Accident Scenarios of the TRIGA Mark II Reactor in Vienna

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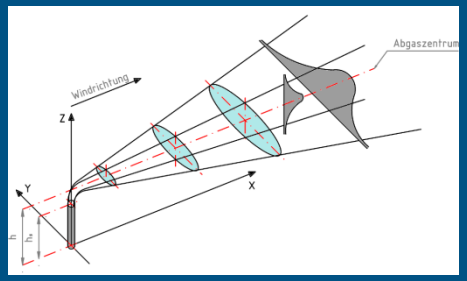


PC-COSYMA
→ Introduction

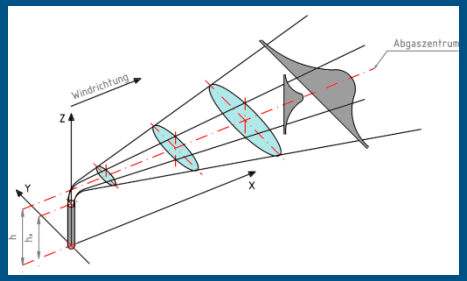
- The program system PC-Cosyma was used to assess the off-site consequences of an accidental release of radioactive material into the atmosphere.

- National Radiological Protection Board (UK)
- Forschungszentrum Karlsruhe (Germany)

- Personal Computer

- **deterministic Calculations**
- probabilistic Calculations

- Version 2.01 1995



PC-COSYMA
→ Endpoints

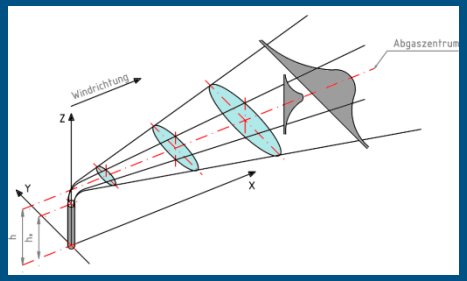
- concentration of all nuclides in the air
- deposition of all nuclides

- **individually doses**
- individually risks (health effects)

- collective doses
- collective risks (health effects)

- economical costs

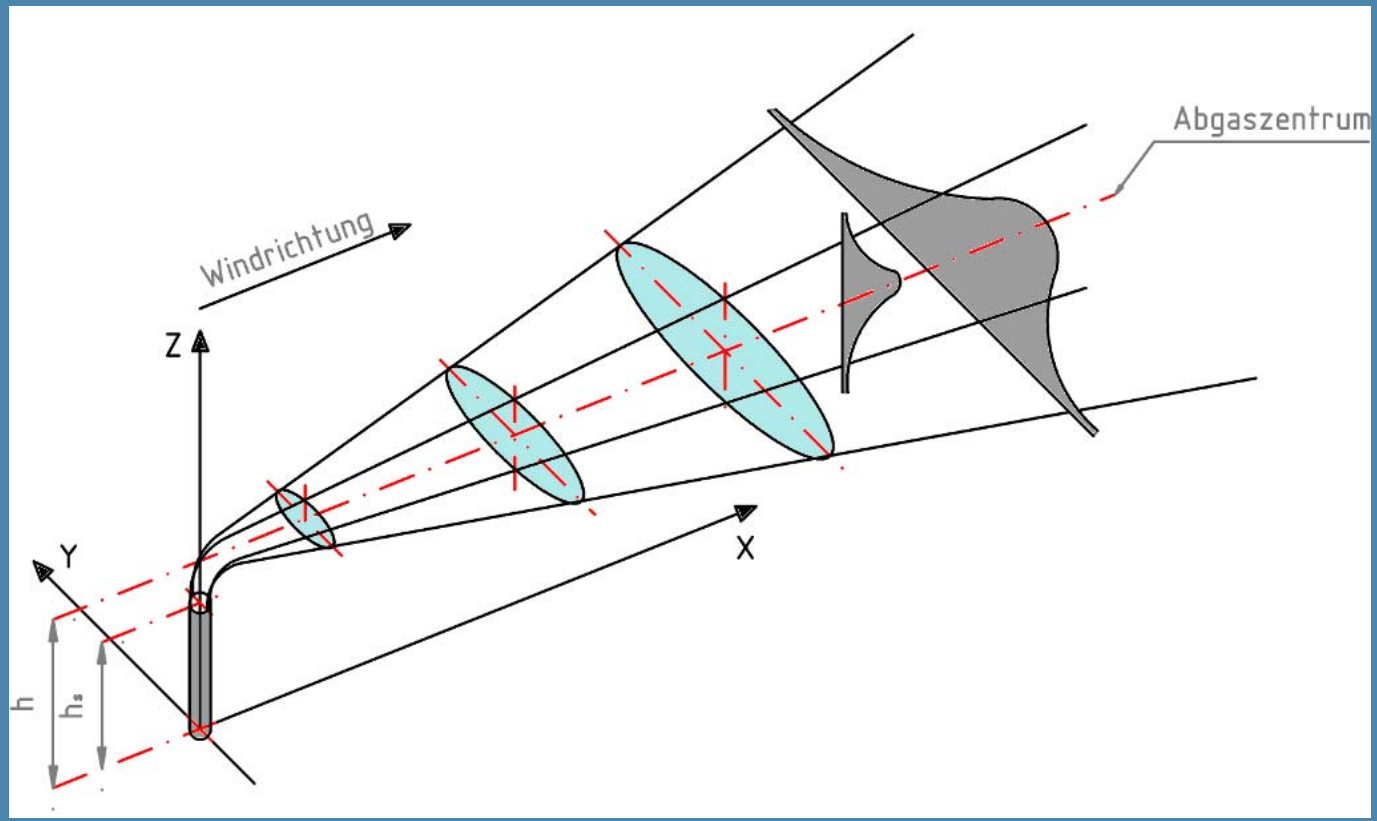
- **Pathways**
    - cloud radiation
    - ground radiation
    - inhalation
    - re suspension
    - deposition on skin and clothes

