv

External (total)
Inhalation

ii. Max. effective dose received due to the 1

year = 132 mSv

External (total): 3.8 mSv
Inhalation (total): 0 mSv
Ingestion (total): 128.2 mSv

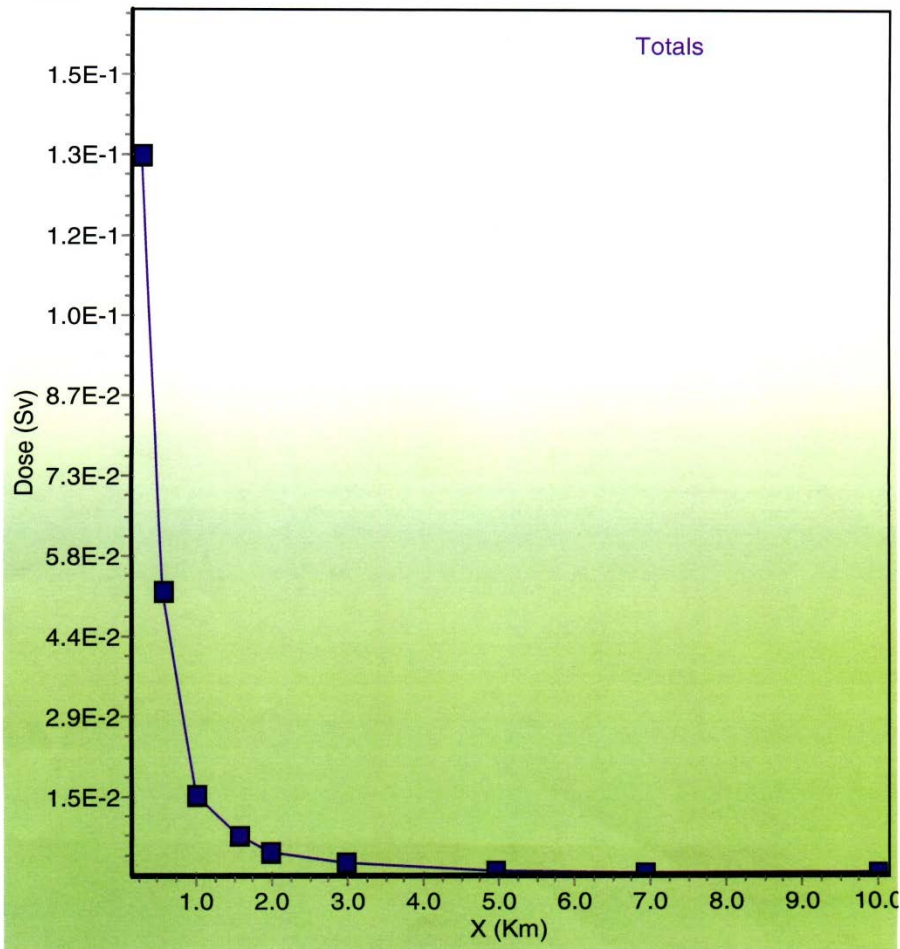
Considering a velocity of 10 m/sec for exit : considering a Plume
At a distance of 700 m max. effective dose due to 1 h acute release: 0.17 mSv
At a distance of 700 m max. effective dose due to 1 y resuspension: 7.4 mSv

