

EMRAS II
WG 9 “Urban Areas”
Short range

Dejan Trifunović, Hamilton, Canada, 15.-17. June 2011

Experiment SET-UP



Orientation of the blast:
"PARALEL" TO THE GROUND

Modelling requirement:
Unbounded upwards



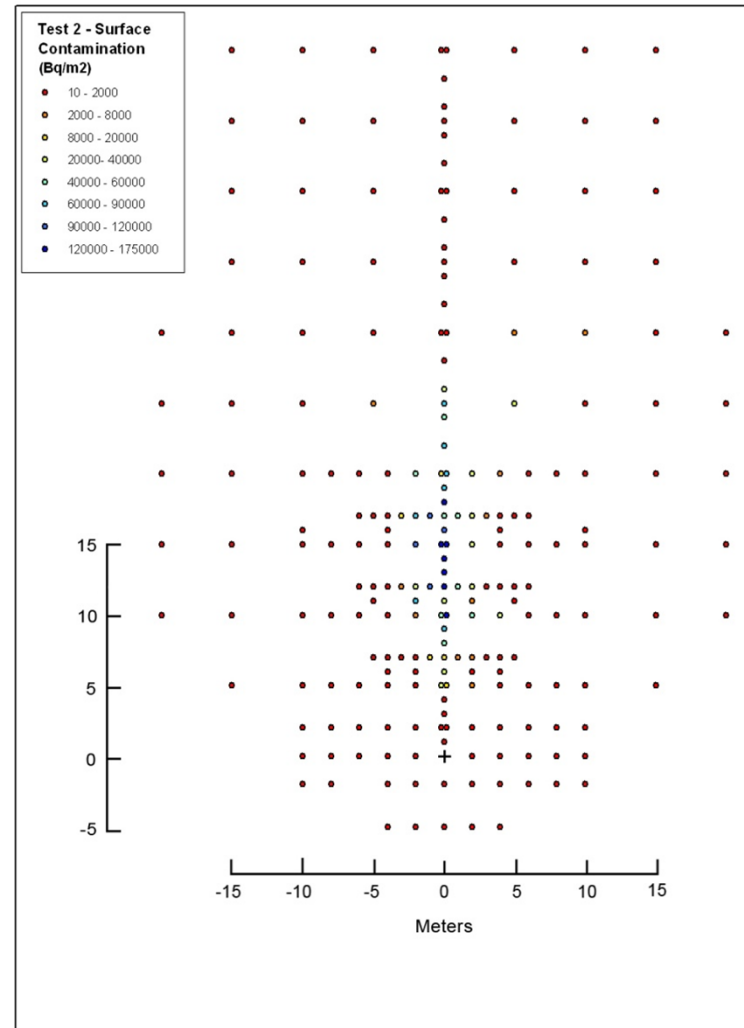
BACK BLAST WAVE – due to explosion set-up

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.



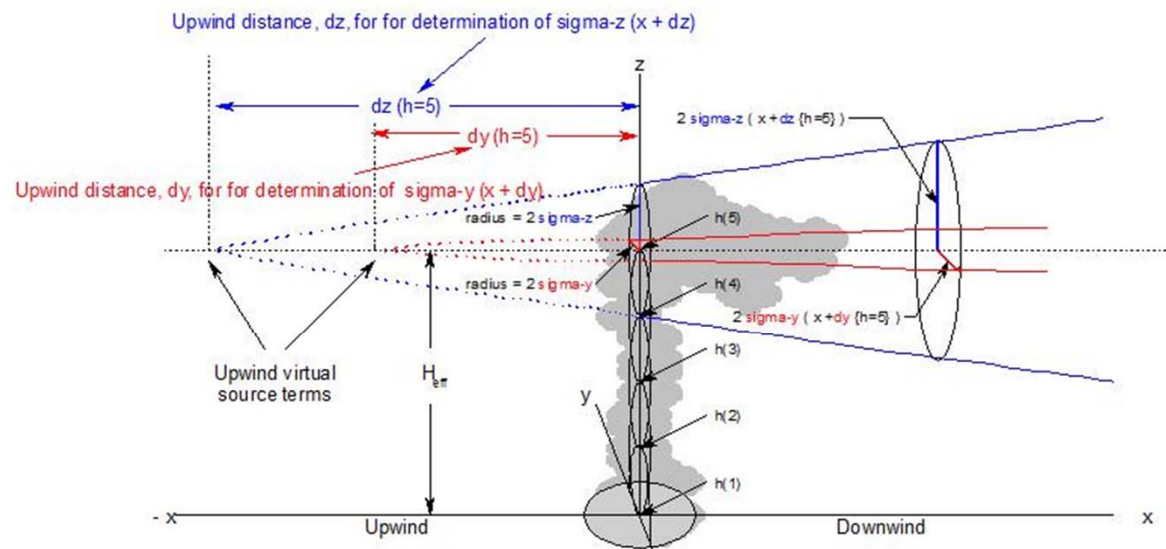
HotSpot model

Explosion geometry

Explosion (Non-nuclear)

Explosion

The release is partitioned as follows:



