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BANSKÁ BYSTRICA, SLOVAK REPUBLIC, 8 – 10 OCTOBER 2018

The activity has been implemented within the framework of national project
***Information and providing advice on improving the quality of environment in Slovakia**.*
The project is cofinanced by Cohesion Fund of the EU under Operational programme Quality of Environment.

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Italian Guidelines on the Assessment of Vapour Migration in Contaminated Sites

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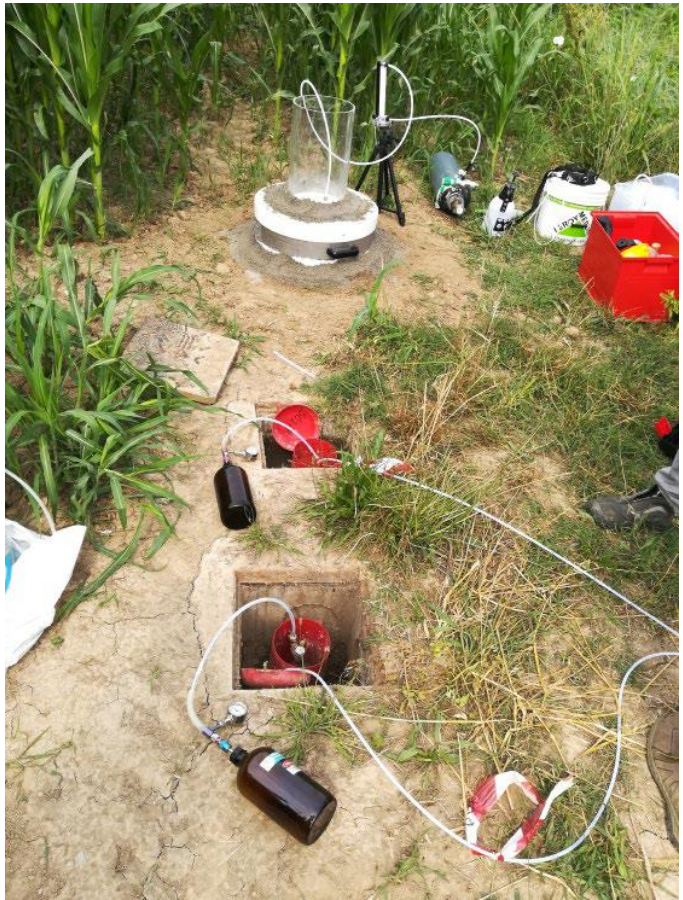
Why a guideline?

2008 Guidelines on Site specific RA
Analytical models (e.g. Johnson & Ettinger) and exposure parameters used for the assessment of vapour migration are very conservative and often unreliable

Unrealistic and unacheavable soil and GW remediation goals

Extensive use of field measurements (soil gas survey, flux measures, air monitoring) to overcome the limitations of analytical models



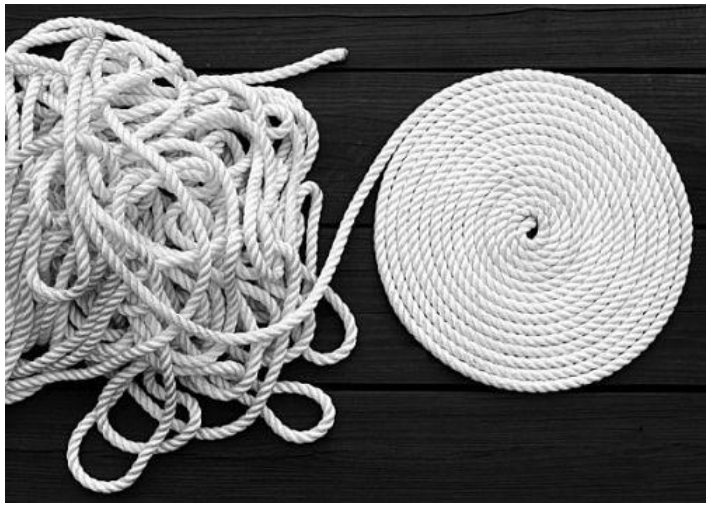
Why a guideline?