FROM THE SOURCE

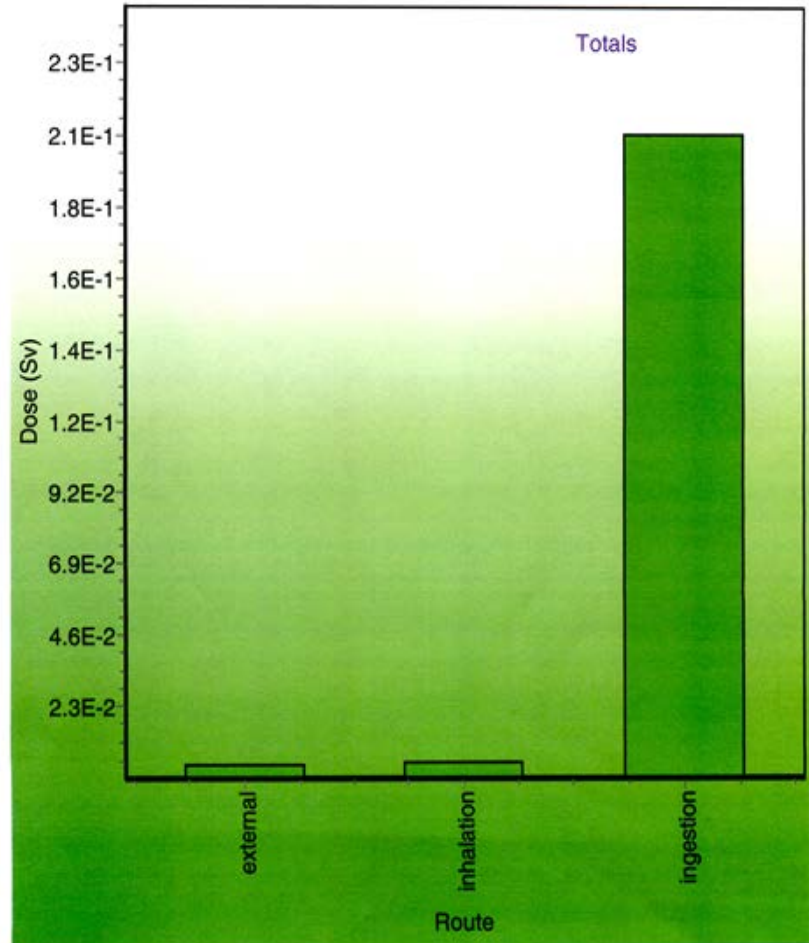
Code GENII/FRAMES

Acute Plume at the End Of Bombardment di SPES (3)

Data from the file: C:\FRAMES\ALLOFF.HIF



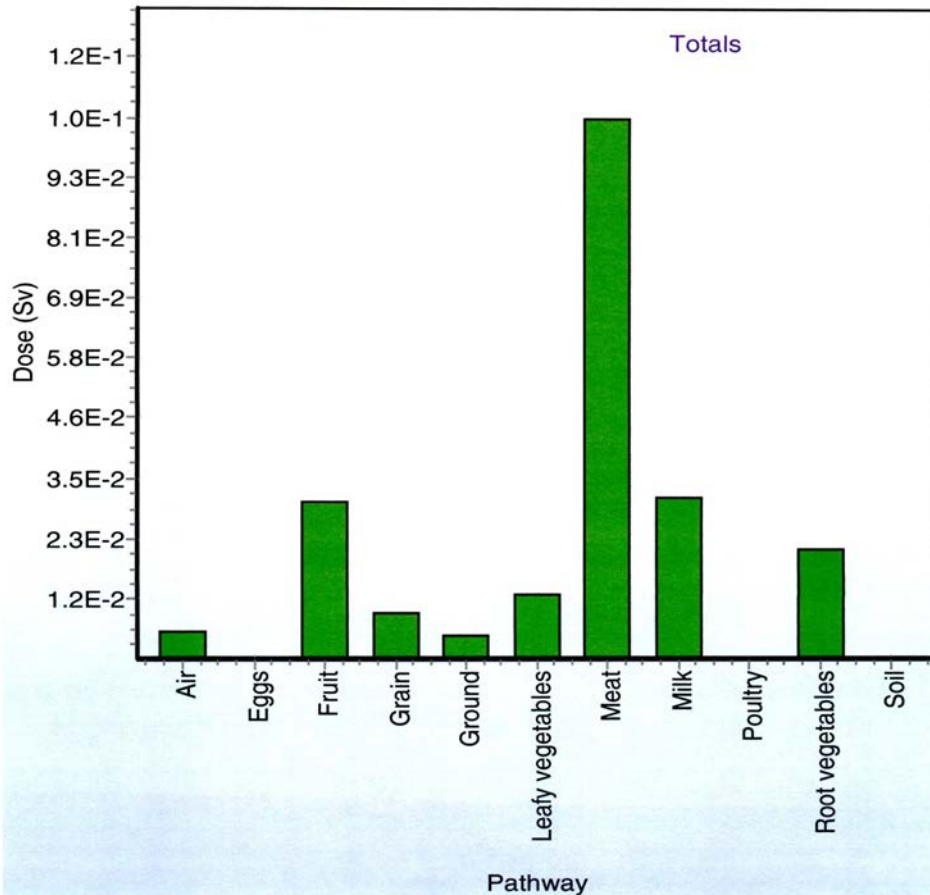
Data from the file: C:\FRAMES\ALLOFF.HIF