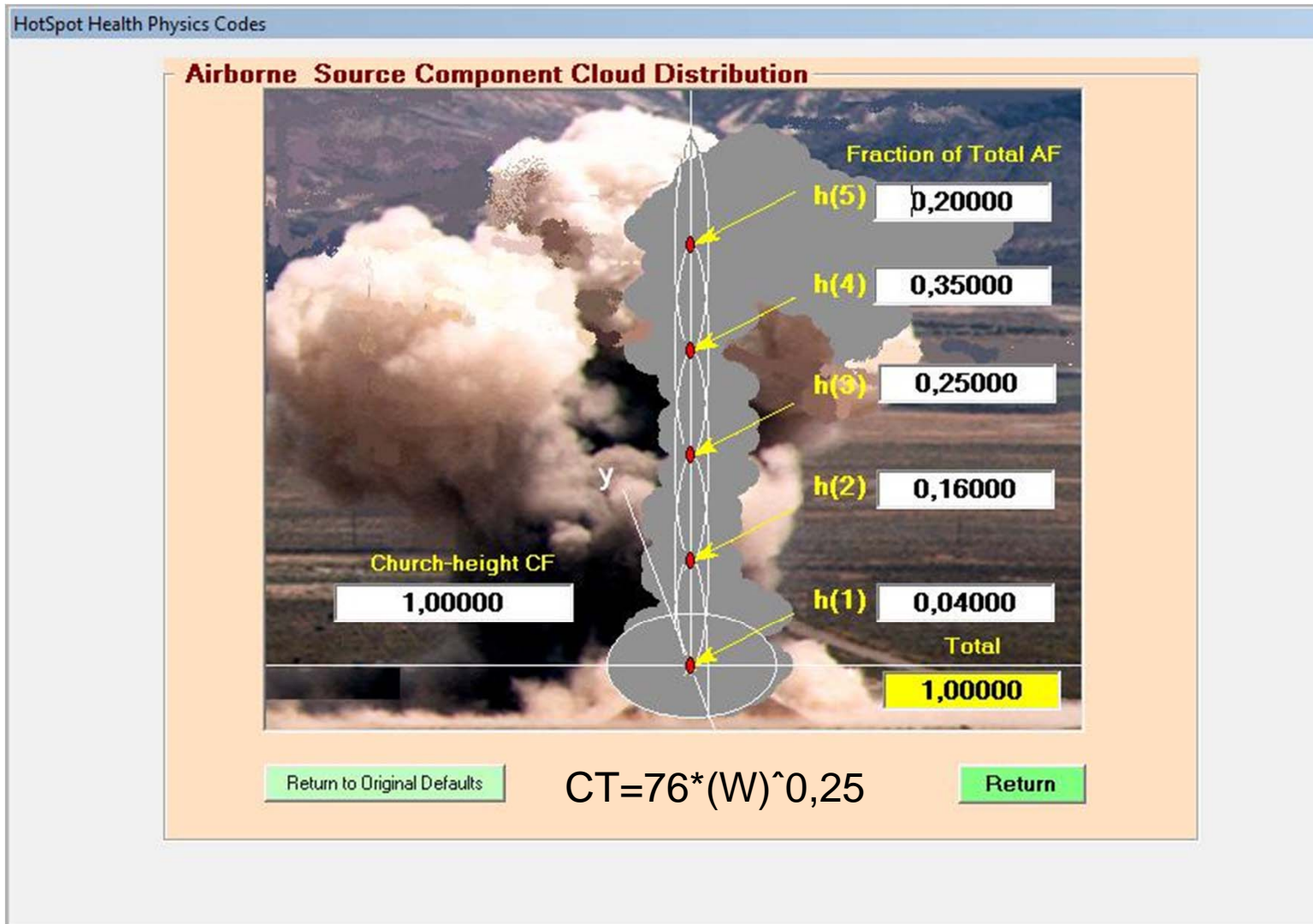
Cloud top = $76 (w)^{0.25}$ (meter)
 Cloud radius = 0.20 cloud top (meter)
 where: w = pounds of high explosive (church, 1969)

$\sigma\text{-}y (x=0) = 0.5$ cloud radius
 $\sigma\text{-}z (x=0) = 0.2$ cloud top

Source distribution

20% @ $h(5) = 0.8$ cloud top
 35% @ $h(4) = 0.6$ cloud top
 25% @ $h(3) = 0.4$ cloud top
 16% @ $h(2) = 0.2$ cloud top
 4% @ $h(1) =$ ground level

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).
- σ_y = [Standard deviation](#) of the integrated concentration distribution in the crosswind direction (m).
- σ_z = 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 Version 2.07 srijeda, lipanj 02, 2010