Control Authorities (ISPRA and Regional EPAs) have to:

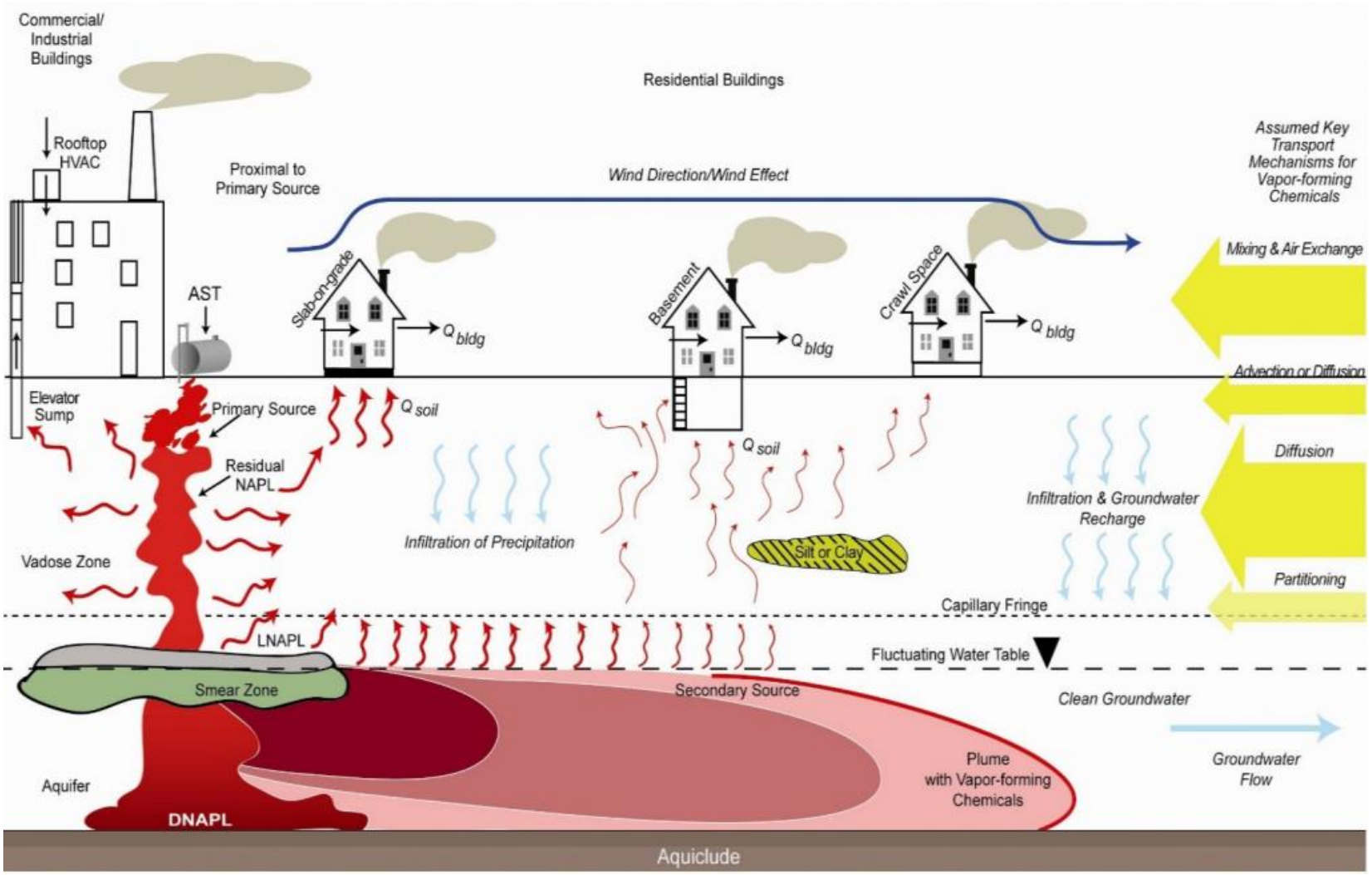
- Follow the sampling procedures in field
- Validate analytical results
- Evaluate the use of field data into sites-specific RA
- Verify and validate the results of RA

