EMRAS II
WG 9 “Urban Areas”
Short range

Dejan Trifunović, Vienna, Austria, 24.-28. January 2011

Experiment SET-UP

Orientation of the blast:
“PARALEL” TO THE GROUND

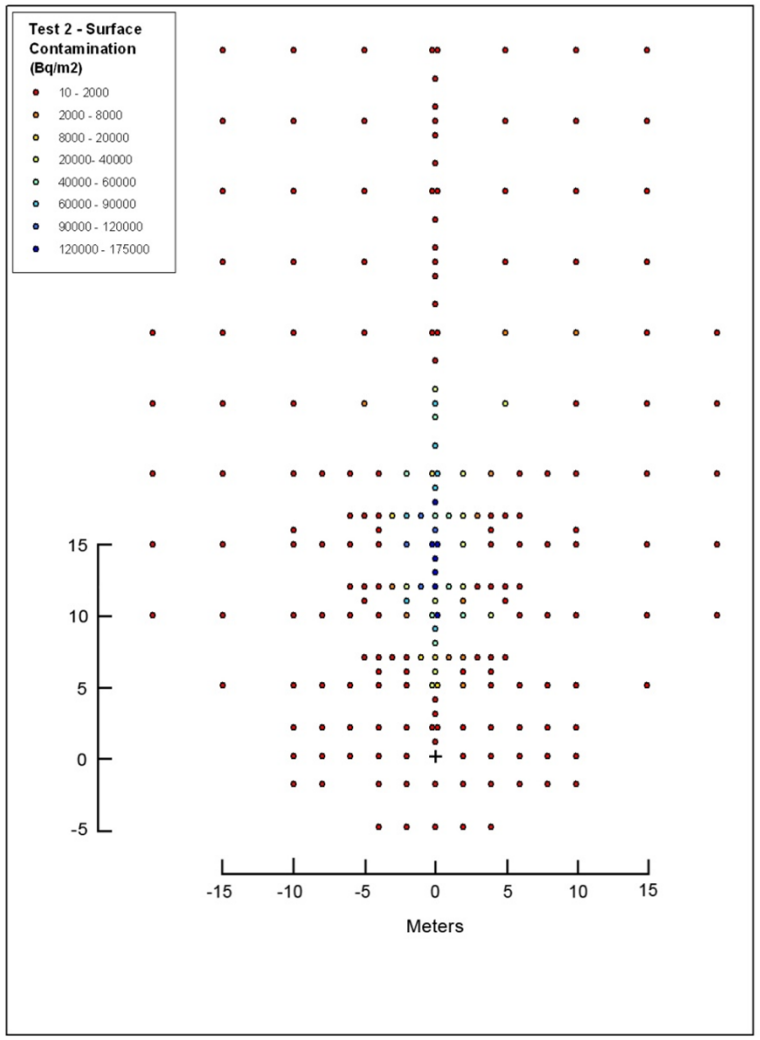
Modelling requirement:
Unbounded upwards

BACK BLAST WAVE – due to explosion set-up

Modelling requirement:
Unrestricted 360° geometry explosion

Experiment SET-UP dispersion outcome

Shift of the maximum deposition location around explosion point forward for about 10 - 15 m.

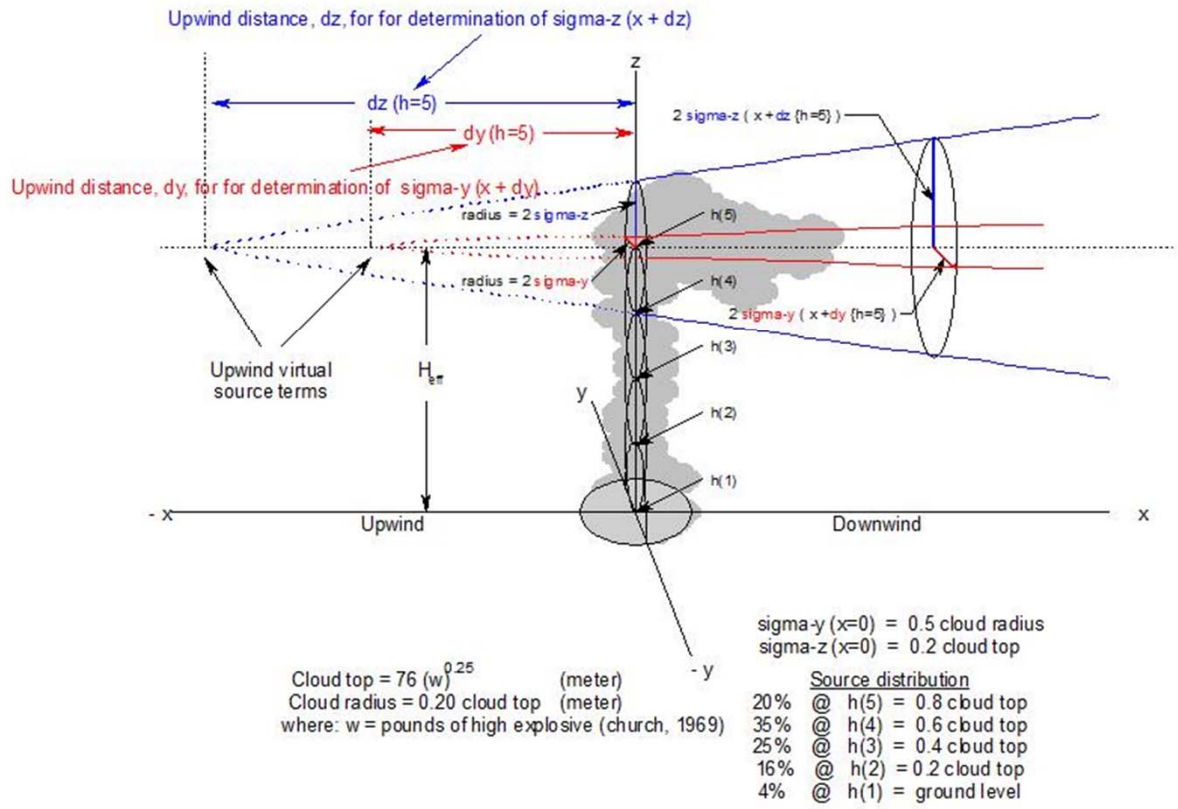


HotSpot model
Explosion geometry

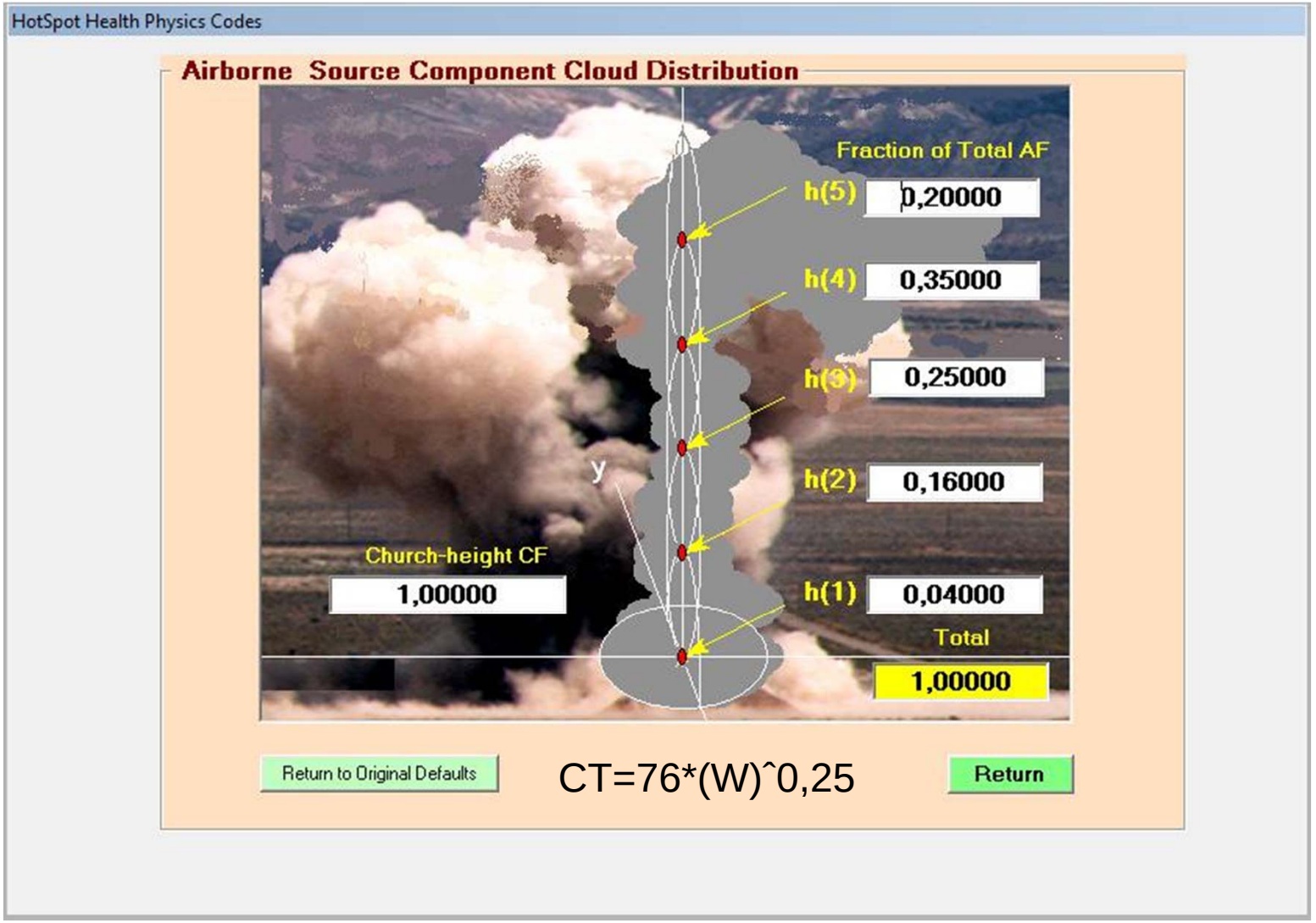
Explosion (Non-nuclear)