File Help

Models **Source Term** Meteorology Receptors Setup Output

Model **General Explosion**

Radionuclide
Tc-99m D 6.02h
Change Radionuclide Source Term

Material at Risk
1,0580E+09 Bq

Damage Ratio
1,000

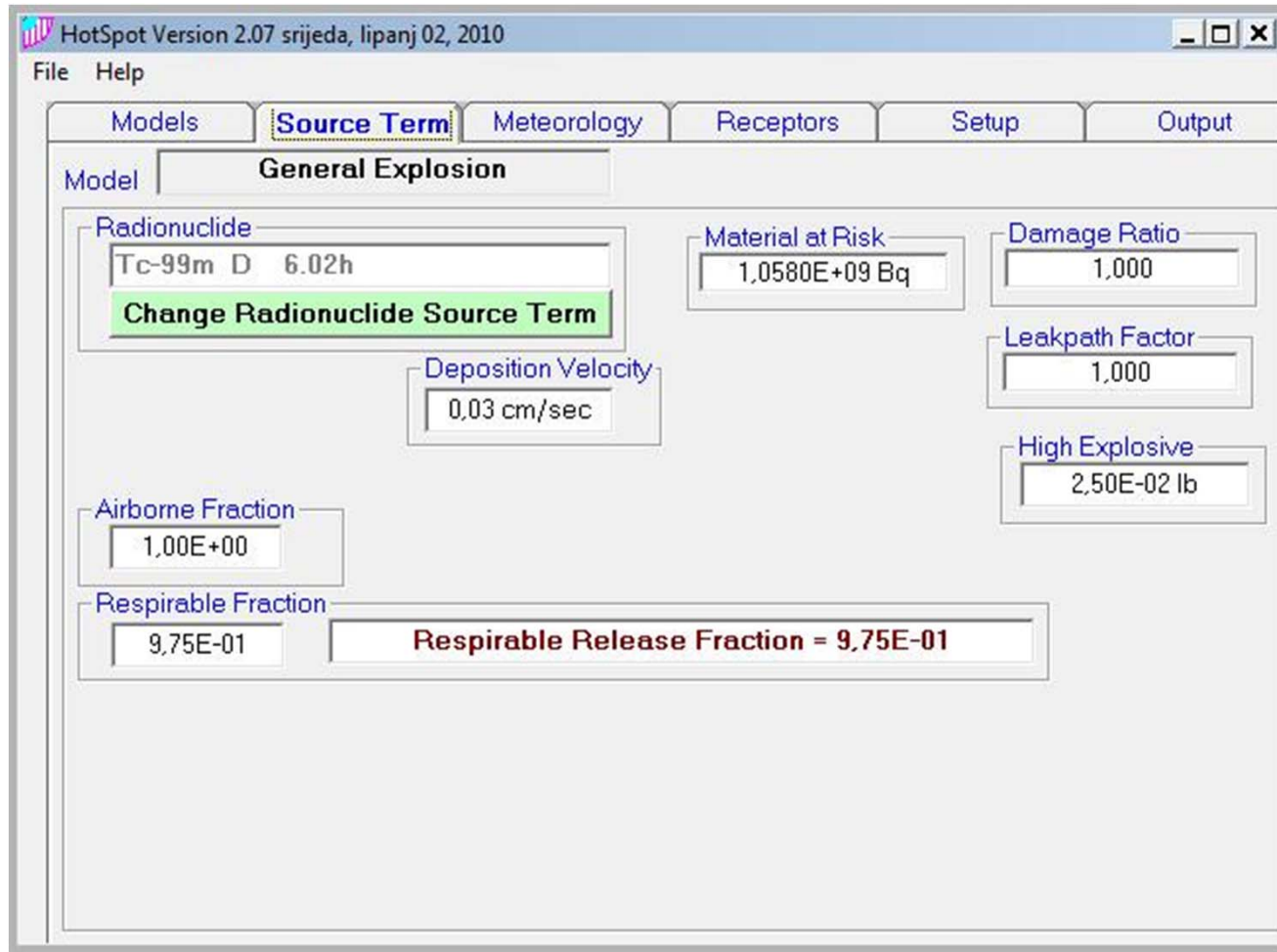
Leakpath Factor
1,000

High Explosive
2,50E-02 lb

Deposition Velocity
0,03 cm/sec

Airborne Fraction
1,00E+00

Respirable Fraction
9,75E-01
Respirable Release Fraction = 9,75E-01

The image shows a software window titled "HotSpot Version 2.07 srijeda, lipanj 02, 2010". The window has a menu bar with "File" and "Help". Below the menu bar are several tabs: "Models", "Source Term" (which is selected and highlighted in yellow), "Meteorology", "Receptors", "Setup", and "Output". Under the "Source Term" tab, there is a sub-tab labeled "Model" and a button labeled "General Explosion". The main area of the window contains several input fields and buttons. On the left, there is a "Radionuclide" field containing "Tc-99m D 6.02h" and a green button labeled "Change Radionuclide Source Term". To the right of this is a "Material at Risk" field containing "1,0580E+09 Bq". Further right are "Damage Ratio" and "Leakpath Factor" fields, both containing "1,000". Below these are "High Explosive" (containing "2,50E-02 lb") and "Deposition Velocity" (containing "0,03 cm/sec"). At the bottom left, there is an "Airborne Fraction" field containing "1,00E+00" and a "Respirable Fraction" field containing "9,75E-01". A large box at the bottom right displays "Respirable Release Fraction = 9,75E-01" in red text.

HotSpot model INPUT

HotSpot Version 2.07 srijeda, lipanj 02, 2010

File Help

Models Source Term **Meteorology** Receptors Setup Output

10-meter Wind Speed: Selected Stability Class:

Display Wind Chart

Wind Direction: Wind from the West

Atmospheric Stability

Enter Solar Information - or- Enter the Actual Stability

<input type="radio"/> Sun High in the sky	<input type="radio"/> A - Very unstable
<input type="radio"/> Sun Low in the sky or cloudy	<input type="radio"/> B - Moderately unstable
<input type="radio"/> Night	<input type="radio"/> C - Slightly unstable
	<input checked="" type="radio"/> D - Neutral
	<input type="radio"/> E - Slightly stable
	<input type="radio"/> F - Moderately stable
	<input type="radio"/> G - Special nighttime (low wind)

HotSpot model INPUT

HotSpot Version 2.07 srijeda, lipanj 02, 2010

File Help

Models Source Term Meteorology Receptors **Setup** Output

Terrain
 Standard : Conservative Option
 City : Large Metropolitan Area

Radiological Units
 Classic (rem, rad, Ci)
 SI (Sievert, Gray, Bq)

Distance Units
 Metric
 English

Wind Ref Height **Sample Time**

Source Geometry
 Simple
 Complex

Explosion Model AF Distribution
Default HotSpot Vertical AF
 Change/View AF Distribution

Mixing Layer
 Enable Inversion

DCF Library
 FGR 11 FGR 13 Acute (1-day)

Ground Shine & Resuspension
 Include Ground Shine (Weathering Correction Factor : None)
 Include Resuspension (Resuspension Factor : NCRP Report No, 129)

Exposure Time: (Start: 0,00 days; Duration: 4,00 days)

Contour Values

	TEDE (Sv)	Deposition (kBq/m2)
Inner	<input type="text" value="1,00E-05"/>	<input type="text" value="3700,00"/>
Middle	<input type="text" value="5,00E-07"/>	<input type="text" value="370,00"/>
Outer	<input type="text" value="1,00E-08"/>	<input type="text" value="37,00"/>