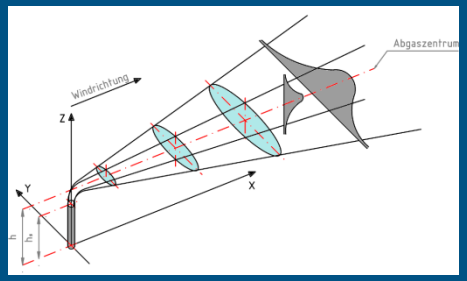


PC-COSYMA
→ Model

- Gaussian Plume Dispersion Model

- Broadening in the wind direction





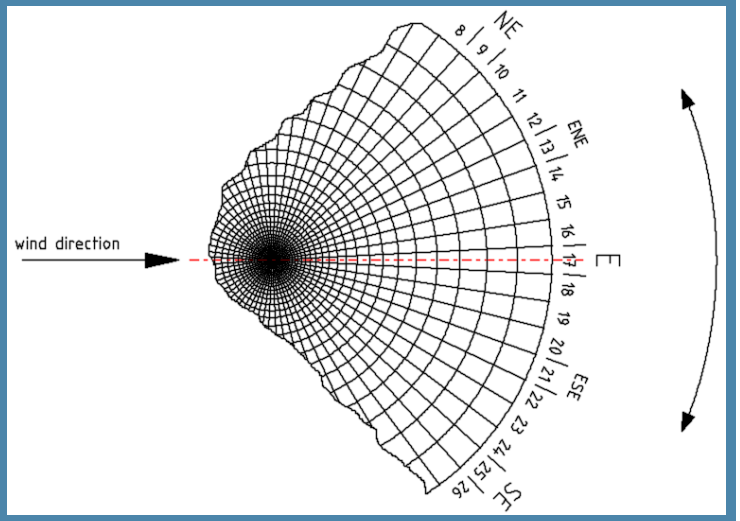
PC-COSYMA
→ Main Parameters

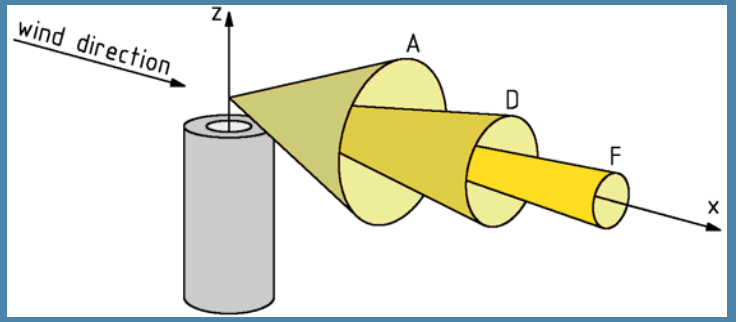
-**Deterministic calculations**
- Only one weather condition
- Stabile in time
- only one wind direction

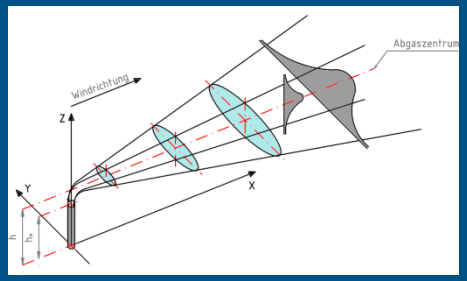
- Atmospheric conditions
- 1m/s wind speed
- WNW
- 0mm/s rain rate
- Pasquill Stability class E

- Source code
- Release time 1h
- Release height 20m or 1m
- Iodine + Krypton + Xenon

- Shielding factors
- worst case







Scenario 1

→ Destruction of the fuel element with the highest activity content

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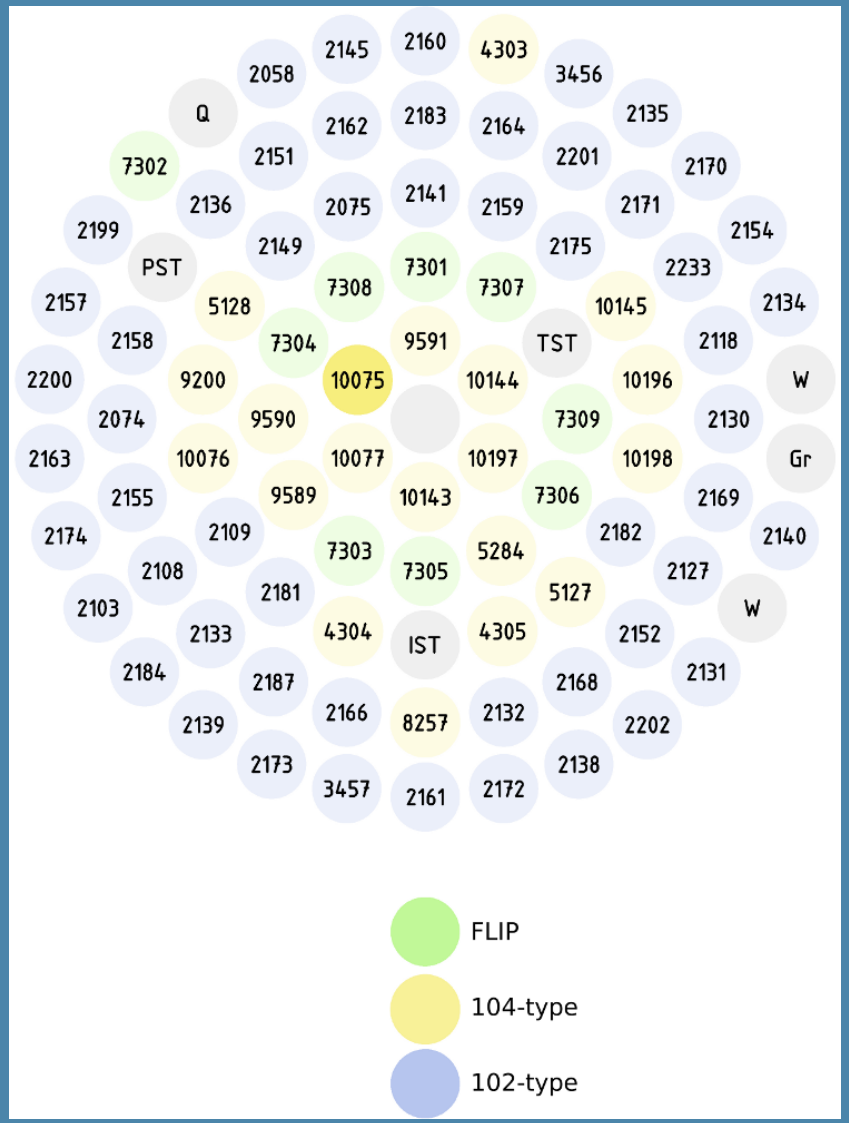
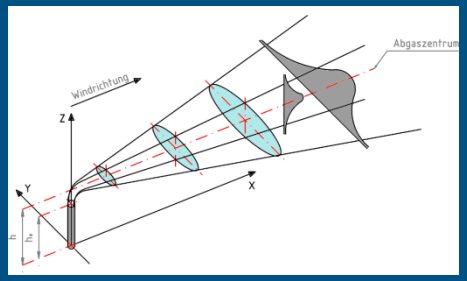
References

Inventar [Bq]

Kr-83m	$5.91 \cdot 10^{10}$
Kr-85m	$1.39 \cdot 10^{11}$
Kr-85	$2.22 \cdot 10^{10}$
Kr-87	$2.81 \cdot 10^{11}$
Kr-88	$3.97 \cdot 10^{11}$
I-129	$7.47 \cdot 10^{4}$
I-130	$7.16 \cdot 10^{8}$
I-131	$3.21 \cdot 10^{11}$
I-132	$4.77 \cdot 10^{11}$
I-133	$7.44 \cdot 10^{11}$
I-134	$8.40 \cdot 10^{11}$
I-135	$6.93 \cdot 10^{11}$
Xe-131m	$3.56 \cdot 10^{9}$
Xe-133m	$2.18 \cdot 10^{10}$
Xe-133	$7.45 \cdot 10^{11}$
Xe-135m	$1.26 \cdot 10^{11}$
Xe-135	$7.03 \cdot 10^{11}$
Xe-138	$6.87 \cdot 10^{11}$





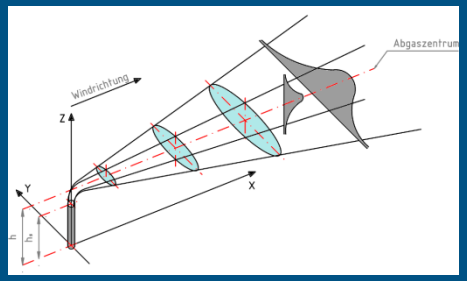
Scenario 1

→ Destruction of the fuel element with the highest activity content

$w_i = e_i \cdot f_i \cdot g_i$

w_i ... Fraction of released noble gases and halogens
e_i … Fuel → gap
f_i … gap → Water tank
g_i ... Water tank → Atmosphere