Explosion

The release is partitioned as follows:



HotSpot Airborne Fraction DEFAULT



HotSpot model
Dispersion and Deposition

The following Gaussian model equations determine the atmospheric concentration of a gas or an aerosol :

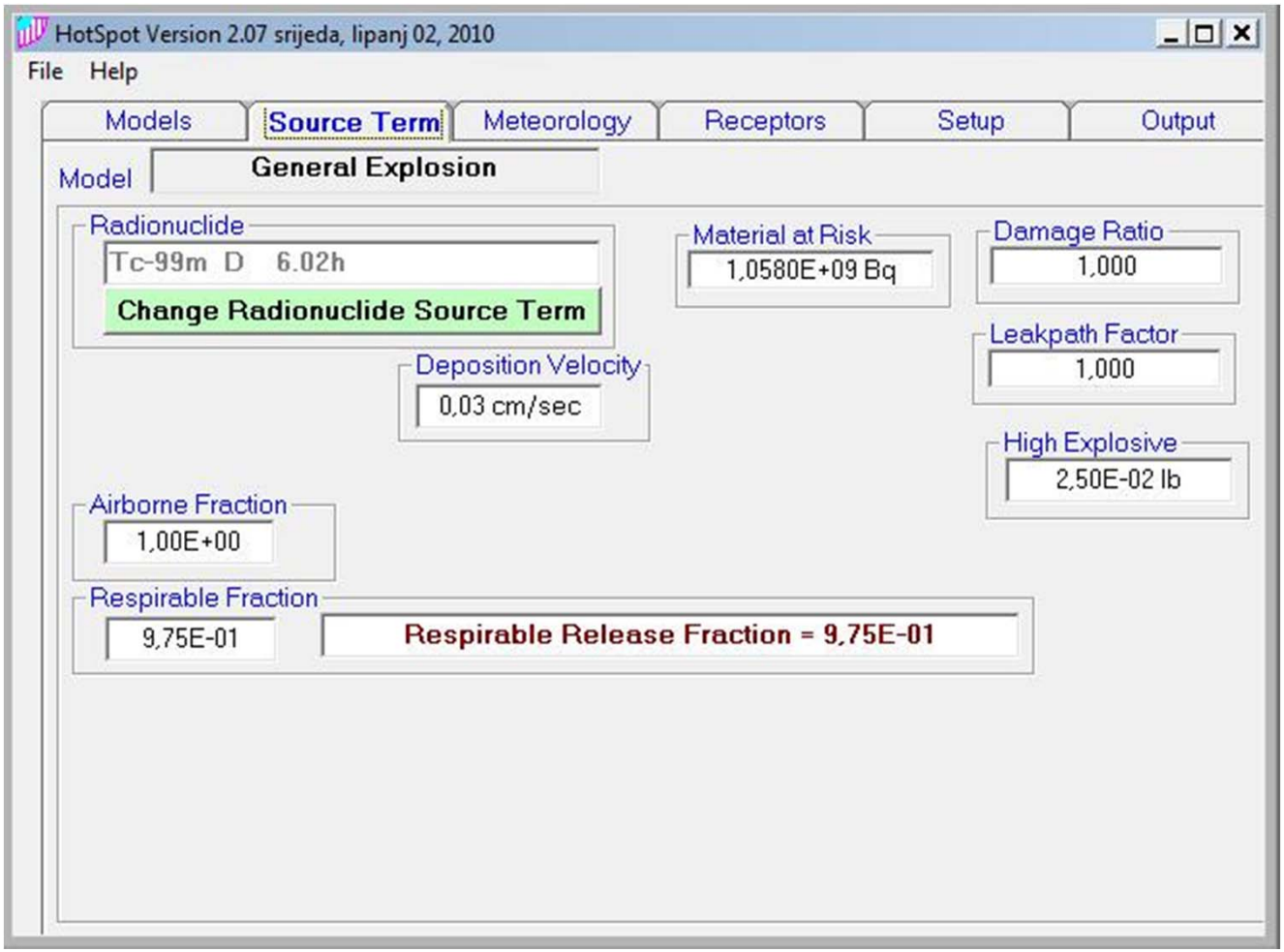
$$C(x,y,z,H)=\frac{Q}{2\pi\sigma_y\sigma_z u}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right]+\exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}\exp\left[-\frac{\lambda x}{u}\right]$$

where—

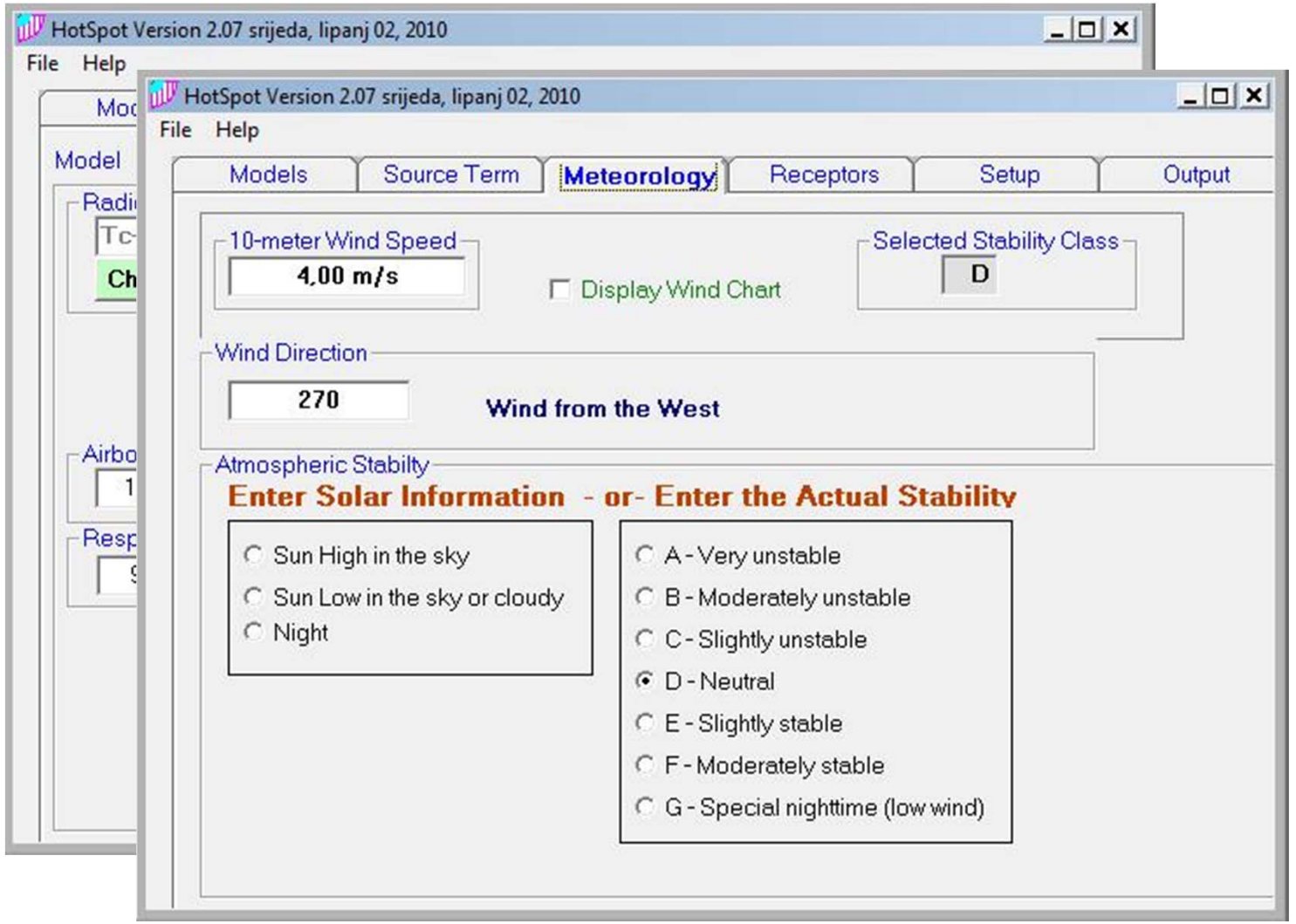
- C = Time-integrated atmospheric concentration (Ci-sec)/(m3).
- Q = Source term (Ci).
- H = Effective release height (m).
- λ = Radioactive decay constant (s−1).
- x = Downwind distance (m).
- y = Crosswind distance (m).
- z = Vertical axis distance (m).
- σy = Standard deviation of the integrated concentration distribution in the crosswind direction (m).
- σz = Standard deviation of the integrated concentration distribution in the vertical direction (m).
- u = Average windspeed at the effective release height (H), (m/s).
- L = Inversion layer height (m).

$$DF(x)=\left[\exp\int_0^x\frac{1}{\sigma_z(x)\exp\left[\frac{1}{2}\left(\frac{H}{\sigma_z(x)}\right)^2\right]}dx\right]^{-\frac{v}{u}\sqrt{\frac{2}{\pi}}}$$