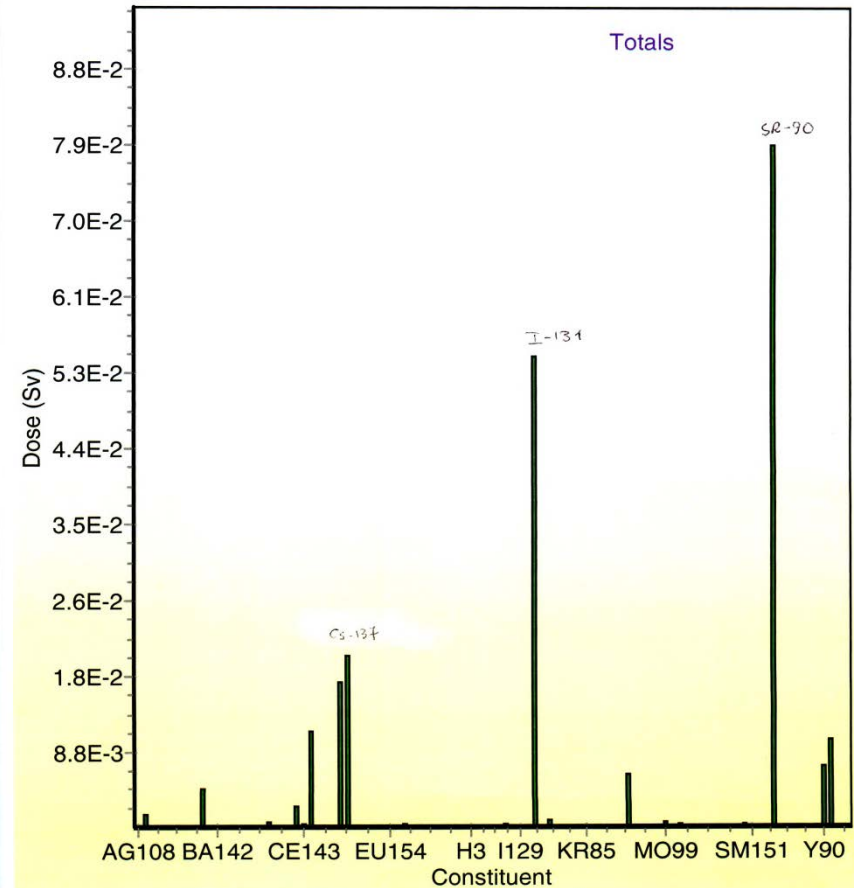
Code GENII/FRAMES

Acute Plume at the End Of Bombardment di SPES (4)

Data from the file: C:\FRAMES\ALLOFF.HIF



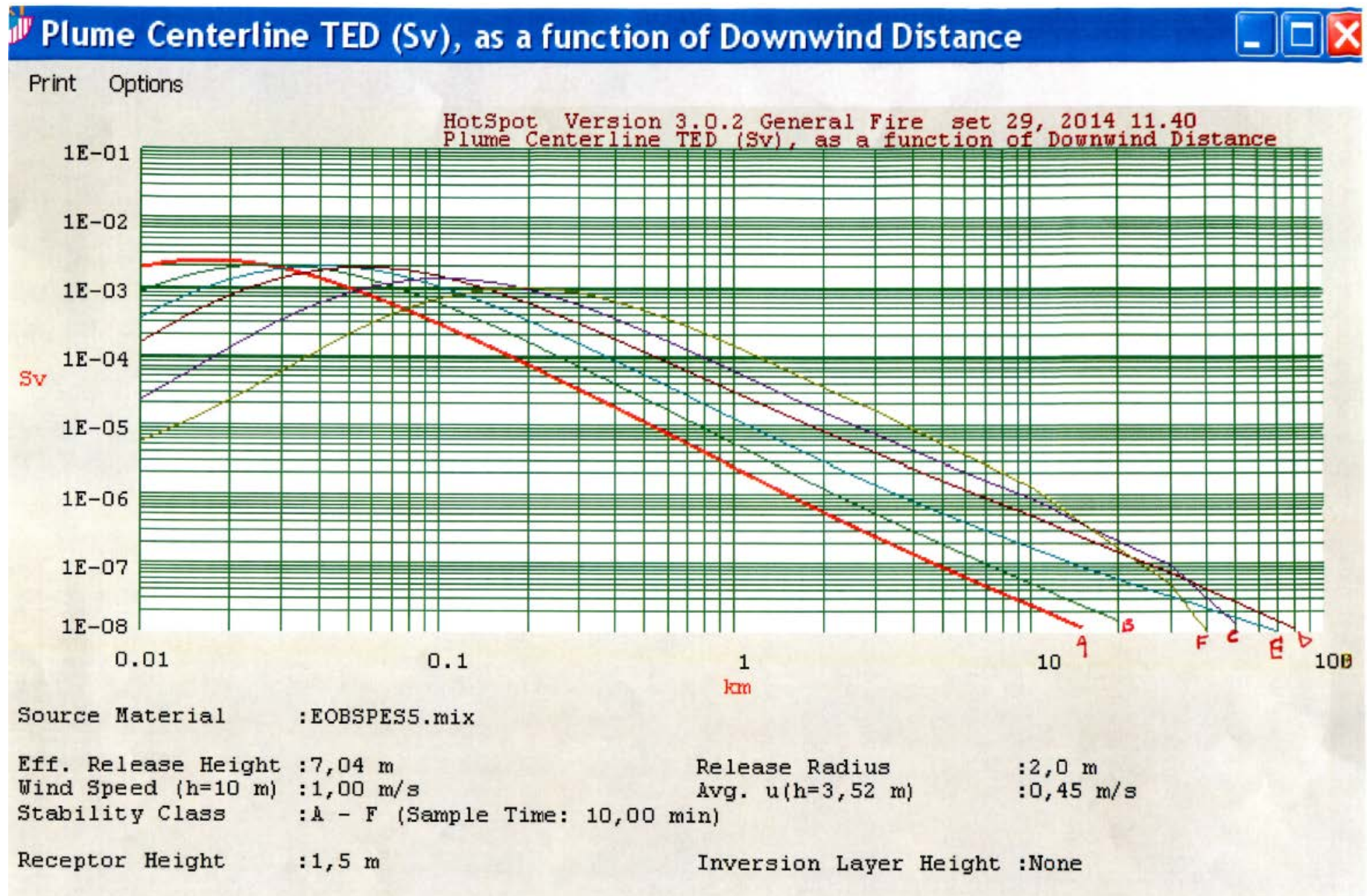
Data from the file: C:\FRAMES\ALLOFF.HIF