	Noble gases	Organically halogens	Other halogens
e_i	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$
f_i	1	0.5	0.5
g_i	1	0.1	0.009
w_i	$1.5 \cdot 10^{-5}$	$7.5 \cdot 10^{-7}$	$6.75 \cdot 10^{-8}$



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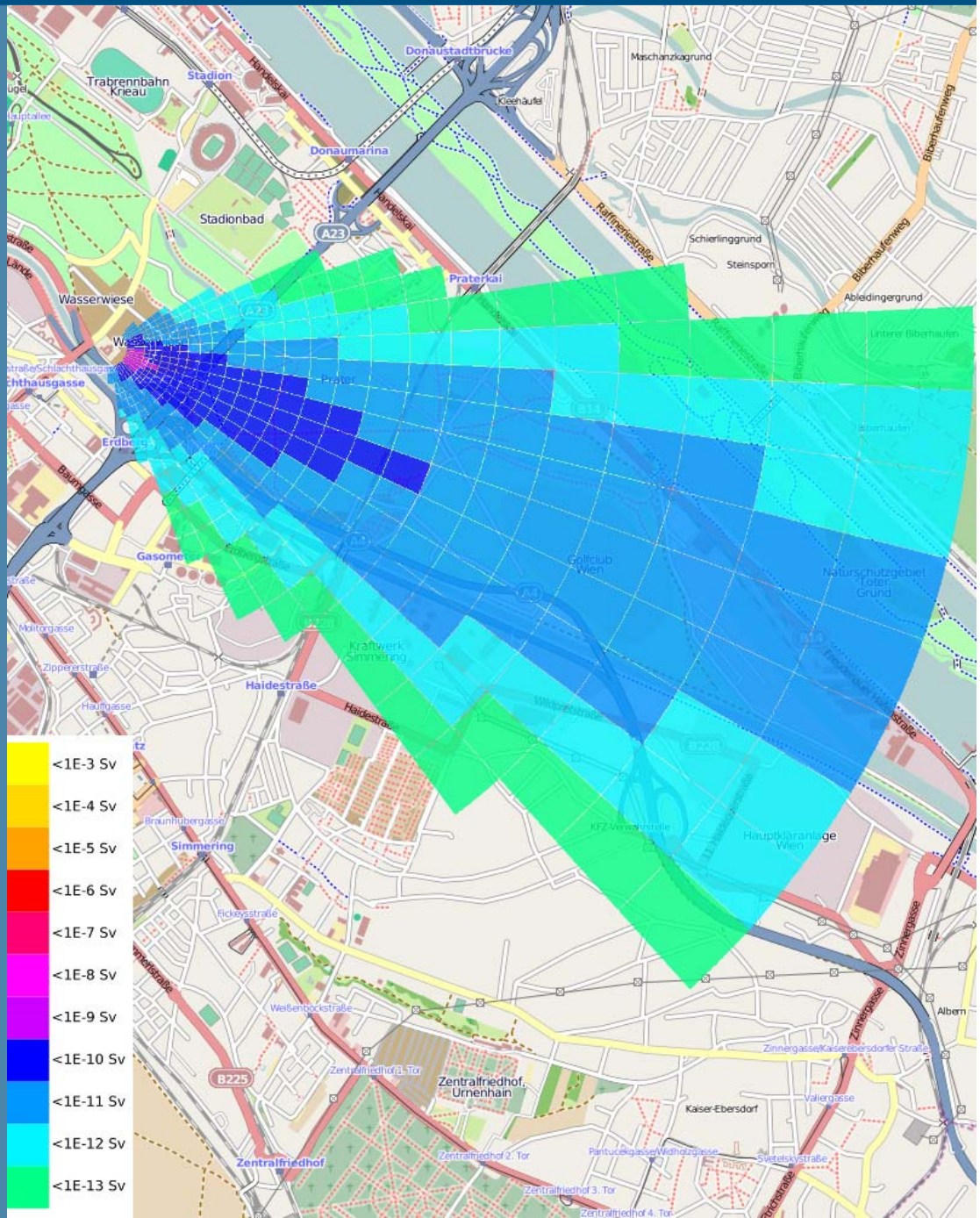
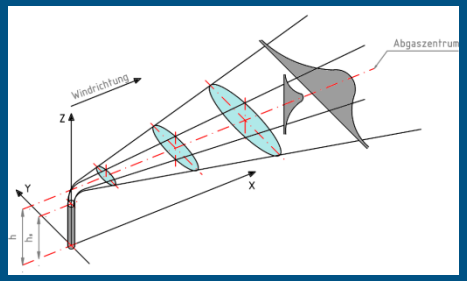
Effective Dose (ICRP-60) After one day

max. $2{,}51 \cdot 10^{-10}$ Sv

Radius > 0.31km
→ Dose < 10^{-10} Sv

Radius > 1.98km
→ Dose < 10^{-11} Sv





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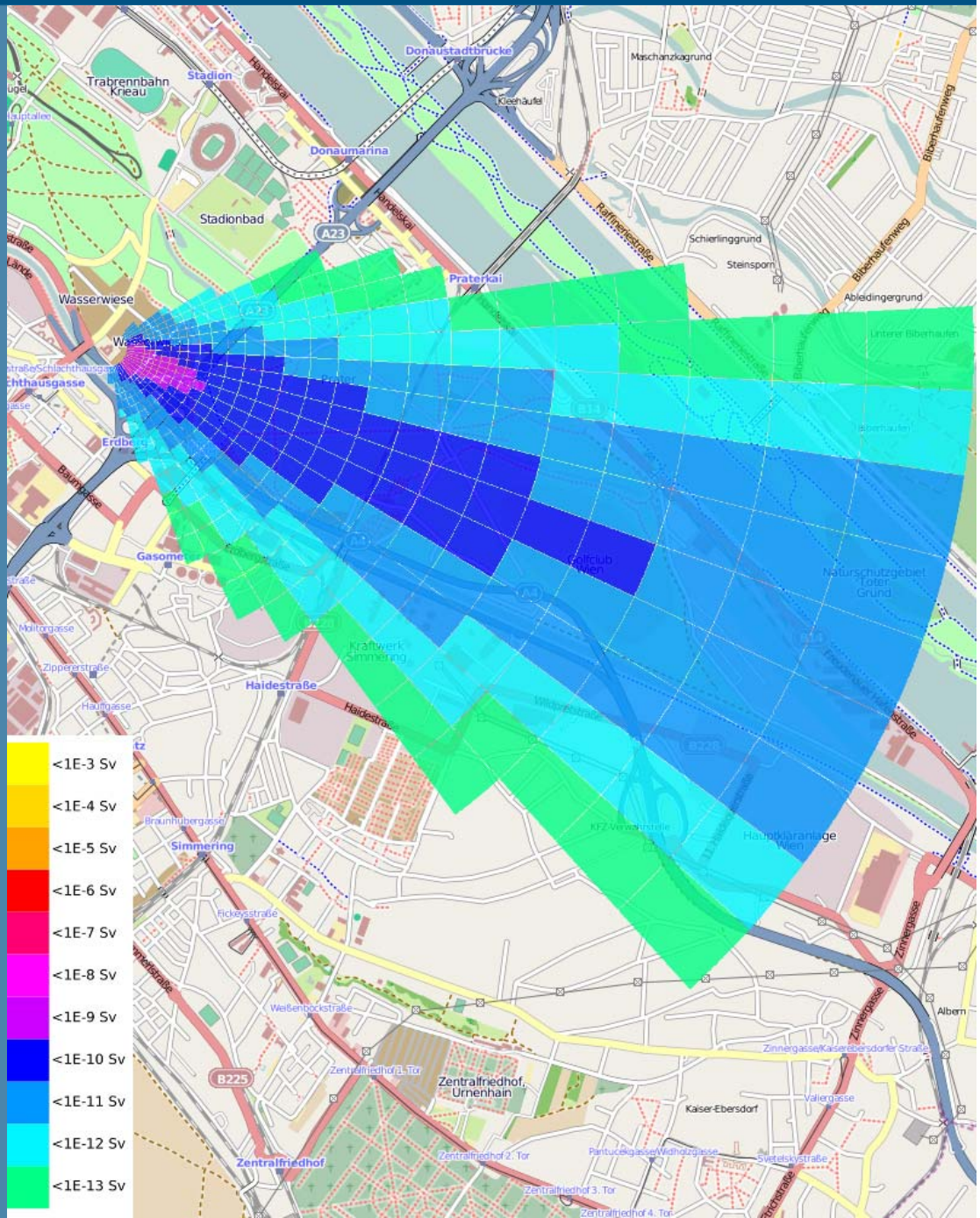
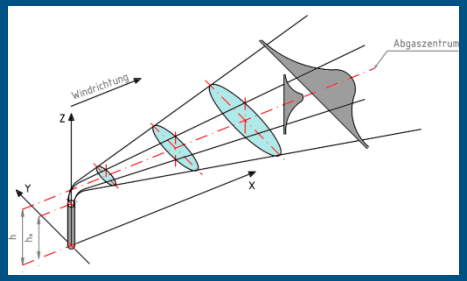
Effektive Dose (ICRP-60) After 50 years