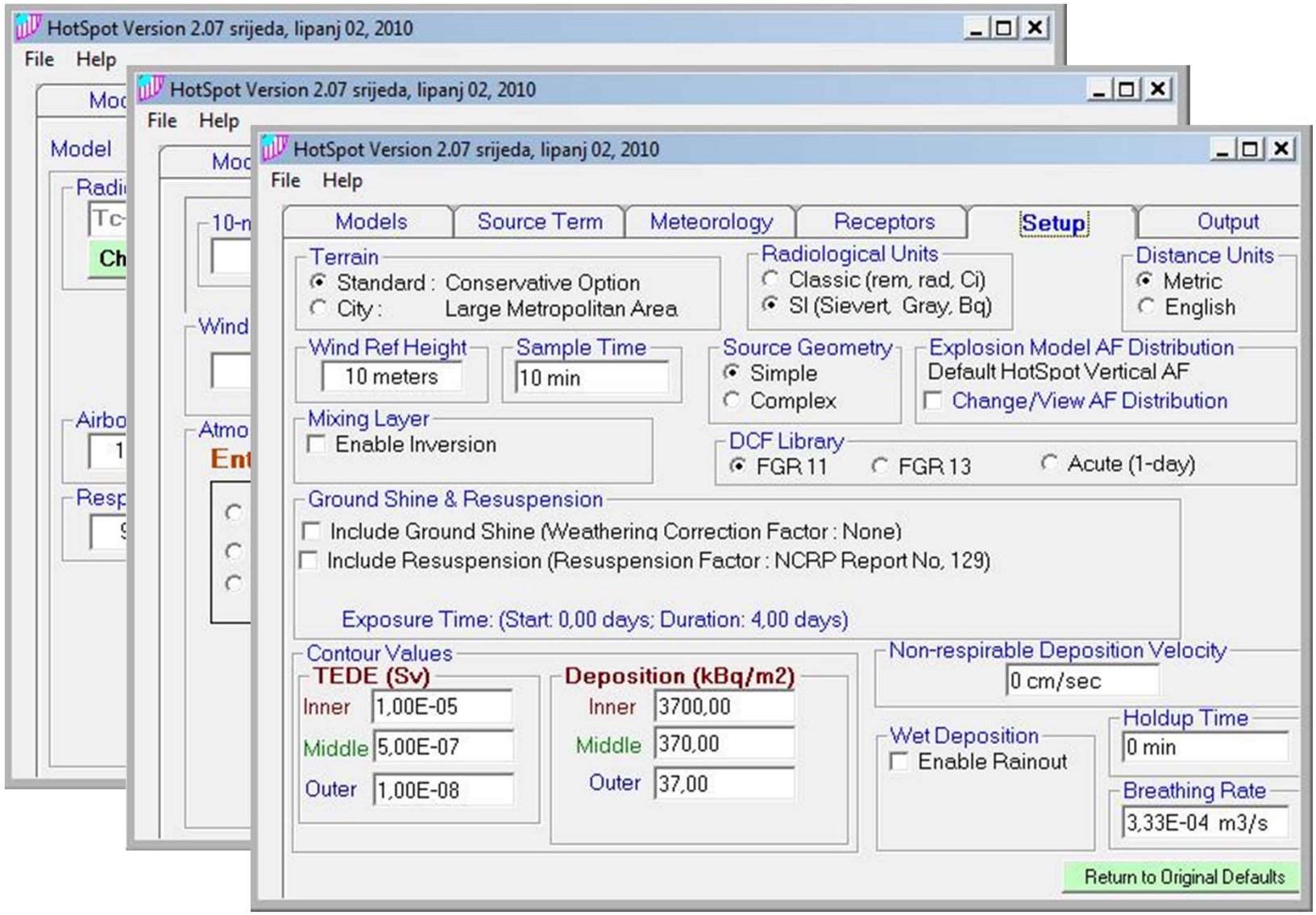
HotSpot model INPUT



HotSpot model INPUT

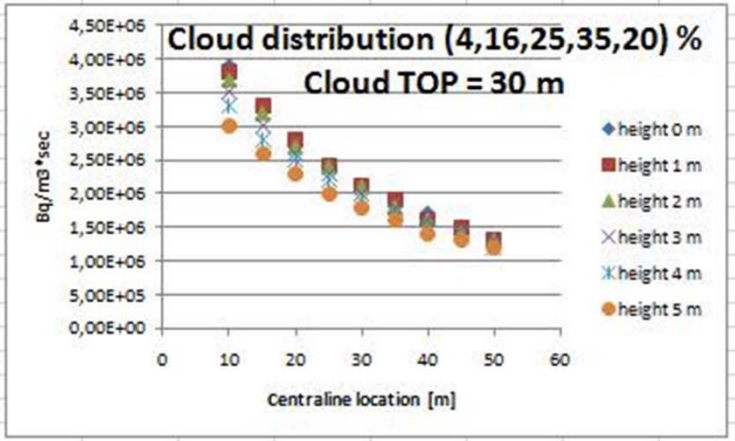


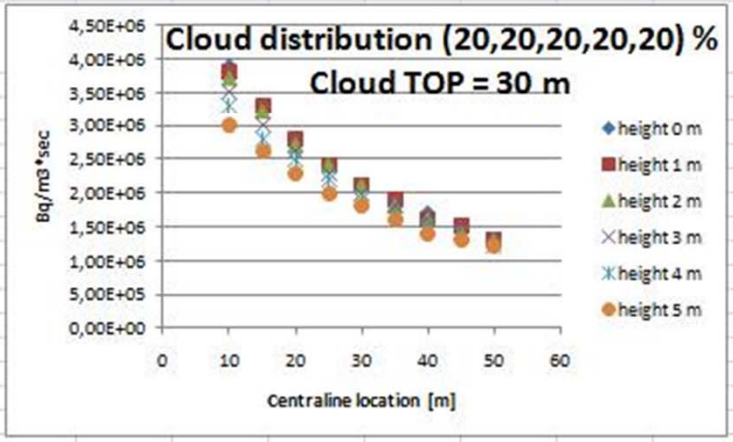
HotSpot model INPUT



Plume Centraline Vertical Profile

	A	B	C	D	E	F	G	H
1			Air concentrations					
2			(Bq/m3 * s)					
3				Cloud distribution: (4,16,25,35,20) % - DEFAULT				
4	Location (m)		height (m)					
5	X	Y	0	1	2	3	4	5
6	0	0						
7	0	5						
8	0	10	3900000,0	3800000,0	3700000,0	3500000,0	3300000,0	3000000,0
9	0	15	3300000,0	3300000,0	3200000,0	3000000,0	2800000,0	2600000,0
10	0	20	2800000,0	2800000,0	2700000,0	2600000,0	2500000,0	2300000,0
11	0	25	2400000,0	2400000,0	2400000,0	2300000,0	2200000,0	2000000,0
12	0	30	2100000,0	2100000,0	2100000,0	2000000,0	1900000,0	1800000,0
13	0	35	1900000,0	1900000,0	1800000,0	1800000,0	1700000,0	1600000,0
14	0	40	1700000,0	1600000,0	1600000,0	1600000,0	1500000,0	1400000,0
15	0	45	1500000,0	1500000,0	1400000,0	1400000,0	1400000,0	1300000,0
16	0	50	1300000,0	1300000,0	1300000,0	1300000,0	1200000,0	1200000,0
17								
18								
19								
20								
21			Air concentrations					
22			(Bq/m3 * s)					
23					Cloud distribution: (20,20,20,20,20) %			
24	Location (m)		height (m)					
25	X	Y	0	1	2	3	4	5
26	0	0						
27	0	5						
28	0	10	3,90E+06	3,90E+06	3,80E+06	3,60E+06	3,30E+06	3,00E+06
29	0	15	3,40E+06	3,30E+06	3,20E+06	3,10E+06	2,90E+06	2,60E+06
30	0	20	2,90E+06	2,90E+06	2,80E+06	2,70E+06	2,50E+06	2,30E+06
31	0	25	2,50E+06	2,50E+06	2,40E+06	2,30E+06	2,20E+06	2,10E+06
32	0	30	2,20E+06	2,20E+06	2,20E+06	2,10E+06	2,00E+06	1,80E+06
33	0	35	2,00E+06	1,90E+06	1,90E+06	1,80E+06	1,80E+06	1,70E+06
34	0	40	1,80E+06	1,70E+06	1,70E+06	1,70E+06	1,60E+06	1,50E+06
35	0	45	1,60E+06	1,60E+06	1,50E+06	1,50E+06	1,40E+06	1,40E+06
36	0	50	1,40E+06	1,40E+06	1,40E+06	1,40E+06	1,30E+06	1,20E+06





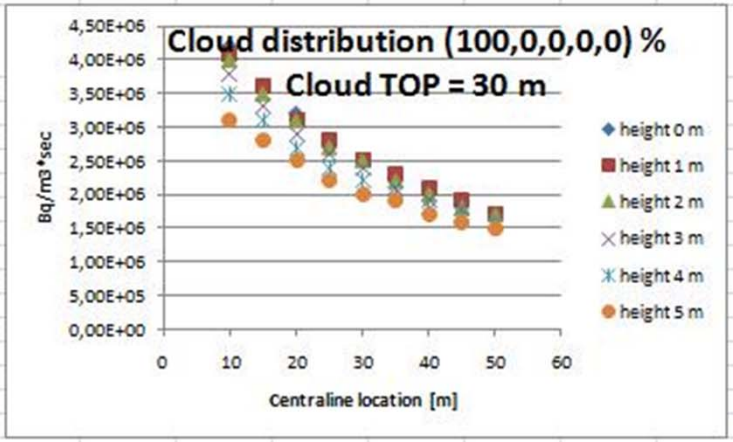
Plume Centraline Vertical Profile

Air concentrations

Air concentrations (Bq/m3 * s)