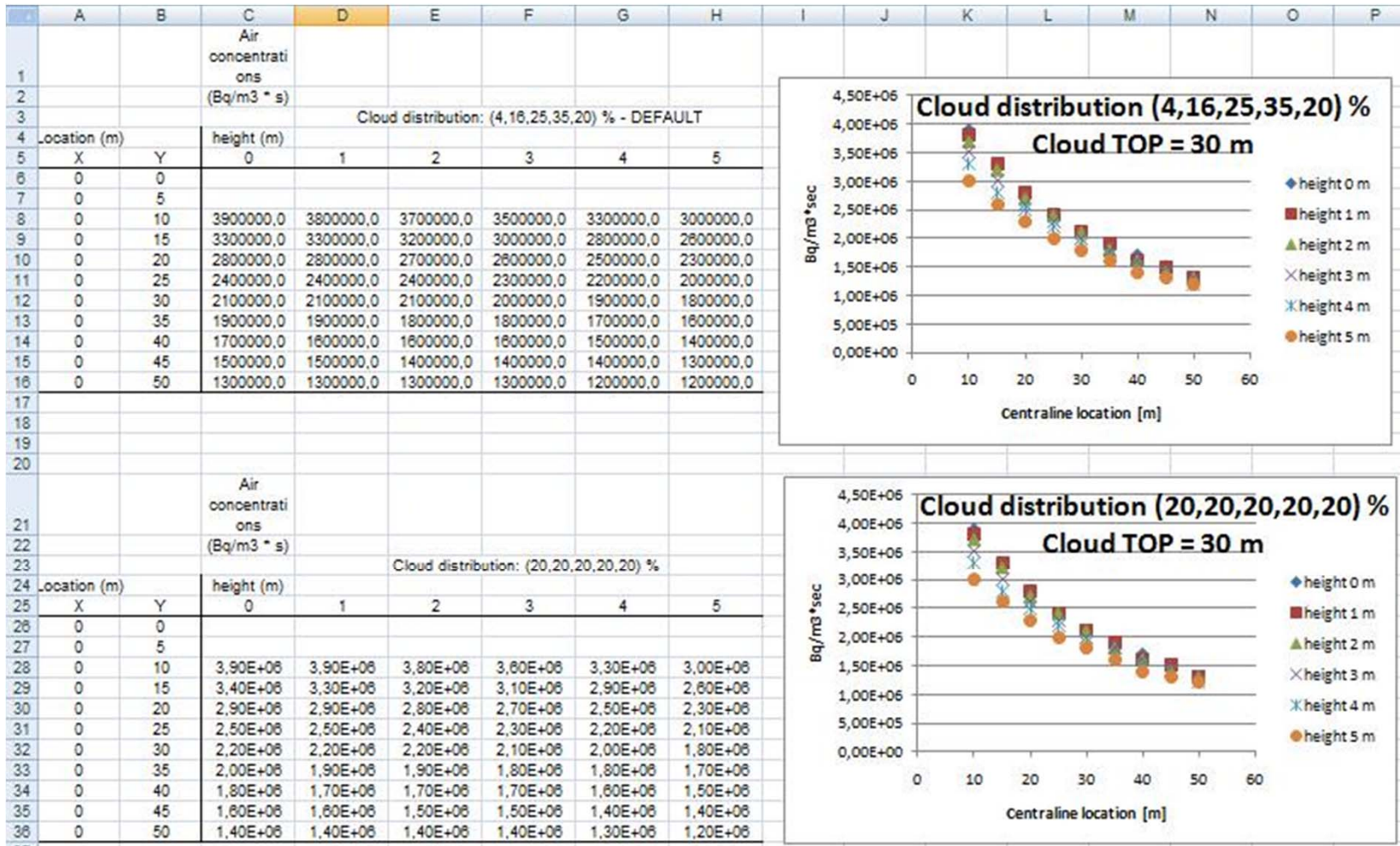
Non-respirable Deposition Velocity

Wet Deposition
 Enable Rainout

Holdup Time

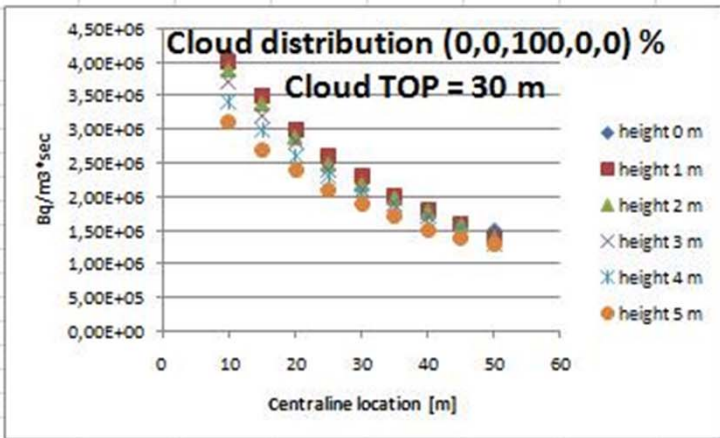
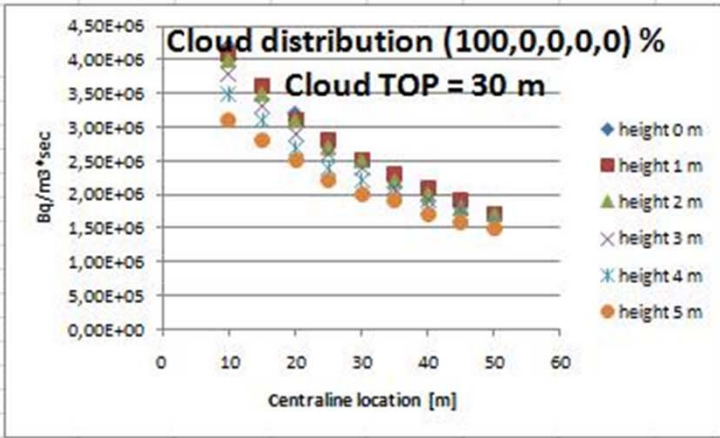
Breathing Rate

Plume Centralline Vertical Profile



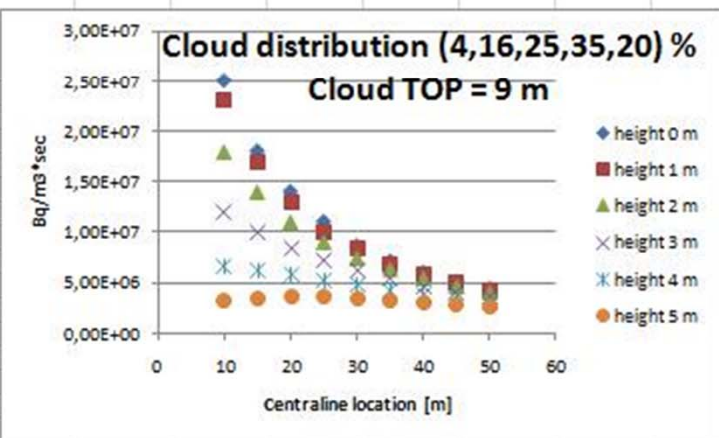
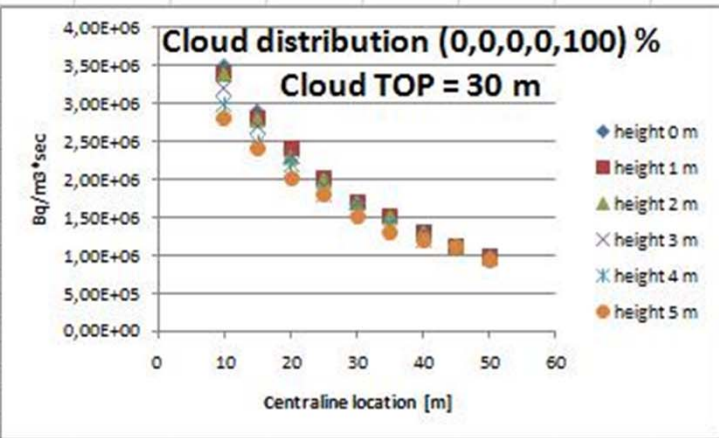
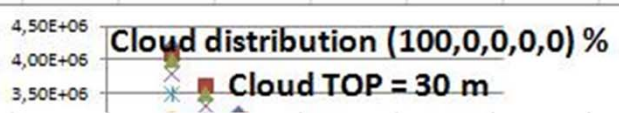
Plume Centraline Vertical Profile

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1			Air concentrations													
2																
3				Air concentrations												
4	Loca			Air concentrations												
5				(Bq/m ³ * s)												
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																
21																
22																
23																
24	Loca															
25																
26																
27																
28																
29																
30																
31																
32																
33																
34																
35																
36																
37																
38																
39																
40																
41																
42																
43																
44																
45																
46																
47																
48																
49																
50																
51																
52																
53																
54																
55																
56																
57																
58																
59																
60																
61																
62																
63																
64																
65																
66																
67																
68																
69																
70																
71																



Plume Centraline Vertical Profile

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1			Air concentrations													
2																
3			Air concentrations													
4	Loca															
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																
21																
22																
23																
24	Loca															
25																
26																
27																
28																
29																
30																
31																
32																
33																
34																
35																
36																
37																
38																
39																
40																
41																
42																
43																
44																
45																
46																
47																
48																
49																
50																
51																
52																
53																
54																
55																
56																
57																
58																
59																
60																
61																
62																
63																
64																
65																
66																
67																
68																
69																
70																
71																
72																
73																
74																
75																
76																
77																
78																
79																
80																
81																
82																
83																
84																
85																
86																
87																
88																