max. 7,73 $\cdot 10^{-10}$ Sv

Radius > 0.60km
→ Dose < 10^{-10} Sv

Radius > 3.36km
→ Dose < 10^{-11} Sv





Scenario 2

→ Destruction of all fuel elements

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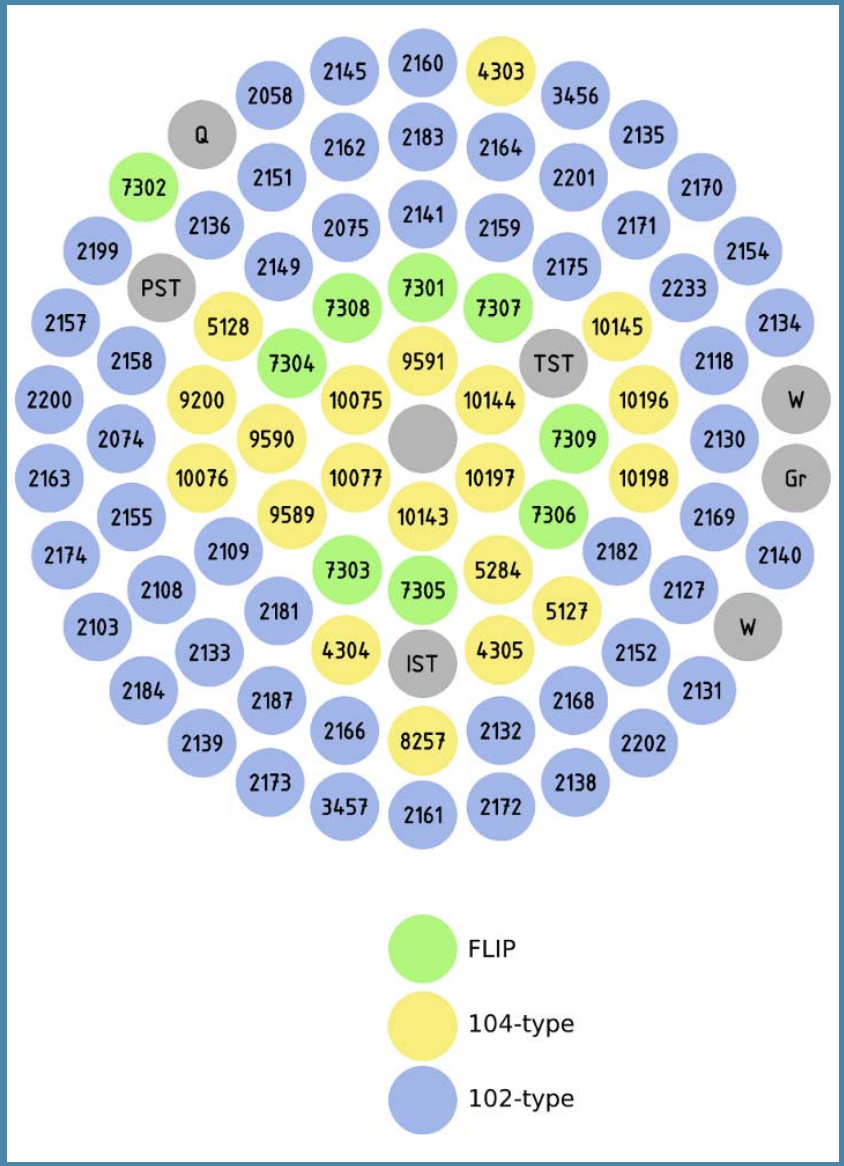
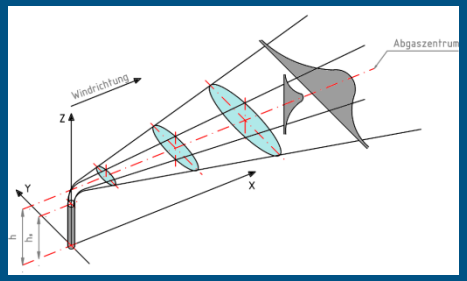
References

Inventar [Bq]

Kr-83m	$3.82 \cdot 10^{12}$
Kr-85m	$9.00 \cdot 10^{12}$
Kr-85	$1.67 \cdot 10^{12}$
Kr-87	$1.82 \cdot 10^{13}$
Kr-88	$2.57 \cdot 10^{13}$
I-129	$8.78 \cdot 10^{6}$
I-130	$6.57 \cdot 10^{10}$
I-131	$2.08 \cdot 10^{13}$
I-132	$3.10 \cdot 10^{13}$
I-133	$4.83 \cdot 10^{13}$
I-134	$5.45 \cdot 10^{13}$
I-135	$4.49 \cdot 10^{13}$
Xe-131m	$2.30 \cdot 10^{11}$
Xe-133m	$1.41 \cdot 10^{12}$
Xe-133	$4.83 \cdot 10^{13}$
Xe-135m	$8.19 \cdot 10^{12}$
Xe-135	$4.59 \cdot 10^{13}$
Xe-138	$4.45 \cdot 10^{13}$





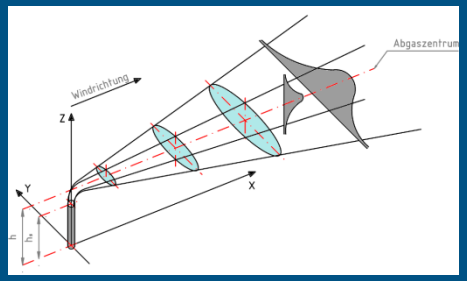
Scenario 2

→ Destruction of all fuel elements

$w_i = e_i \cdot f_i \cdot g_i$

w_i ... Fraction of released noble gases and halogens
e_i … Fuel → gap
f_i … gap → Water tank
g_i ... Water tank → Atmosphere