Cloud distribution: (100,0,0,0,0) %

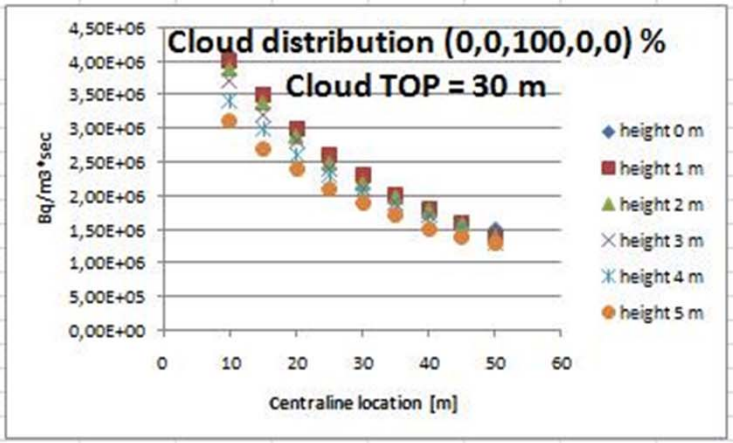
Location (m)		height (m)					
X	Y	0	1	2	3	4	5
0	0						
0	5						
0	10	4,20E+06	4,10E+06	4,00E+06	3,80E+06	3,50E+06	3,10E+06
0	15	3,60E+06	3,60E+06	3,50E+06	3,30E+06	3,10E+06	2,80E+06
0	20	3,20E+06	3,10E+06	3,10E+06	2,90E+06	2,70E+06	2,50E+06
0	25	2,80E+06	2,80E+06	2,70E+06	2,60E+06	2,40E+06	2,20E+06
0	30	2,50E+06	2,50E+06	2,50E+06	2,40E+06	2,20E+06	2,00E+06
0	35	2,30E+06	2,30E+06	2,20E+06	2,10E+06	2,00E+06	1,90E+06
0	40	2,10E+06	2,10E+06	2,00E+06	1,90E+06	1,80E+06	1,70E+06
0	45	1,90E+06	1,90E+06	1,80E+06	1,80E+06	1,70E+06	1,60E+06
0	50	1,70E+06	1,70E+06	1,70E+06	1,60E+06	1,60E+06	1,50E+06



Air concentrations (Bq/m3 * s)

Cloud distribution: (0,0,100,0,0) %

Location (m)		height (m)					
X	Y	0	1	2	3	4	5
0	0						
0	5						
0	10	4,10E+06	4,00E+06	3,90E+06	3,70E+06	3,40E+06	3,10E+06
0	15	3,50E+06	3,50E+06	3,40E+06	3,20E+06	3,00E+06	2,70E+06
0	20	3,00E+06	3,00E+06	2,90E+06	2,80E+06	2,60E+06	2,40E+06
0	25	2,60E+06	2,60E+06	2,50E+06	2,40E+06	2,30E+06	2,10E+06
0	30	2,30E+06	2,30E+06	2,20E+06	2,10E+06	2,00E+06	1,90E+06
0	35	2,00E+06	2,00E+06	2,00E+06	1,90E+06	1,80E+06	1,70E+06
0	40	1,80E+06	1,80E+06	1,80E+06	1,70E+06	1,60E+06	1,50E+06
0	45	1,60E+06	1,60E+06	1,60E+06	1,50E+06	1,50E+06	1,40E+06
0	50	1,50E+06	1,40E+06	1,40E+06	1,40E+06	1,30E+06	1,30E+06



Plume Centraline Vertical Profile

Air concentrations

Air concentrations (Bq/m3 * s)

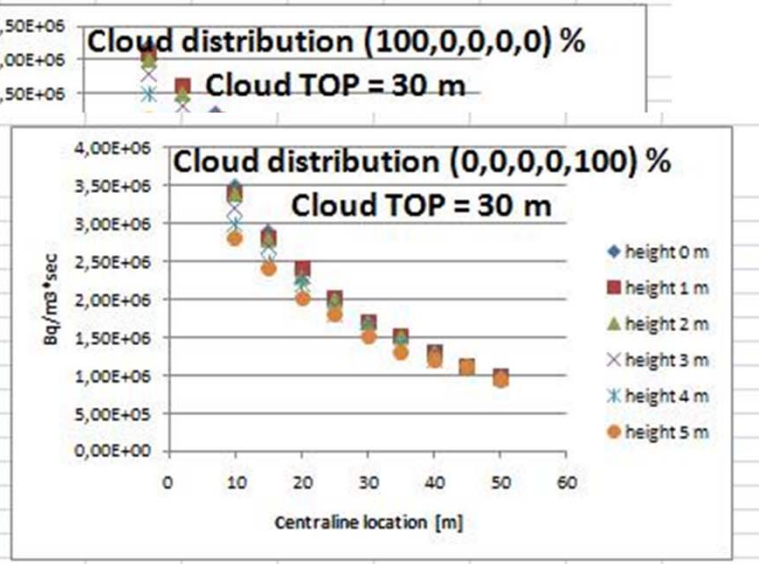
Cloud distribution: (0,0,0,0,100) %

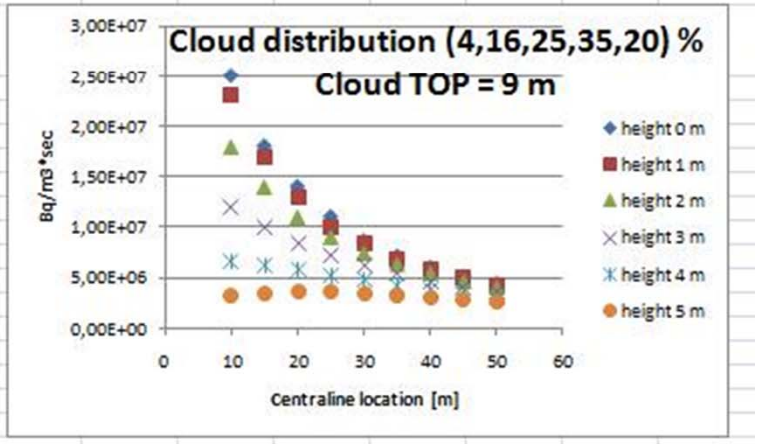
Location (m)		height (m)					
X	Y	0	1	2	3	4	5
0	0						
0	5						
0	10	3,50E+06	3,40E+06	3,40E+06	3,20E+06	3,00E+06	2,80E+06
0	15	2,90E+06	2,80E+06	2,80E+06	2,70E+06	2,50E+06	2,40E+06
0	20	2,40E+06	2,40E+06	2,30E+06	2,30E+06	2,20E+06	2,00E+06
0	25	2,00E+06	2,00E+06	2,00E+06	1,90E+06	1,80E+06	1,80E+06
0	30	1,70E+06	1,70E+06	1,70E+06	1,70E+06	1,60E+06	1,50E+06
0	35	1,50E+06	1,50E+06	1,50E+06	1,40E+06	1,40E+06	1,30E+06
0	40	1,30E+06	1,30E+06	1,30E+06	1,30E+06	1,20E+06	1,20E+06
0	45	1,10E+06	1,10E+06	1,10E+06	1,10E+06	1,10E+06	1,10E+06
0	50	9,90E+05	9,90E+05	9,80E+05	9,70E+05	9,60E+05	9,40E+05

Air concentrations (Bq/m3 * s)

Cloud distribution: (4,16,25,35,20) % - DEFAULT, CF = 1/3

Location (m)		height (m)					
X	Y	0	1	2	3	4	5
0	0						
0	5						
0	10	2,50E+07	2,30E+07	1,80E+07	1,20E+07	6,70E+06	3,20E+06
0	15	1,80E+07	1,70E+07	1,40E+07	1,00E+07	6,30E+06	3,50E+06
0	20	1,40E+07	1,30E+07	1,10E+07	8,40E+06	5,80E+06	3,60E+06
0	25	1,10E+07	1,00E+07	9,00E+06	7,20E+06	5,30E+06	3,60E+06
0	30	8,60E+06	8,30E+06	7,40E+06	6,20E+06	4,80E+06	3,40E+06
0	35	7,10E+06	6,90E+06	6,30E+06	5,40E+06	4,30E+06	3,20E+06
0	40	6,00E+06	5,80E+06	5,40E+06	4,70E+06	3,90E+06	3,00E+06
0	45	5,10E+06	5,00E+06	4,60E+06	4,10E+06	3,50E+06	2,80E+06
0	50	4,40E+06	4,30E+06	4,00E+06	3,60E+06	3,10E+06	2,60E+06





Short range scenario

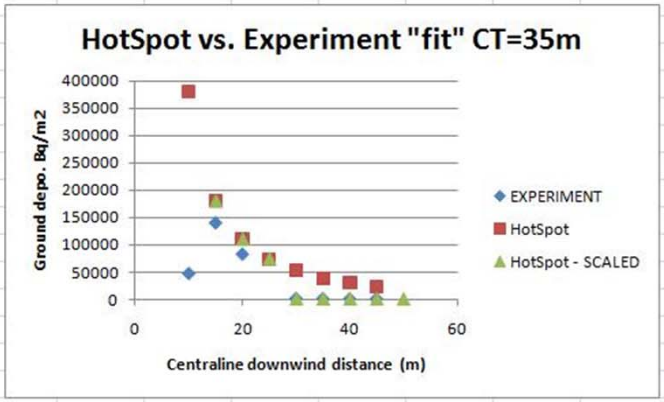
TEST 2

Wind speed: 0,6 m/s
Weather stability class: B
Source term: 1058 MBq
Cloud top: 5 m
Respirable Deposition velocity=0,0008 m/s
Respirable release fr.=99%

HotSpot “Calibration”

REMARK: HotSpot model is not defined for x = (-10, 10) m

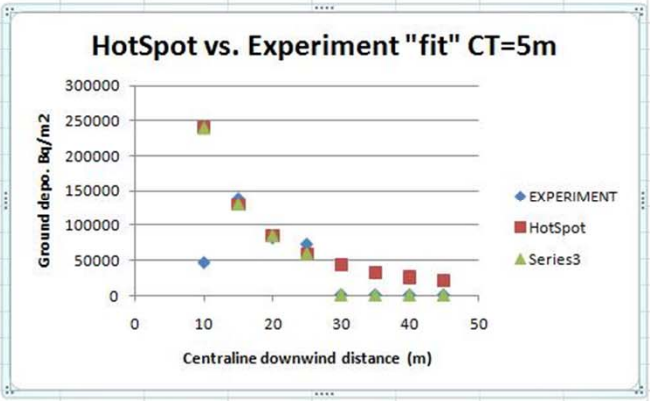
	1. Bq/m2			
10	380000	46689,45		
15	180000	139414,2		180000
20	110000	82108,22		110000
25	74000	72987,95	2. Bq/m2	74000
30	53000	765,22	640	640
35	39000	710,835	560	560
40	31000	308,0733	500	500
45	24000	319,7033	440	440
50			400	400