Working Group 9 bis

Scope: Define an harmonized procedure for vapour monitoring and use of field data in RA of contaminated sites



Vapour migration is a complex issue



The Working Group 9bis

ISPRA and 13 Regional Agencies

Participation of the National Health Institute (ISS) and the National Institute for Insurance against Accidents at Work (INAIL)

Collaboration with universities and private subjects holding patents on specific vapor monitoring techniques

Laboratory networking: Application of common analytical methods to different substances and to different sampling supports (vials, canisters, etc.)

Field campaigns:

- Comparison of different monitoring techniques (soil gas survey, flux measurements, air sampling), different equipments, different sampling supports
- Influence of meteorogical conditions
- Evaluation spatial and time variability of the phenomenon

Definition of the procedure for the use of field data: gradual risk-based approach, use of experimental attenuation factors, simplification

Documents released

1. **Design of vapour monitoring in contaminated sites**: gives indications and criteria on the use of different monitoring techniques, the selection of monitoring points, the minimum number of campaigns, the influence of meteorological conditions. The document includes three Appendices:
   - *Appendix A – Active Soil Gas Survey*
   - *Appendix B – Active Flux Chambers*
   - *Appendix C – Passive samples for soil gas* (only a literature review)
2. **Analytical methods for vapour montoring in contaminated sites**: select analytical methods for different classes of volatile compounds and different sampling supports (vials, canisters, ecc.). Detection Limits of Volatiles for each type of applicable sampling support are also reported.
3. **Procedure for the evaluation and use of soil gas data in risk assesment of contaminated sites**
4. Reports on the exprerimental field activities