Short range scenario

TEST 2

Wind speed: 0,6 m/s

Weather stability class: B

Source term: 1058 MBq

Cloud top: 5 m

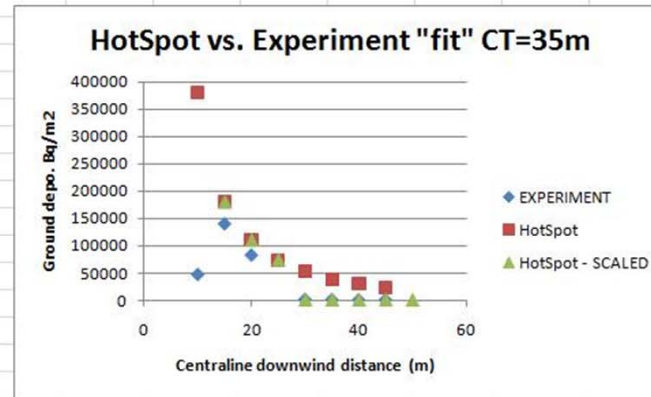
Respirable Deposition velocity=0,0008 m/s

Respirable release fr.=99%

HotSpot "Calibration"

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

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

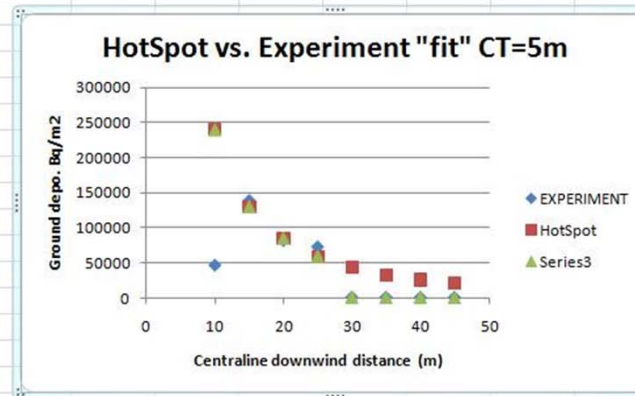
HotSpot "Calibration"

REMARK

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

	1. Bq/m2	%		2. 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	59000
30	44000	765,22		700
35	33000	710,835		540
1. Samp	40	26000	308,0733	420
	45	21000	319,7033	340
2. Samp	50			

HotSpot vs. Experiment "fit" CT=35m



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"

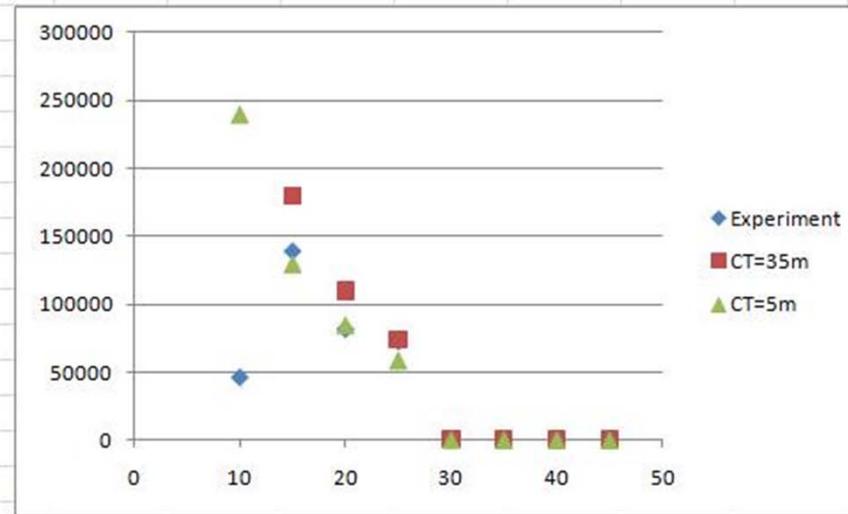
REMARK:

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

Centraline	Experiment	CT=35m	CT=5m
10	46689		240000
15	139414	180000	130000
20	82108	110000	85000
25	72987	74000	59000
1. Sé	30	765	700
2. Sé	35	710	560
	40	308	500
	45	319	440