	Noble gases	Organically halogens	Other halogens
e_i	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$
f_i	1	0.5	0.5
g_i	1	0.1	0.009
w_i	$1.5 \cdot 10^{-5}$	$7.5 \cdot 10^{-7}$	$6.75 \cdot 10^{-8}$



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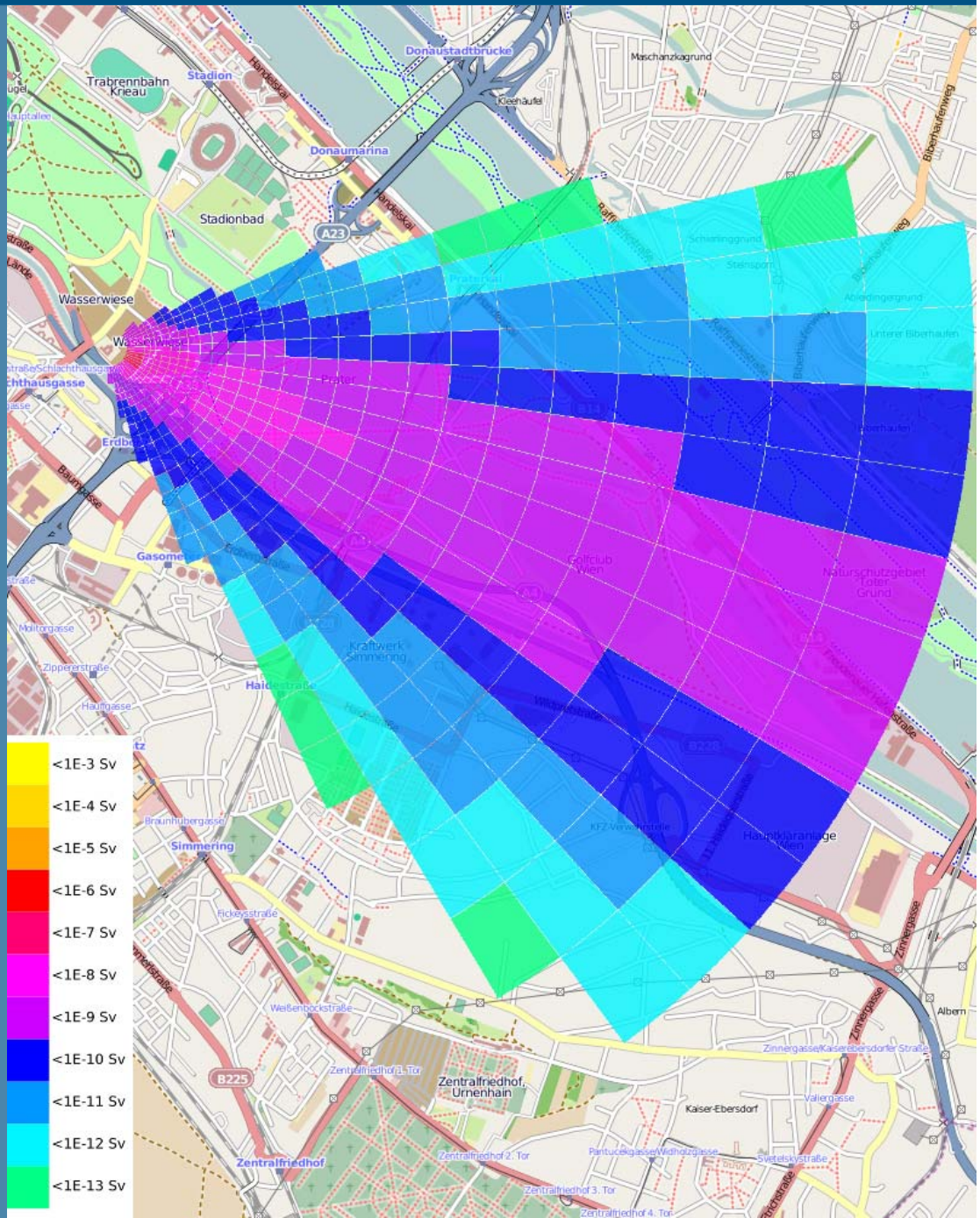
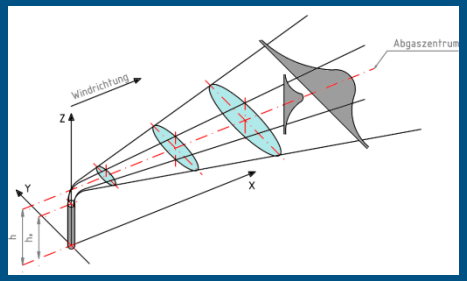
Effective Dose (ICRP-60) After one day

max. 1,63 $\cdot 10^{-8}$ Sv

Radius > 0.21km
→ Dose < 10^{-8} Sv

Radius > 1.52km
→ Dose < 10^{-9} Sv





Scenario 2

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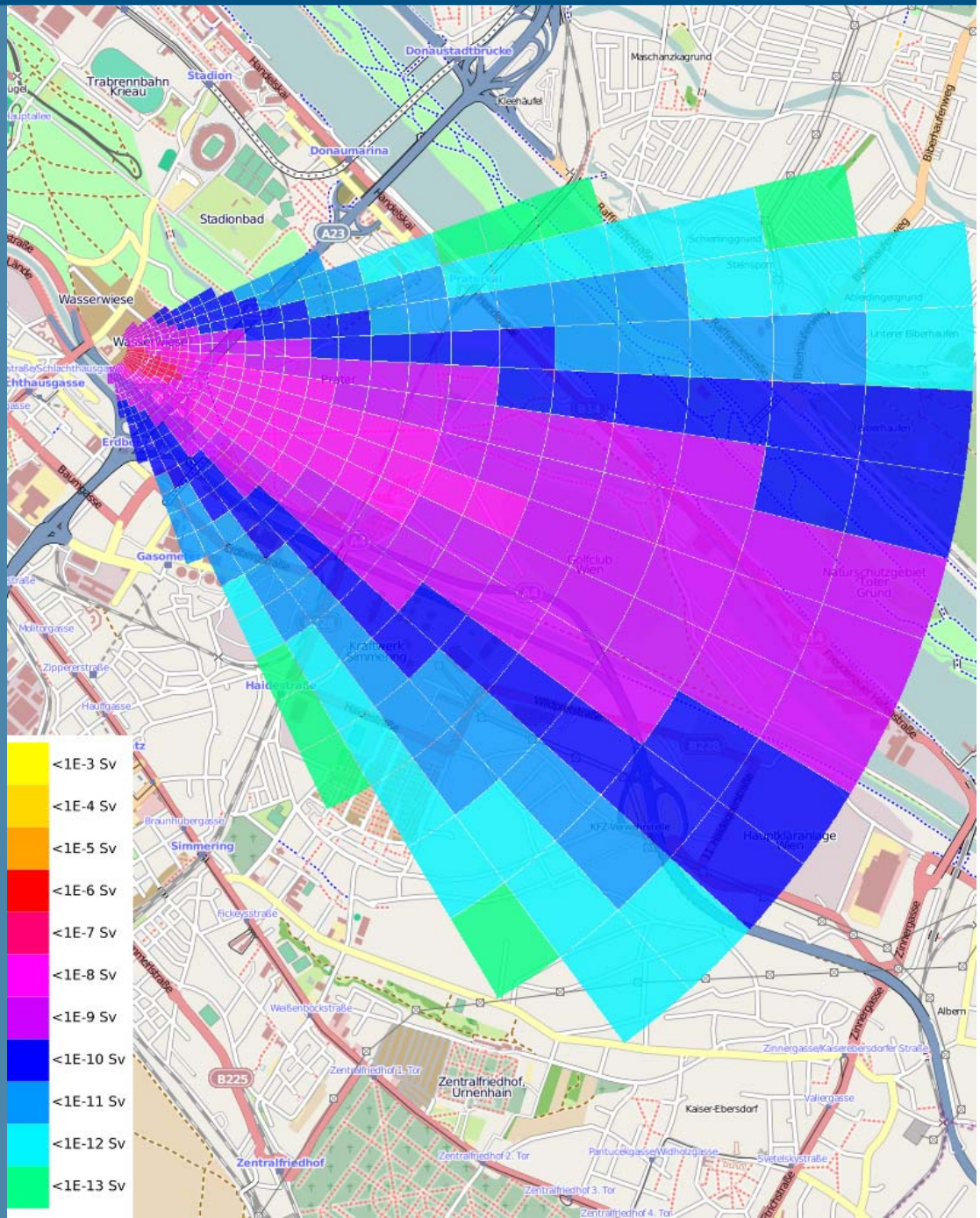
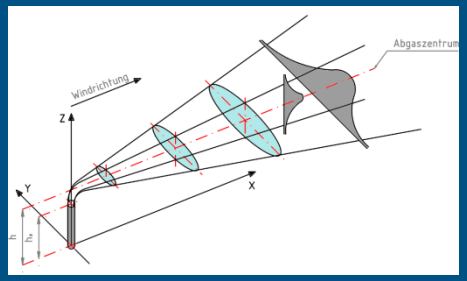
Effektive Dose (ICRP-60) After 50 years