1. Sample time:10 min; Respirable release fraction:97,5%; Non-respirable depo. velocity:40m/s

2. Sample time:10min; Respirable release fraction: 97,5%; Non-respirable depo. velocity: 0m/s; Respirable depo. velocity: 0,03m/s

HotSpot “Calibration”



HotSpot vs. Experiment "fit" CT=35m

REMARK: HotSpot model is not defined for x = (-10, 10) m

	1. Bq/m2		%		
10	240000	46689,45			240000
15	130000	139414,2	6,752698		130000
20	85000	82108,22	-3,52191		85000
25	59000	72987,95	19,16473	2. Bq/m2	59000
30	44000	765,22		700	700
35	33000	710,835		540	540
40	26000	308,0733		420	420
45	21000	319,7033		340	340
50					

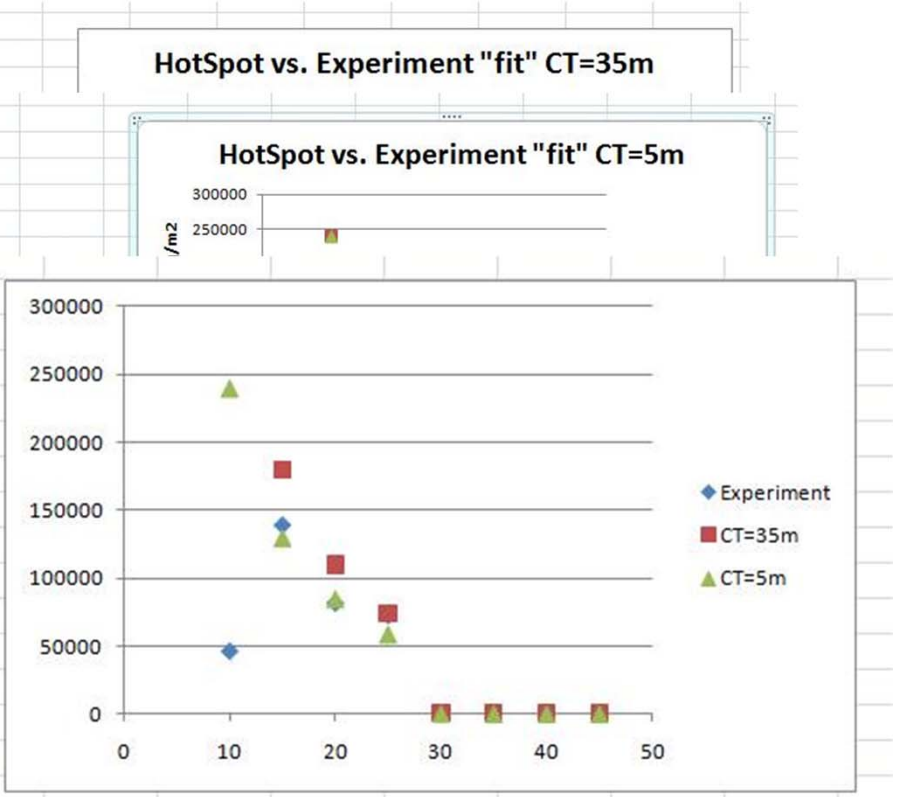
1. Sample time:10 min; Respirable release fraction: 99%; Non-respirable depo. velocity: 40m/s, Respirable depo. velocity: 0,05 cm/s; CT=5m

2. Sample time:10min; Respirable release fraction: 99%; Non-respirable depo. velocity: 40m/s; Respirable depo. velocity: 0,0008 cm/s; CT=5m

HotSpot “Calibration”

REMARK: HotSpot model is not defined for x = (-10, 10) m

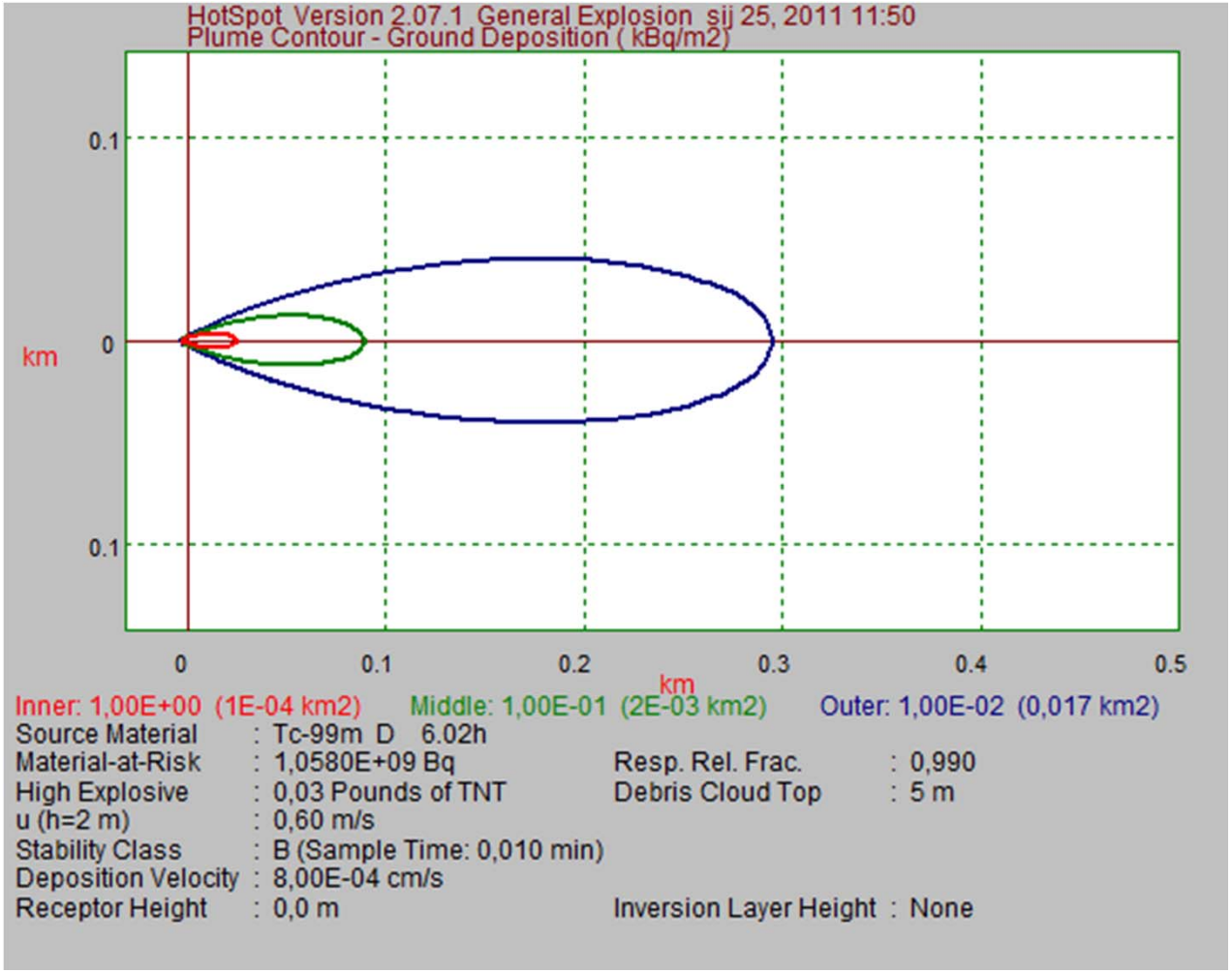
Centraline	Experime	CT=35m	CT=5m
10	46689		240000
15	139414	180000	130000
20	82108	110000	85000
25	72987	74000	59000
30	765	640	700
35	710	560	540
40	308	500	420
45	319	440	340



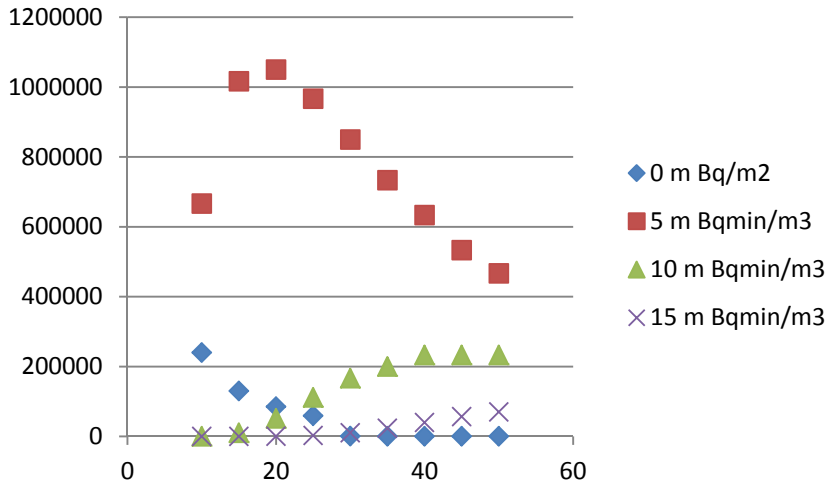
CT=35 m ; Respirable Deposition velociy=0,03 m/s ; Respirable release fr.=97,5%

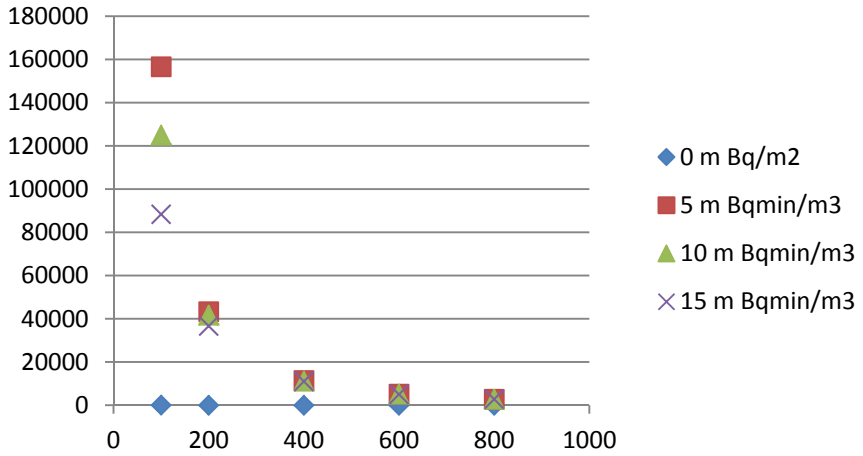
CT=5 m ; Respirable Deposition velocity=0,0008 m/s ; Respirable release fr.=99%