HotSpot vs. Experiment "fit" CT=35m

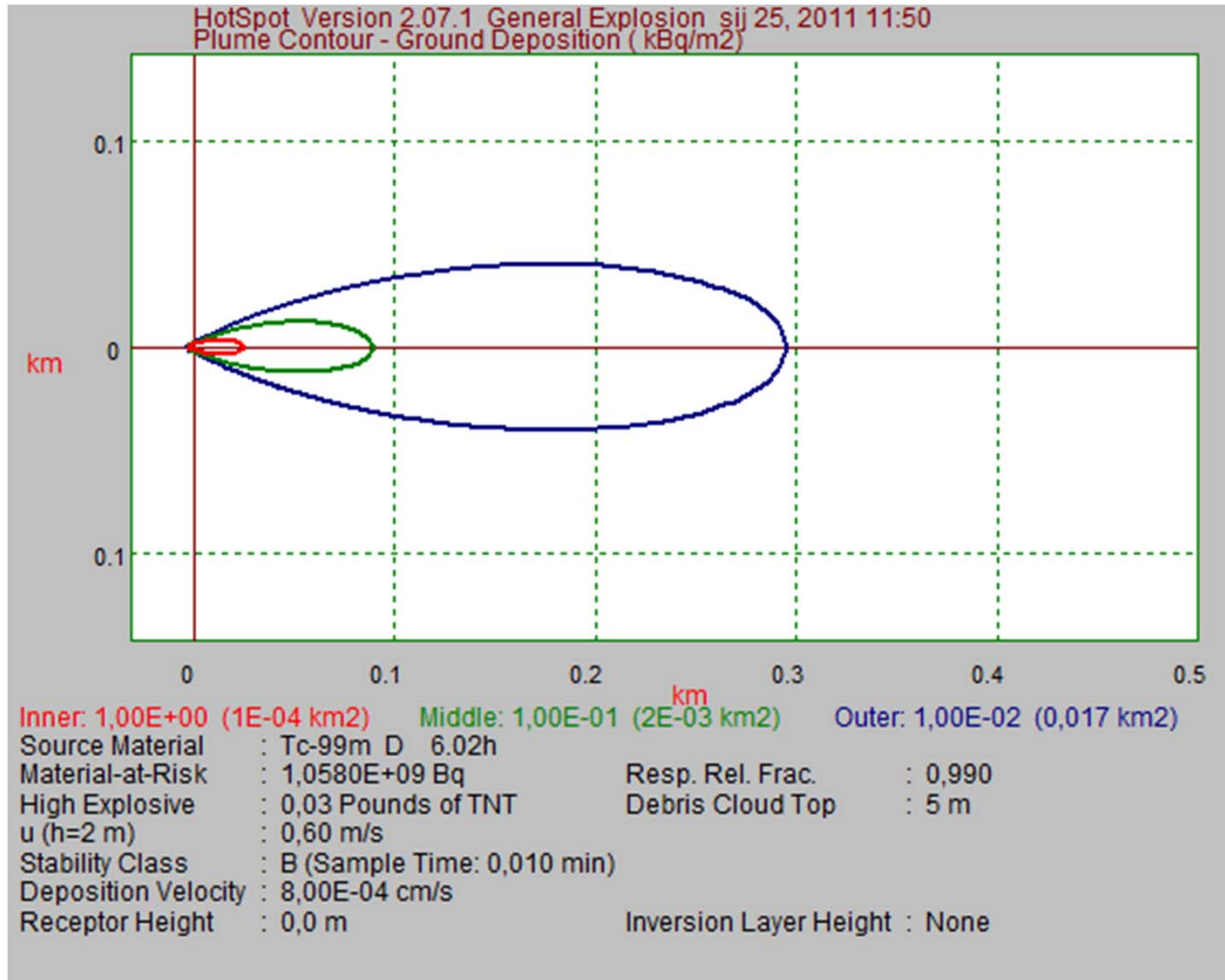
HotSpot vs. Experiment "fit" CT=5m



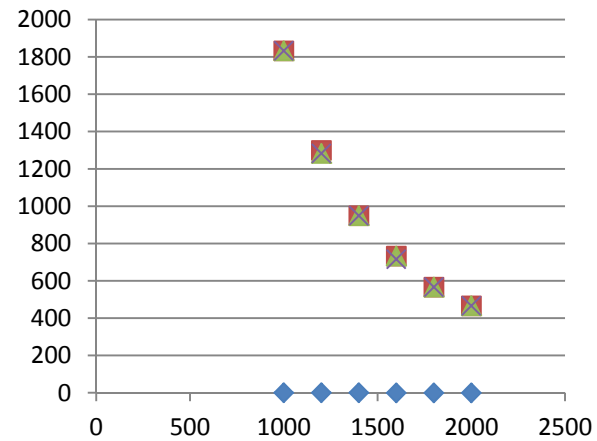
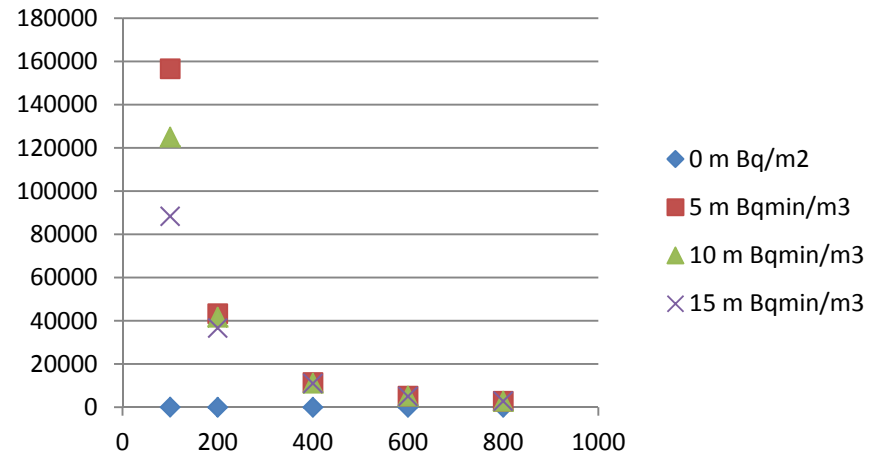
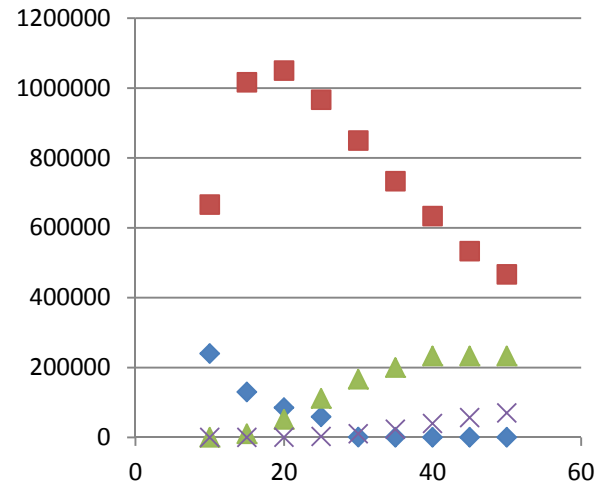
CT=35 m ; Respirable Deposition velocity=0,03 m/s ; Respirable release fr.=97,5%