HotSpot – General fire

- The code is less specific compared with GENII
- A wide choice of different models can be used with GENII
- Using Fire model of HotSpot for instantaneous release of SPES target material at the EOB to the atmosphere, max. doses for different classes of meteorological stability can be reported.

HotSpot – General fire

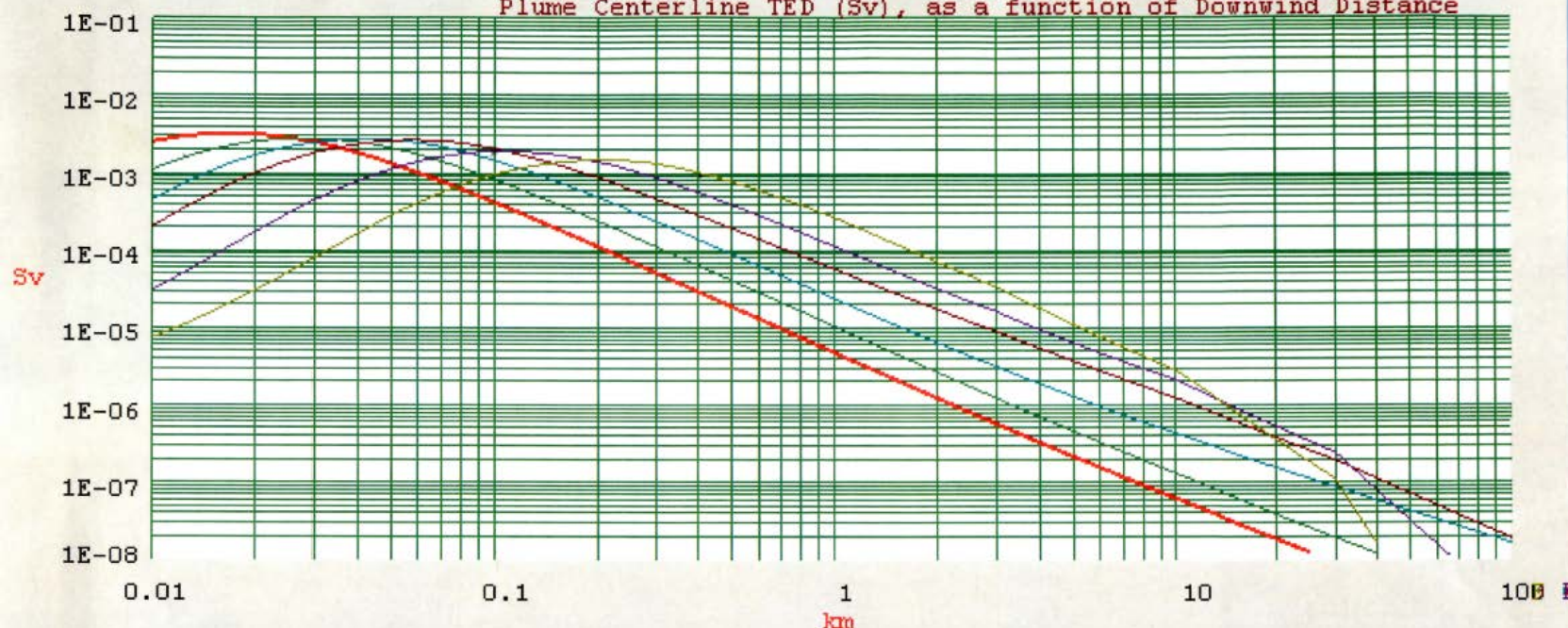


Plume Centerline TED (Sv), as a function of Downwind Distance



Print Options

HotSpot Version 3.0.2 General Fire set 29, 2014 10.26
Plume Centerline TED (Sv), as a function of Downwind Distance



Source Material :SPESUranio2.mix

Eff. Release Height :7,04 m

Wind Speed (h=10 m) :1,00 m/s

Stability Class :A - F (Sample Time: 10,00 min)

Receptor Height :1,5 m

Release Radius :2,0 m

Avg. u(h=3,52 m) :0,45 m/s

Inversion Layer Height :None

FOR 1 HOUR RELEASE, MAX DOSE RECEIVED AT 200 m FROM THE EMISSION POINT EQUAL TO 7 mSv TO BE COMPARED WITH 5 mSv OF GENII

Intervention Levels – Protective measures for the population

Tabella 7.1 – *Livelli di intervento di dose per l'introduzione di misure protettive per esposizioni prolungate*

Azione protettiva	Livelli di intervento (dose efficace)				
	ICRP ⁽¹⁾	IAEA ⁽²⁾	USA ⁽³⁾	Canada ⁽⁴⁾	Germania ⁽⁵⁾