max. 5,01 $\cdot 10^{-8}$ Sv

Radius > 0.46km
→ Dose < 10^{-8} Sv

Radius > 2.58km
→ Dose < 10^{-9} Sv





Scenario 3

→ Crash of a small airplane

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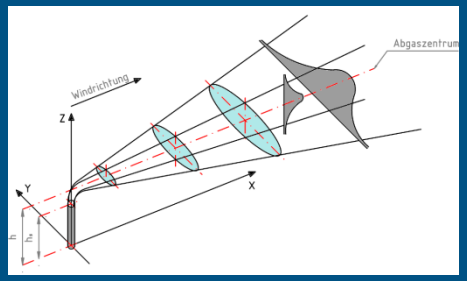
References

$w_i = e_i \cdot f_i \cdot g_i$

w_i ... Fraction of released noble gases and halogens
e_i … Fuel → gap
f_i … gap → Water tank
g_i ... Water tank → Atmosphere

	Noble gases	Organically halogens	Other halogens
e_i	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$
f_i	1	0.5	0.5
g_i	1	0.1	0.9
w_i	$1.5 \cdot 10^{-5}$	$7.5 \cdot 10^{-7}$	$6.75 \cdot 10^{-6}$



Scenario 3

→ Crash of a small airplane

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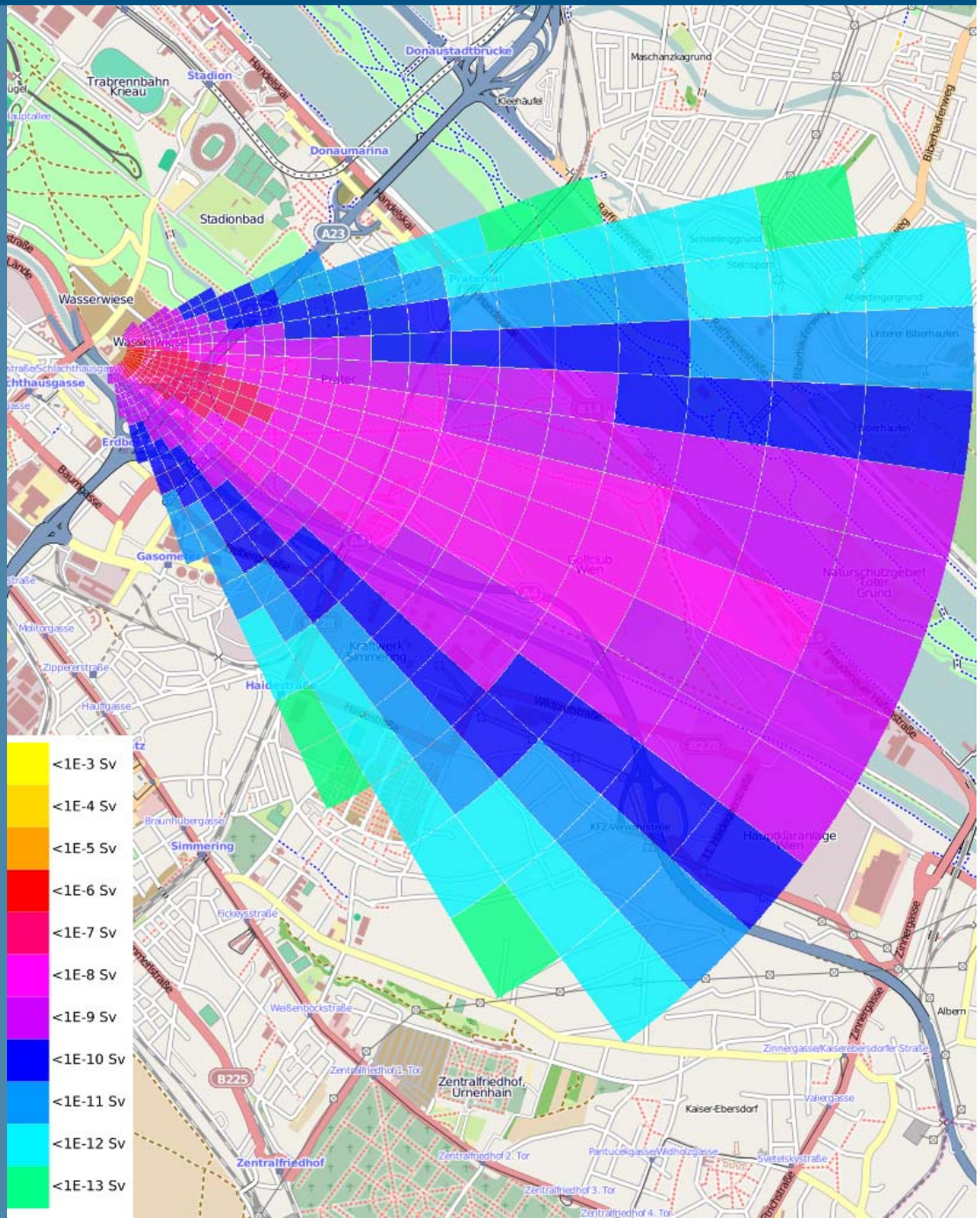
References