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

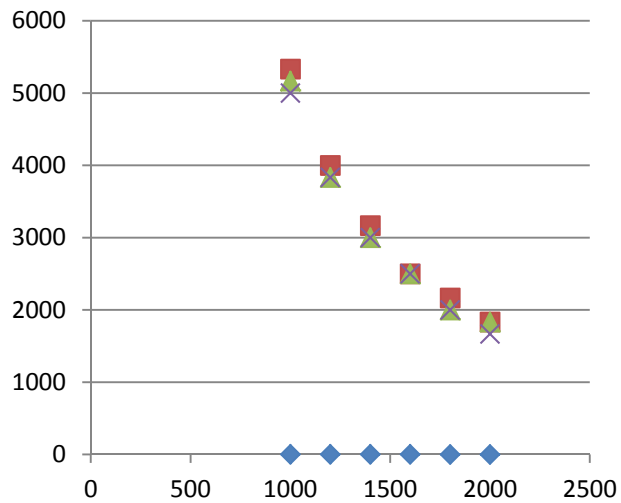
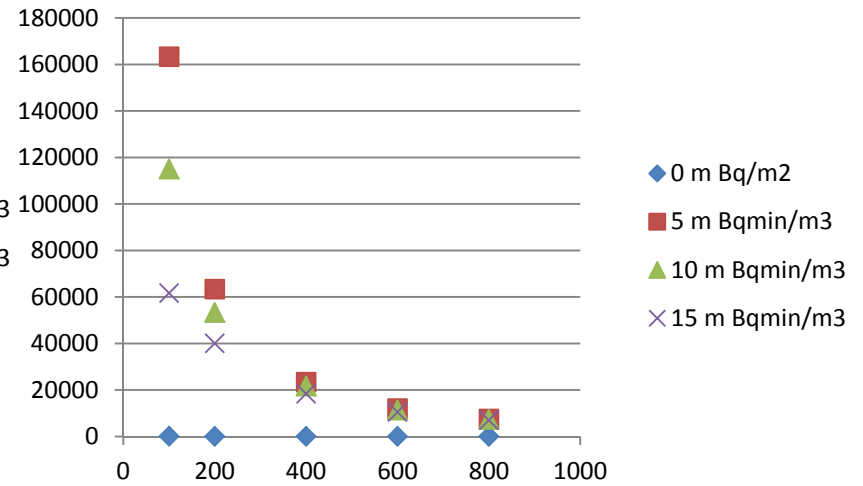
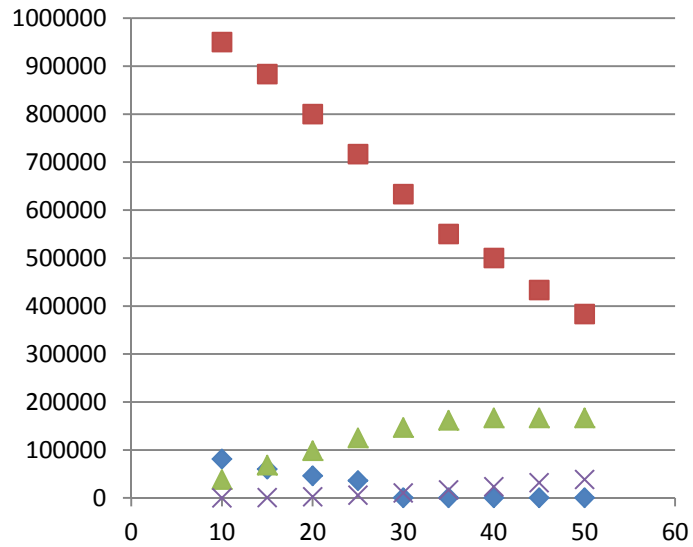
Source term: 1222 MBq

Cloud top: 13 m

Respirable Deposition velocity=0,0008 m/s

Respirable release fr.=99%

ENDPOINTS TEST 3



Short range scenario

TEST 4

Wind speed: 0,1 m/s

Weather stability class: C

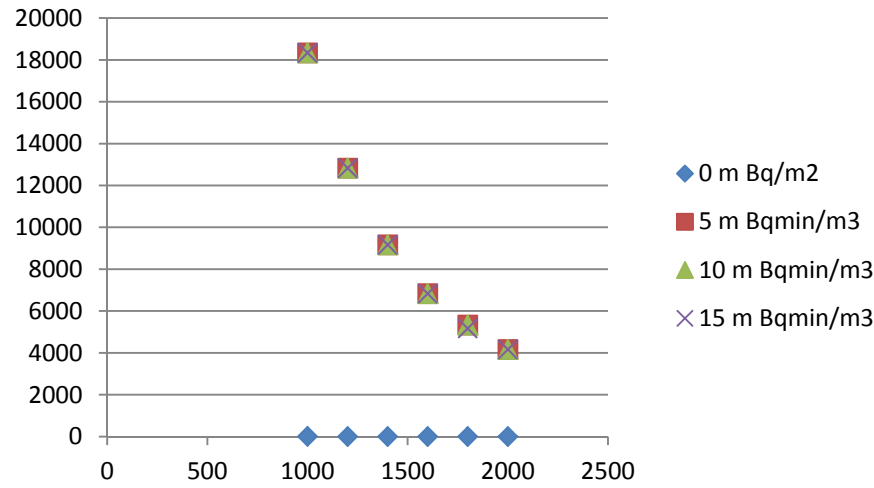
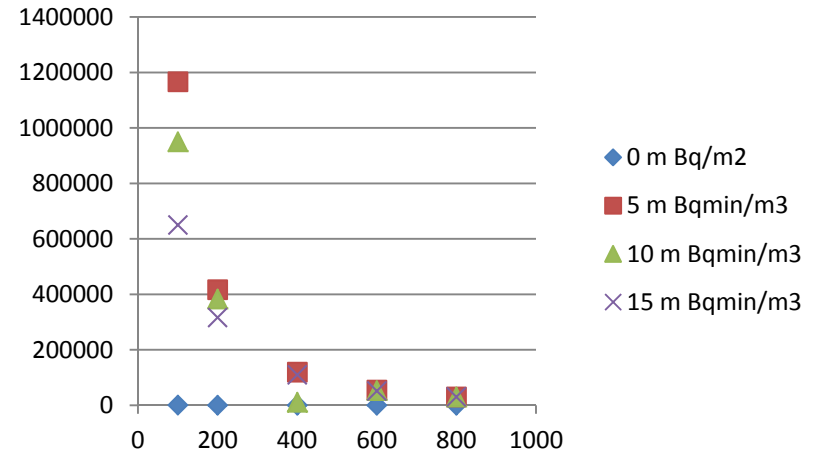
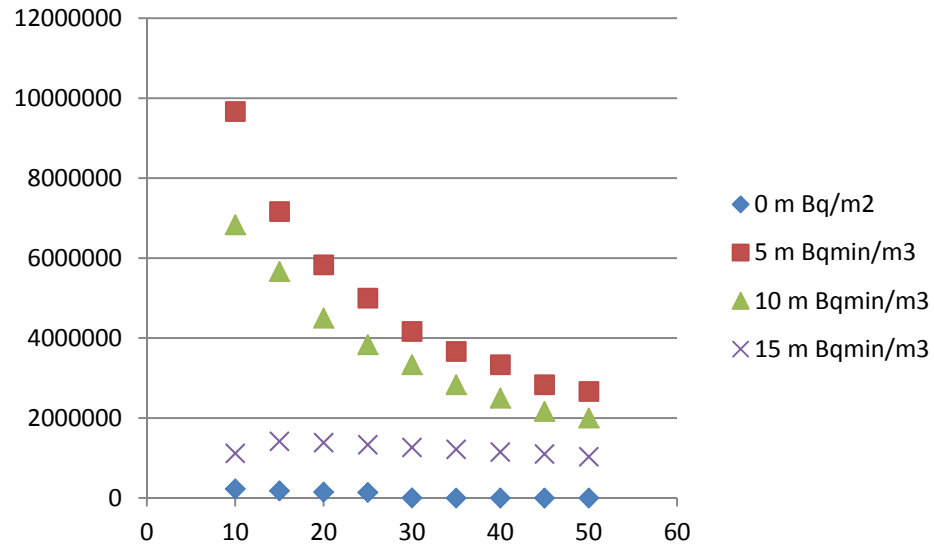
Source term: 1088 MBq