Allontanamento temporaneo	10 mSv / mese	30 mSv (primo mese)	20 mSv (primo anno)	50 mSv / anno	30 mSv/mese
		10 mSv/mese	5 mSv (secondo anno)		
Allontanamento definitivo	1 Sv sull'intera vita	1 Sv sull'intera vita	50 mSv (50 anni)	-	100 mSv/anno

⁽¹⁾ ICRP, 1993b

⁽²⁾ IAEA, 1994

⁽³⁾ USEPA, 1992

⁽⁴⁾ Health Canada 2003

⁽⁵⁾ Länder Committee for Nuclear Energy, Germany 1999

Tabella 7.15 – Contaminazione superficiale iniziale del suolo che determina per ingestione di latte una dose efficace di 1 mSv nel primo anno

Radionuclide	Contaminazione superficiale iniziale (Bq m ⁻²)		
	Lattanti	Bambini	Adulti
Sr-89	5,2 10 ⁴	9,0 10 ⁵	2,3 10 ⁶
Sr-90	2,4 10 ³	2,6 10 ⁴	6,3 10 ⁴
I-131	5,4 10 ³	5,3 10 ⁴	1,4 10 ⁵
Cs-134	4,8 10 ³	2,5 10 ⁴	2,1 10 ⁴
Cs-137	5,2 10 ³	3,0 10 ⁴	2,7 10 ⁴
Pu-239	1,9 10 ⁶	8,1 10 ⁷	1,0 10 ⁸

Tabella 7.16 – Contaminazione superficiale iniziale del suolo che determina per ingestione di carne bovina una dose efficace di 1 mSv nel primo anno

Radionuclide	Contaminazione superficiale iniziale (Bq m ⁻²)		
	Lattanti	Bambini	Adulti
Sr-89	5,7 10 ⁷	1,2 10 ⁸	2,3 10 ⁸
Sr-90	1,7 10 ⁶	2,3 10 ⁶	4,1 10 ⁶
I-131	5,0 10 ⁷	6,0 10 ⁷	1,2 10 ⁸
Cs-134	2,4 10 ⁵	1,5 10 ⁵	9,5 10 ⁴
Cs-137	2,5 10 ⁵	1,8 10 ⁵	1,2 10 ⁵
Pu-239	2,8 10 ⁷	1,5 10 ⁸	1,4 10 ⁸