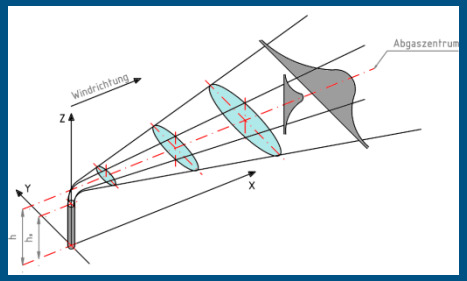
Effective Dose (ICRP-60) After one day

max. 2,07 $\cdot 10^{-7}$ Sv

Radius > 0.21km
→ Dose < 10^{-7} Sv

Radius > 1.02km
→ Dose < 10^{-8} Sv





Szenario 3

→ Crash of a small airplane

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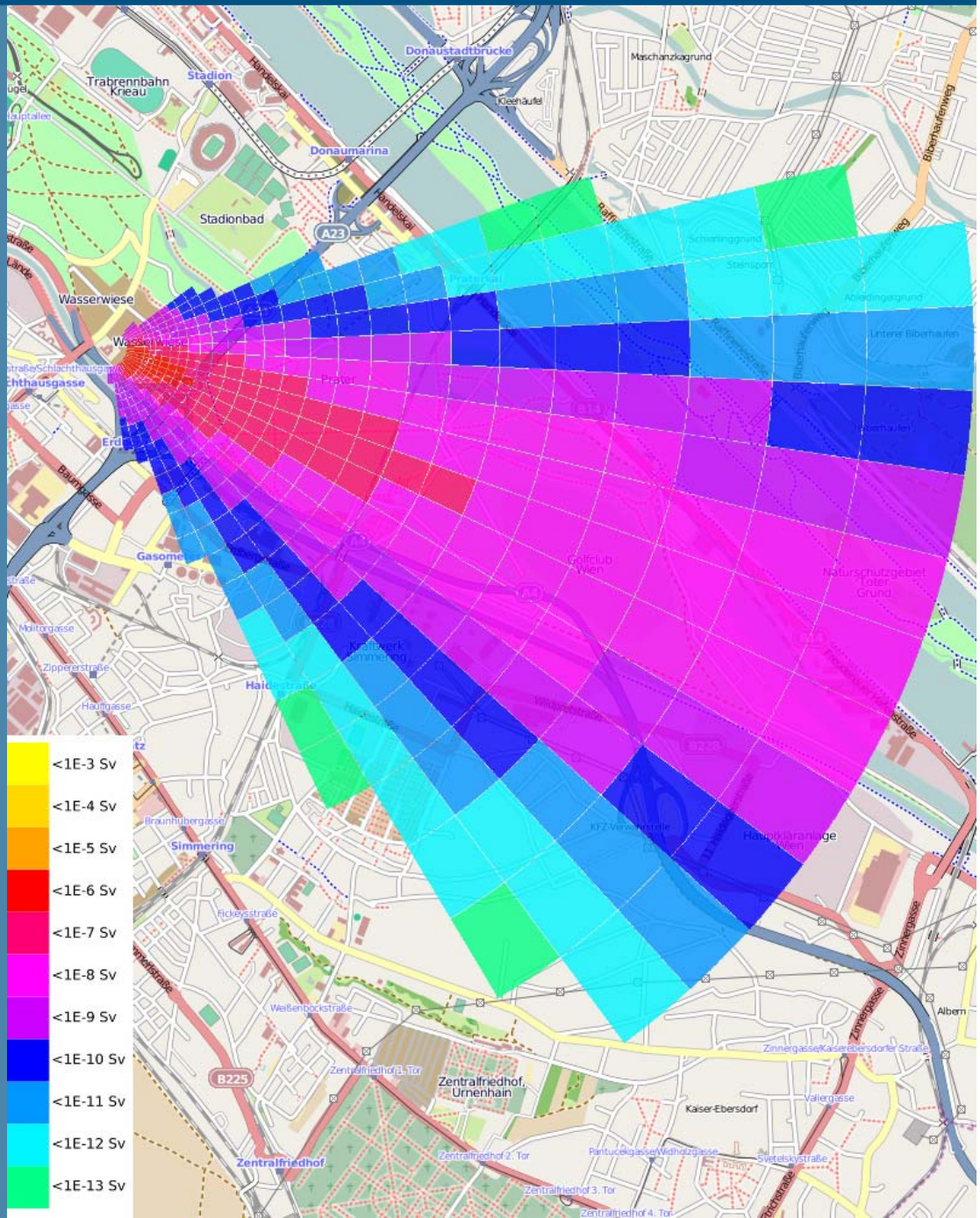
References

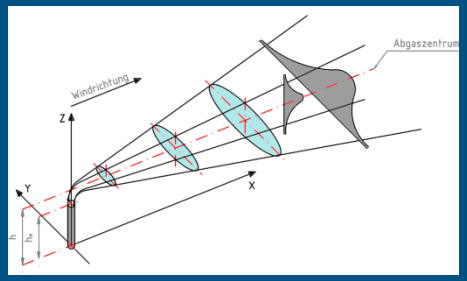
Effective Dose (ICRP-60) After 50 years

max. 7,23 $\cdot 10^{-7}$ Sv

Radius > 0.53km
→ Dose < 10^{-7} Sv

Radius > 2.26km
→ Dose < 10^{-8} Sv





Scenario 4

→ Crash of a large airplane

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References

$w_i = e_i \cdot f_i \cdot g_i$

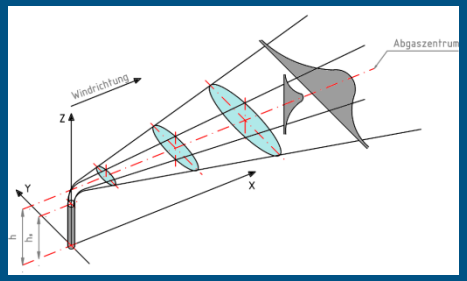
w_i ... Fraction of released noble gases and halogens

e_i … Fuel → gap

f_i … gap → Water tank

g_i ... Water tank → Atmosphere

	Noble gases	Organically halogens	Other halogens
e_i	1	$1.5 \cdot 10^{-5}$	$1.5 \cdot 10^{-5}$
f_i	1	1	1
g_i	1	0.1	0.9
w_i	1	$1.5 \cdot 10^{-6}$	$1.35 \cdot 10^{-5}$