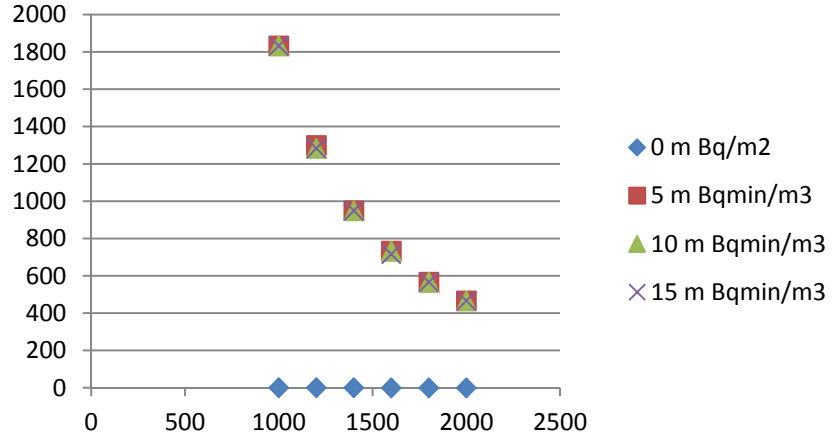
ENDPOINTS TEST 2



ENDPOINTS TEST 2





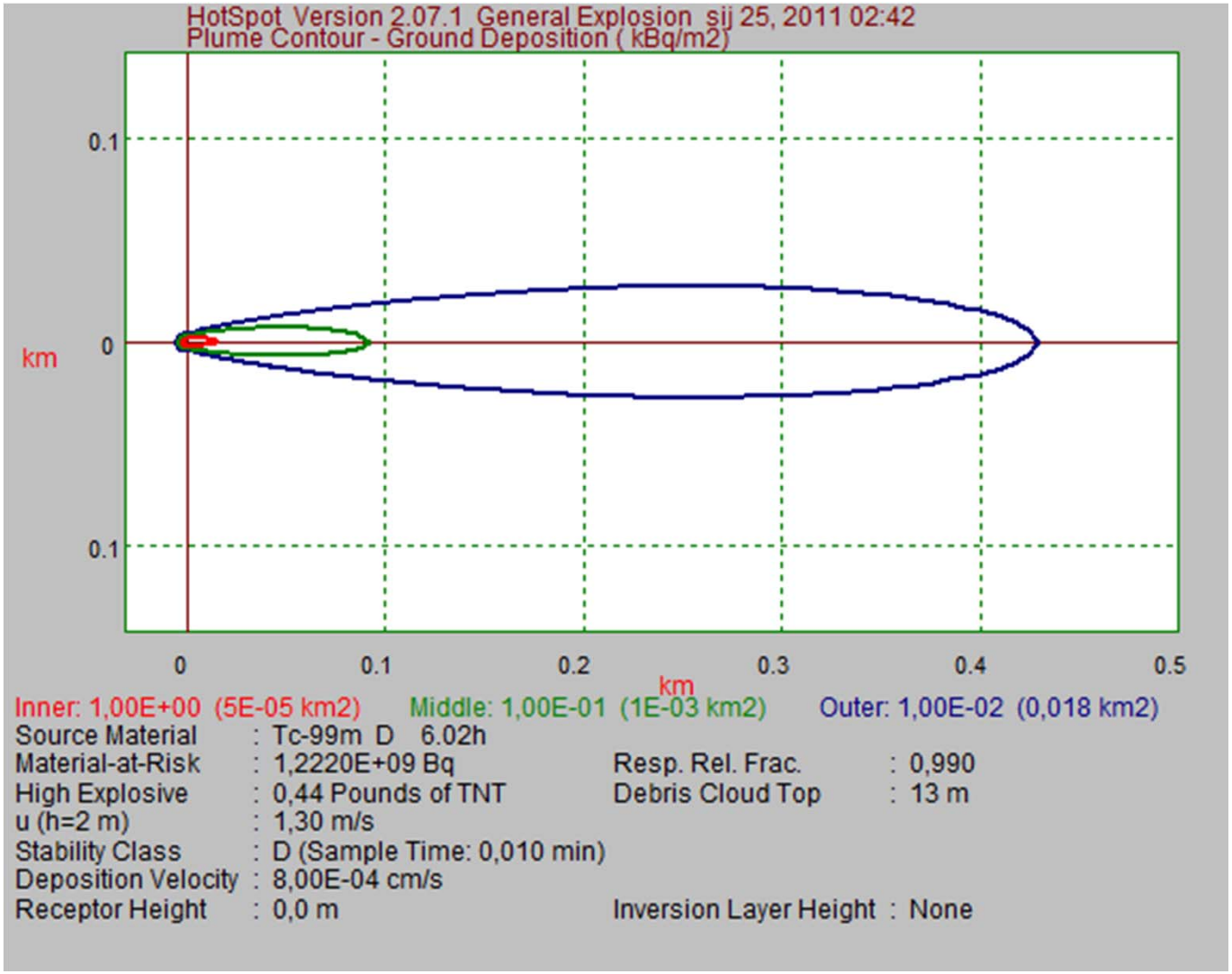


Short range scenario

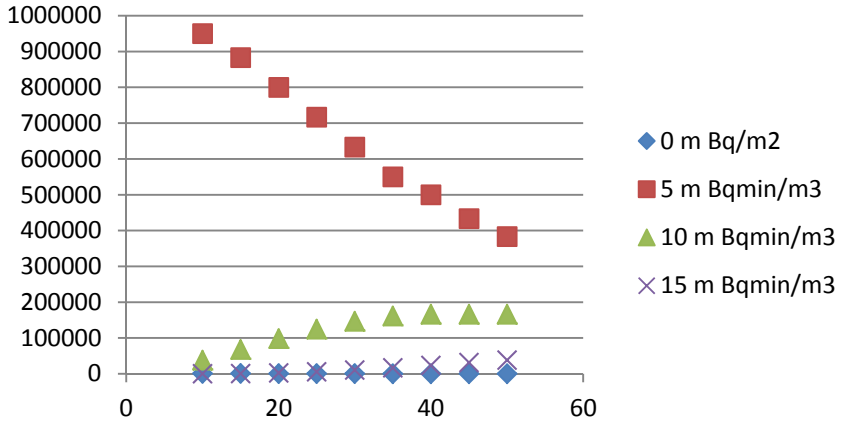
TEST 3

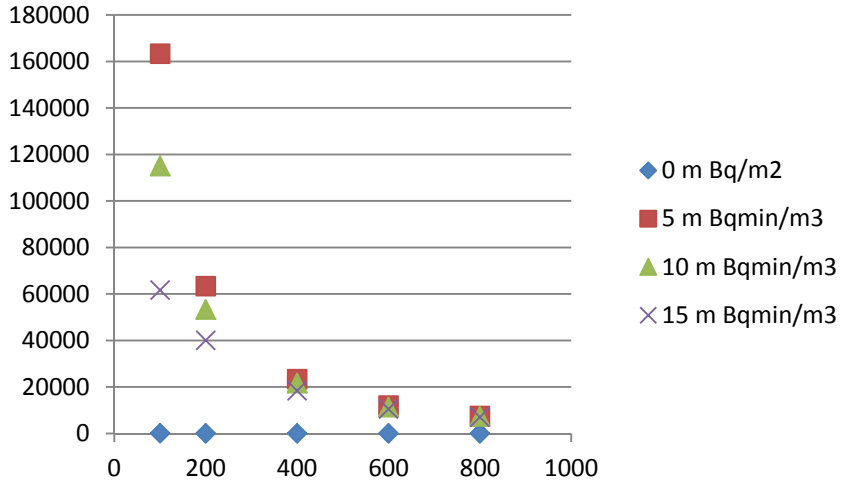
Wind speed: 1,3 m/s
Weather stability class: D
Source term: 1222 MBq
Cloud top: 13 m
Respirable Deposition velocity=0,0008 m/s
Respirable release fr.=99%