Cloud top: 13 m

Respirable Deposition velocity=0,0008 m/s

Respirable release fr.=99%

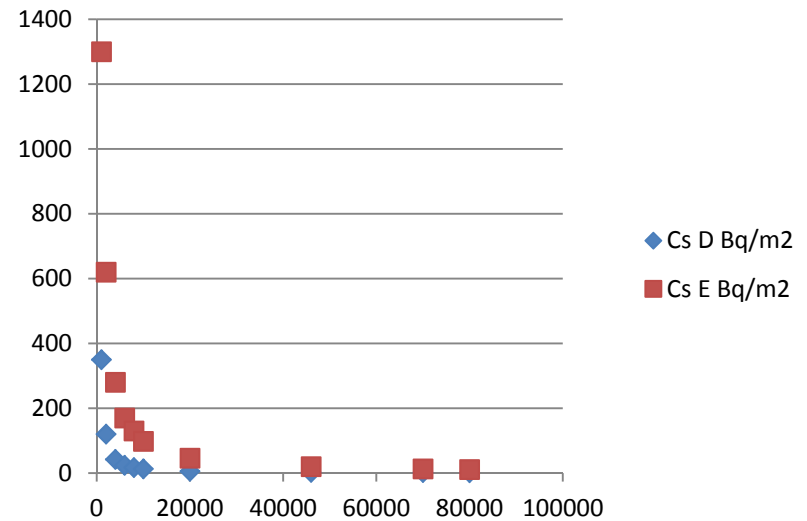
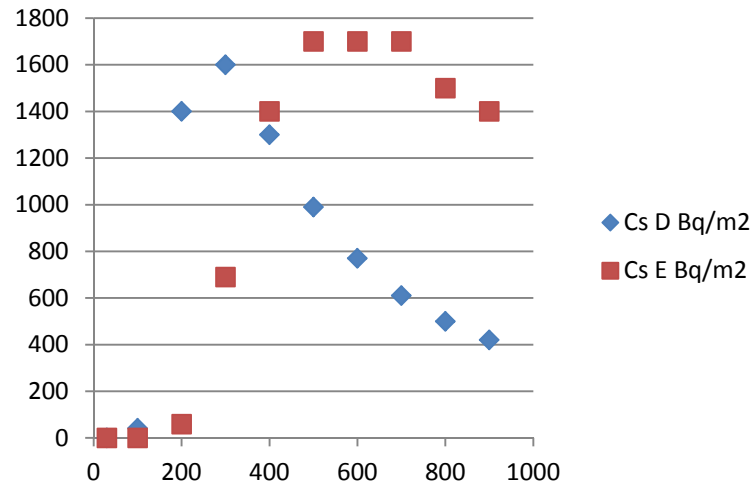
ENDPOINTS TEST 4



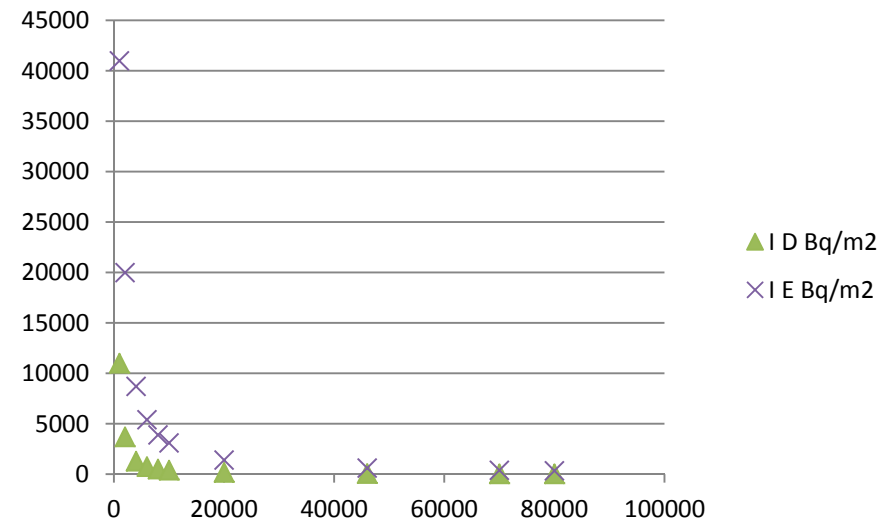
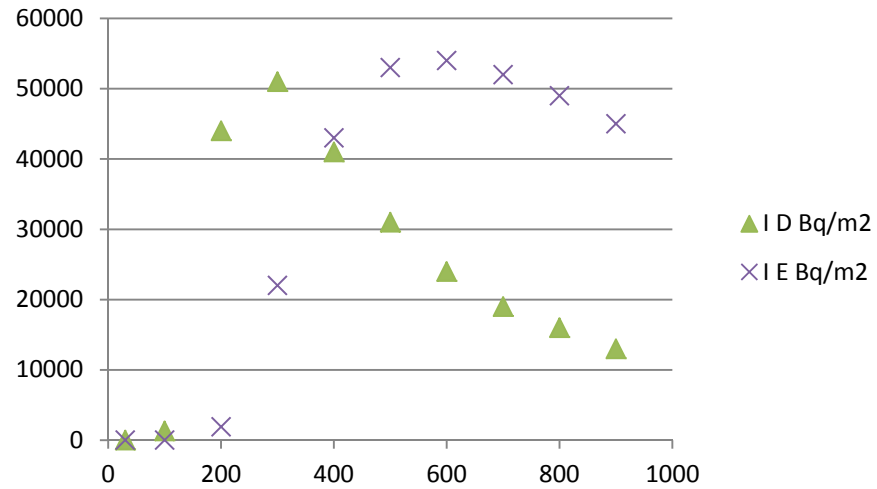
EMRASII
WG 9 “Urban Areas”
Mid range

Dejan Trifunović, Hamilton, Canada, 15.-17. June 2011

MID-RANGE Cs-137 Ground deposition



MID-RANGE I-131 Ground deposition



MID-RANGE SUMMARY

Guadalajara - Ground deposition in Bq/m ²			Madrid - Ground deposition in Bq/m ²			Air concentrations homogenous up to 50 m height in Bq*min/m ³					
	D	E		D	E						
Cs	2,3	20	Cs	1,4	13	Guadalajara			Madrid		
I	71	610	I	45	390		D	E		D	E
						Cs	95	817	Cs	60	517
						I	533	4500	I	333	3000
STABLE			NEUTRAL								
Atmospheric stability class: E			Atmospheric stability class: D								
Wind speed at 10 m height: 3,0 m/s			Wind speed at 10 m height: 6,0 m/s								
Effective release height: 50 m			Cs-137 Deposition velocity = 0,04 cm/s, Source term = 6,4E+11 Bq								
Release time: 1 hour			I-131 Deposition velocity = 0,22 cm/s, Source term = 3,67E+12 Bq								