Scenario 4

→ Crash of a large airplane

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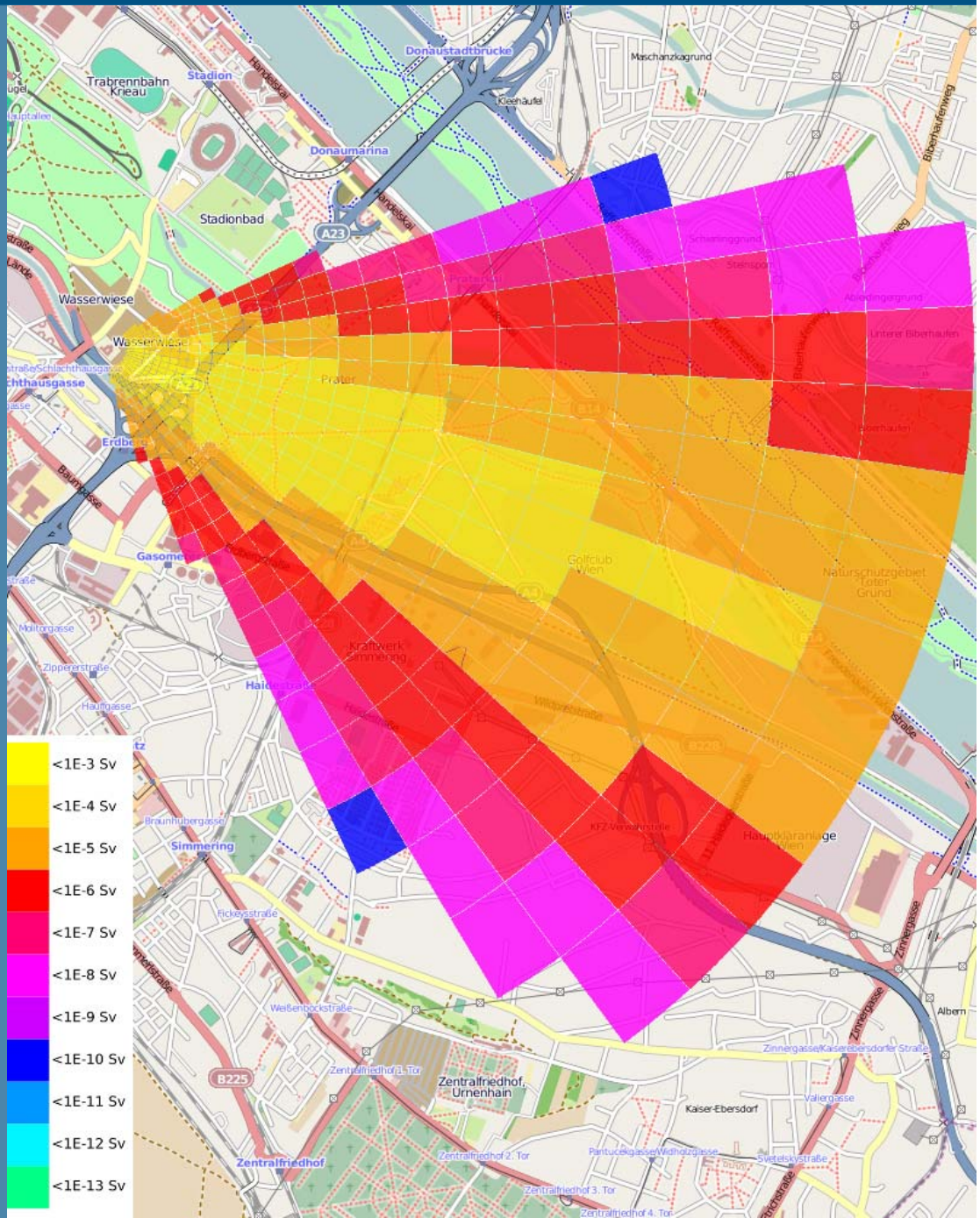
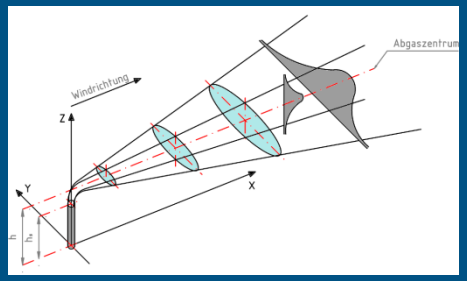
Effective Dose (ICRP-60) After one day

max. 3,72 $\cdot 10^{-4}$ Sv

Radius > 0.60km
→ Dosis < 10^{-4} Sv

Radius > 4.38km
→ Dosis < 10^{-5} Sv





Scenario 4

→ Crash of a large airplane

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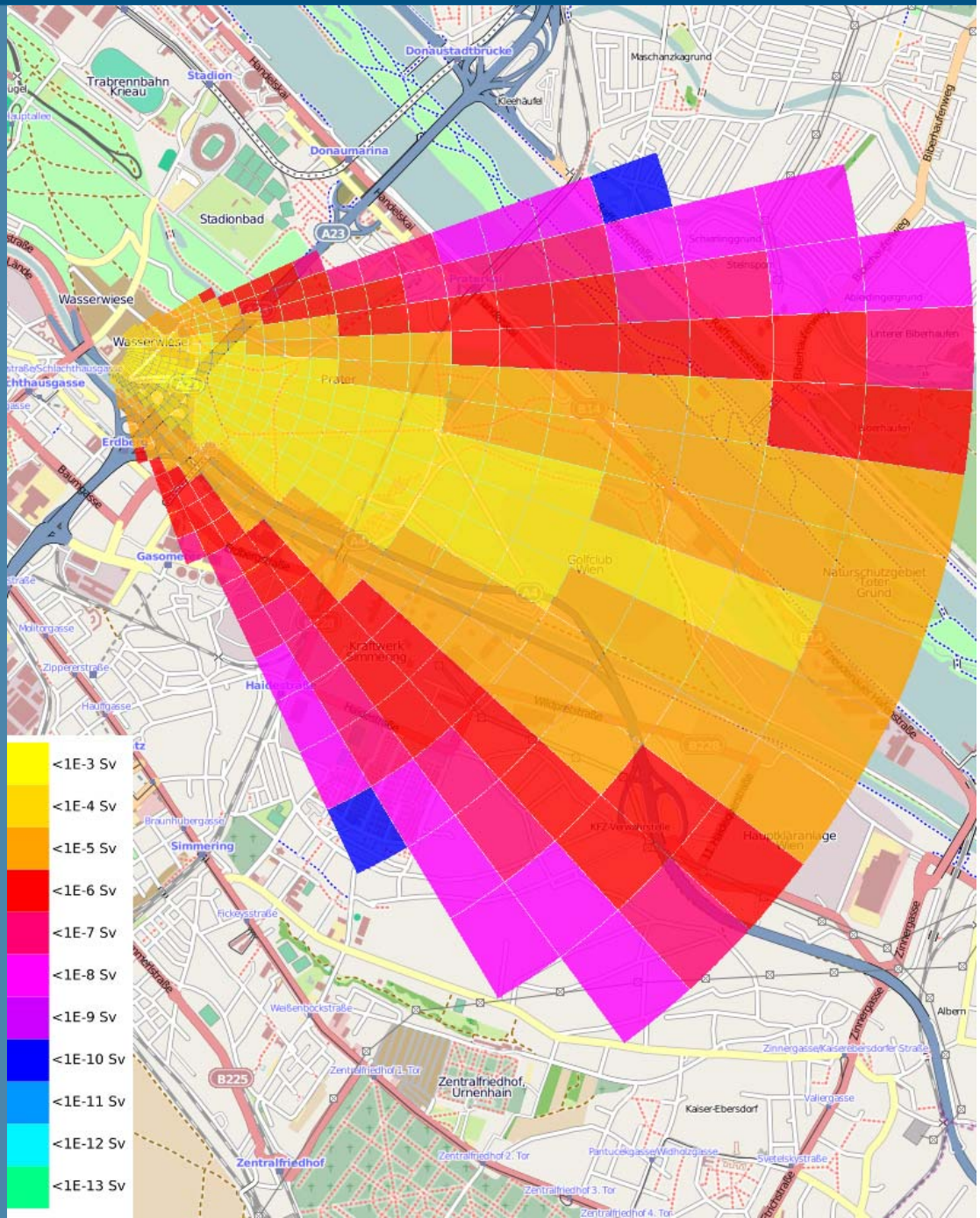
References

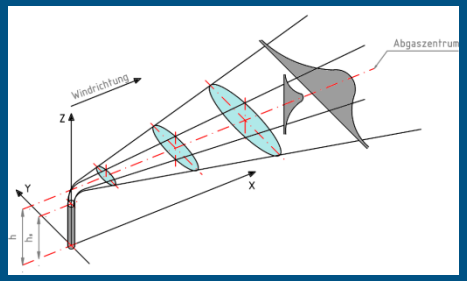
Effective Dose (ICRP-60) After 50 years

max. 3,74 $\cdot 10^{-4}$ Sv

Radius > 0.60km
→ Dose < 10^{-4} Sv

Radius > 4.38km
→ Dose < 10^{-5} Sv





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References

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