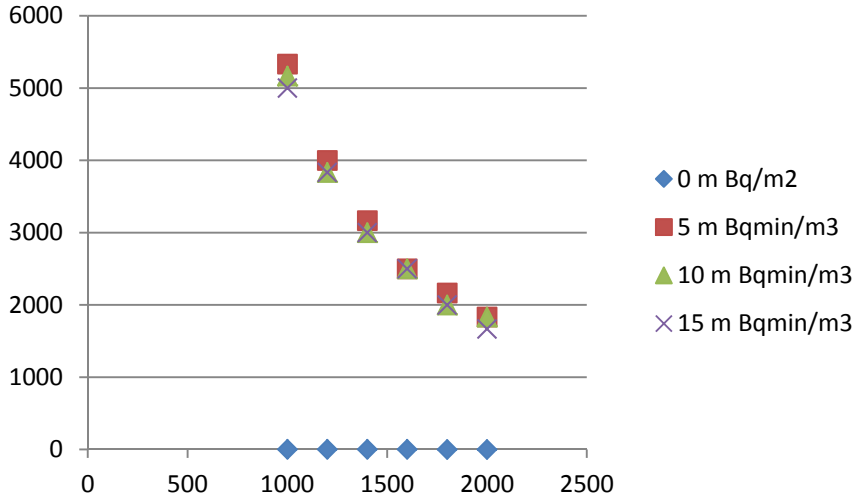
ENDPOINTS TEST 3



ENDPOINTS TEST 3





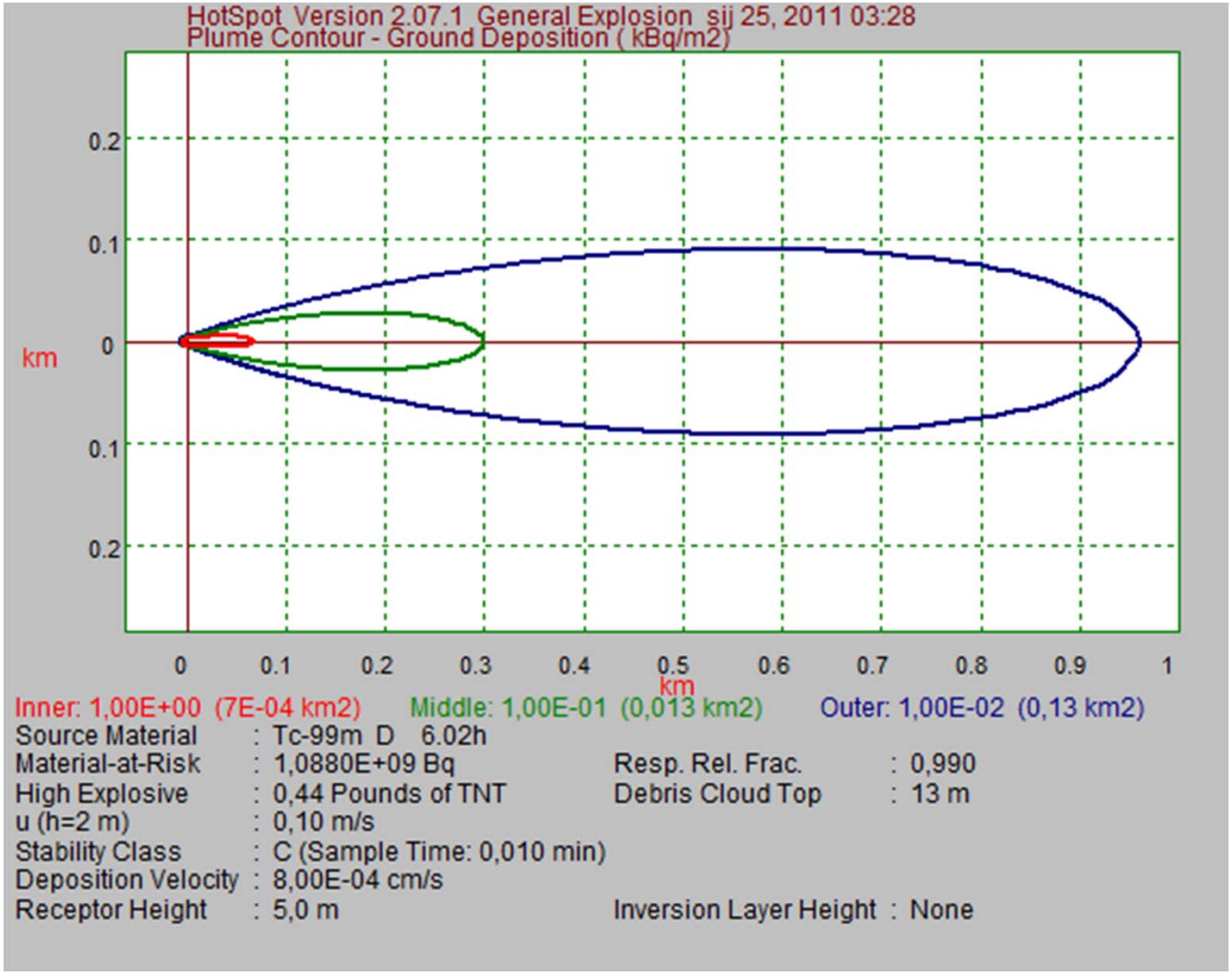


Short range scenario

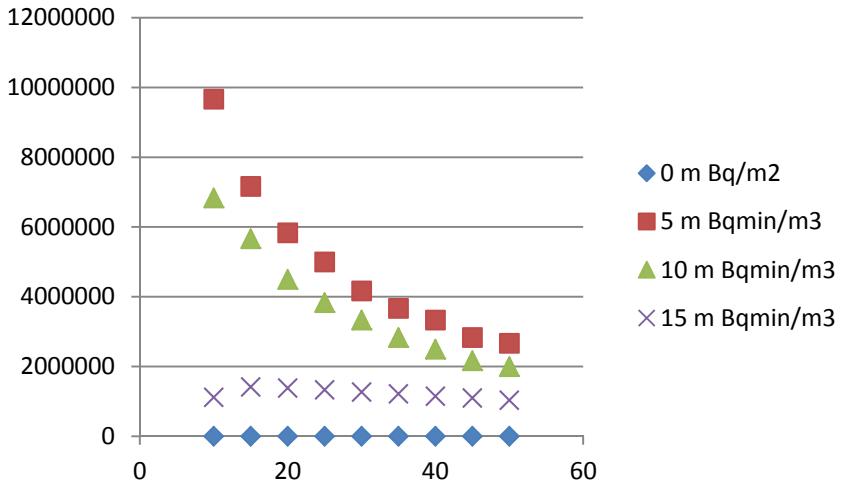
TEST 4

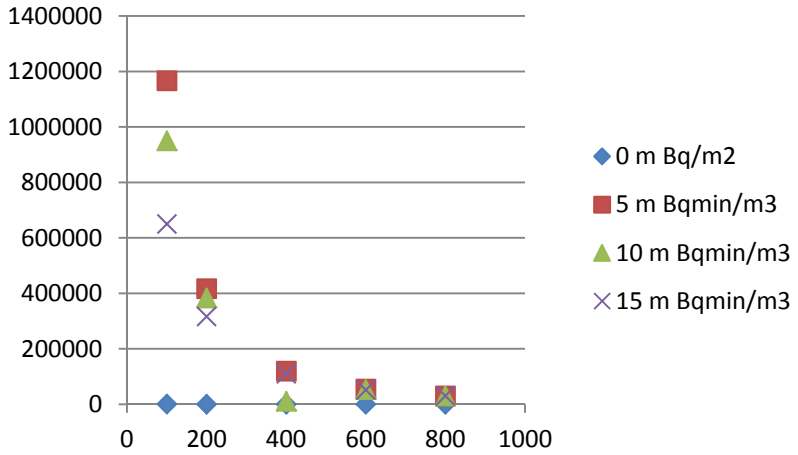
Wind speed: 0,1 m/s
Weather stability class: C
Source term: 1088 MBq
Cloud top: 13 m
Respirable Deposition velocity=0,0008 m/s
Respirable release fr.=99%

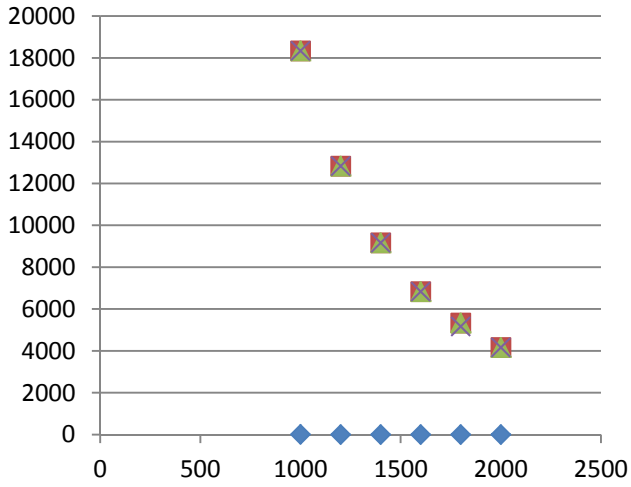
ENDPOINTS TEST 4



ENDPOINTS TEST 4



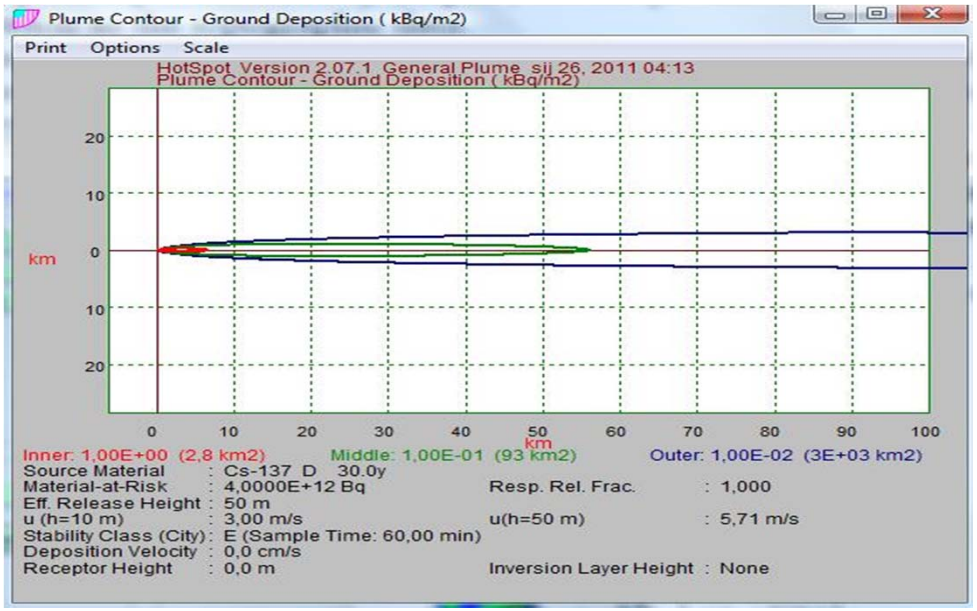


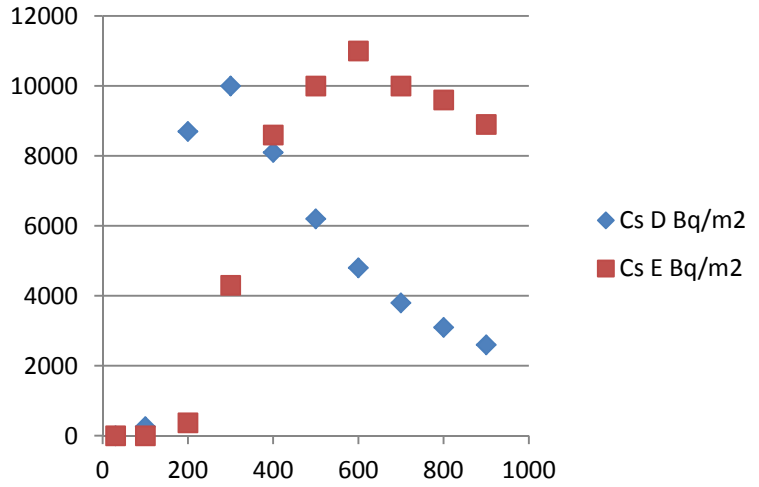


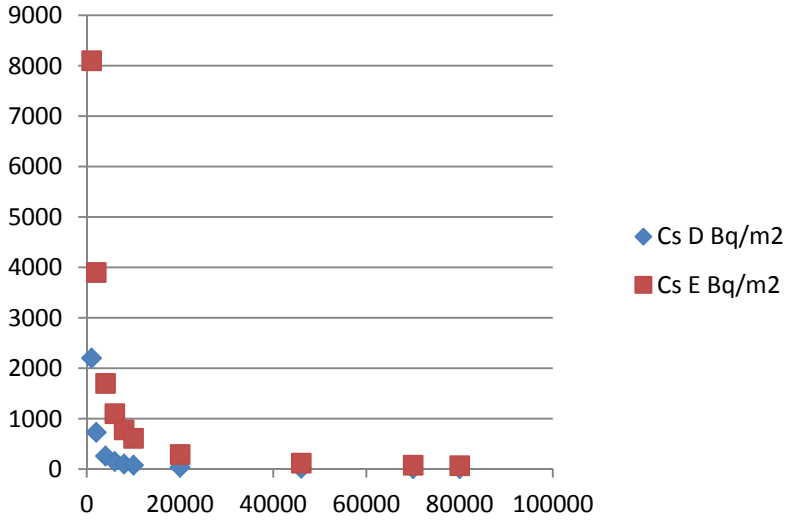
EMRASII
WG 9 “Urban Areas”
Mid range

Dejan Trifunović, Vienna, Austria, 24.-28. January 2011

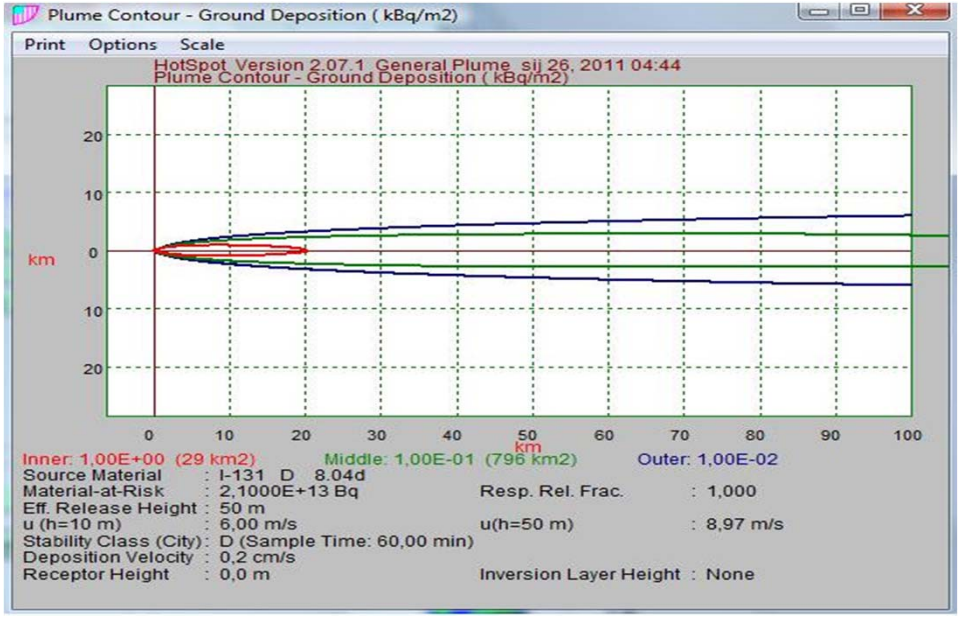
MID-RANGE Cs-137 Ground deposition

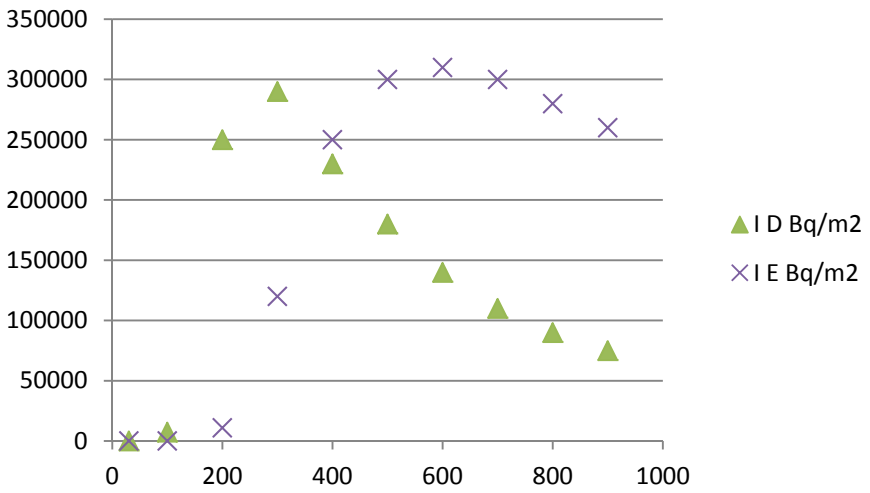


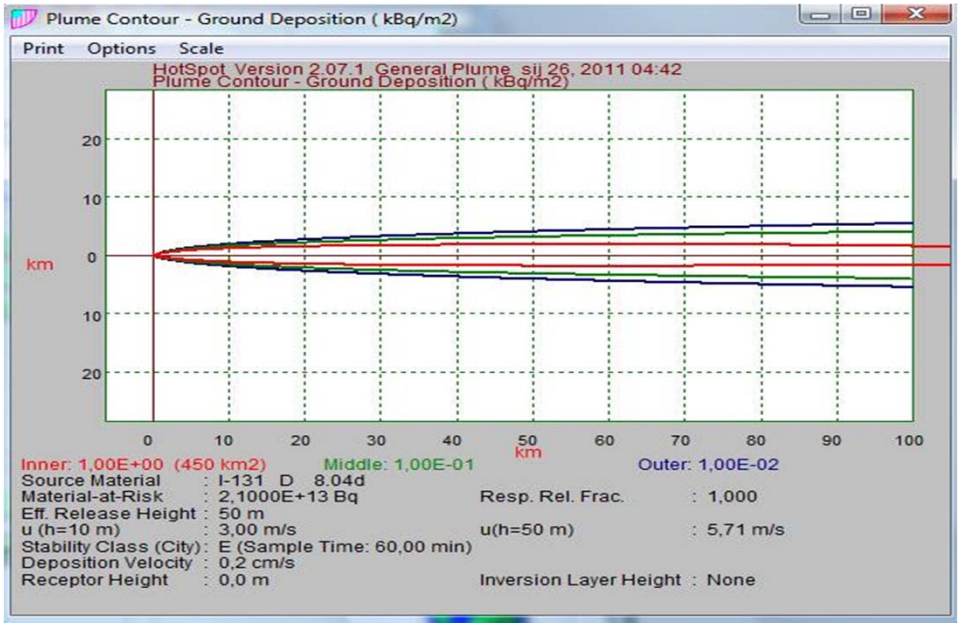


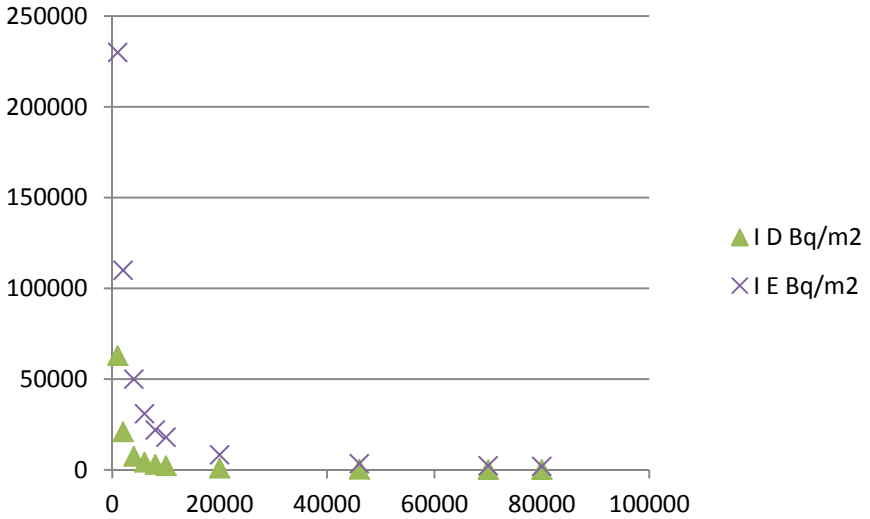


MID-RANGE I-131 Ground deposition









MID-RANGE SUMMARY
Ground deposition

Guadalajara - Ground depoosition in Bq/m2

	D	E
Cs	14	120
I	400	3500

Madrid - Ground deposition in Bq/m2

	D	E
Cs	9,1	79
I	230	2000

STABLE
Atmospheric stability class: E
Wind speed at 10 m height: 3,0 m/s

Effective release height: 50 m
Release time: 1 hour

NEUTRAL
Atmospheric stability class: D
Wind speed at 10 m height: 6,0 m/s

Cs-137 Deposition velocity = 0,04 cm/s, Source term = 4E+12 Bq
I-131 Deposition velocity = 0,22 cm/s, Source term = 21E+12 Bq