Soil gas survey

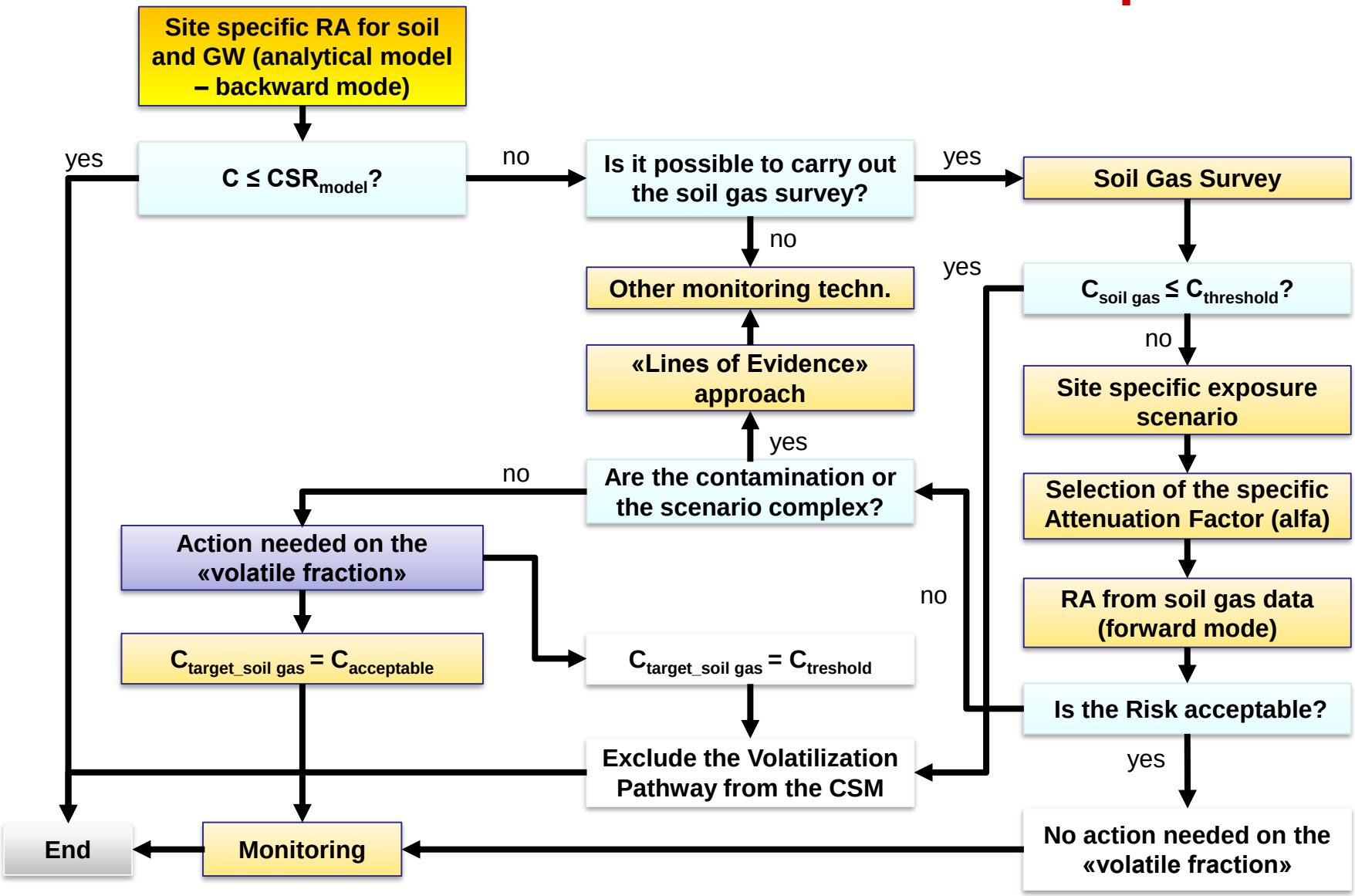
- It is the most proposed/used sampling method by the operators for the evaluation of the presence of volatile compounds in soil
- There is a consolidated experience in many Agencies for the evaluation and validation of soil gas surveys

Privilege the use of soil gas survey with respect to other monitoring techniques

Main changes in RA

- Definition of **chemical of concern for vapour migration pathway** on the basis of their physical characteristics;
- **Update of exposure parameters** for “inhalation pathway” on the basis of **national studies**;
- **Definition of reference values ($C_{threshold}$)** in soil gas matrix for the **exclusion** of volatilization pathway from the Conceptual Site Model;
- **Definition of soil gas to ambient air attenuation factors** on the basis of **experimental data** using the USEPA Vapour Intrusion Database.

General scheme of the procedure



Definition of Chemical of Concern for vapour migration

- exclude the volatilization pathway for substances with **vapor pressure less than 1.0E-06 kPa** (= 7.5E-06 mm Hg) (Harkov, 1989);
- for substances which do not comply with the above criterion, activate the volatilization pathway if (USEPA, 2015):
  - the **vapor pressure is greater than 0.075 mm Hg** (10 Pa), or
  - the **Henry's Constant is greater than 1.0E-05 atm x m^3/mol**;
- Use **Reference Concentration (RfC)** and **Inhalation Unit Risk Factor (IUR)** as toxicological parameters for risk calculations

New National Database of phisical/chemical and toxicological properties of contaminants developed by ISS and INAIL

Simplifications

Definition of «generic» reference values ($C_{threshold}$)

Case A

If **$C \leq C_{threshold}$** in all monitoring campaings → **Pathway Excluded**
No action
No monitoring

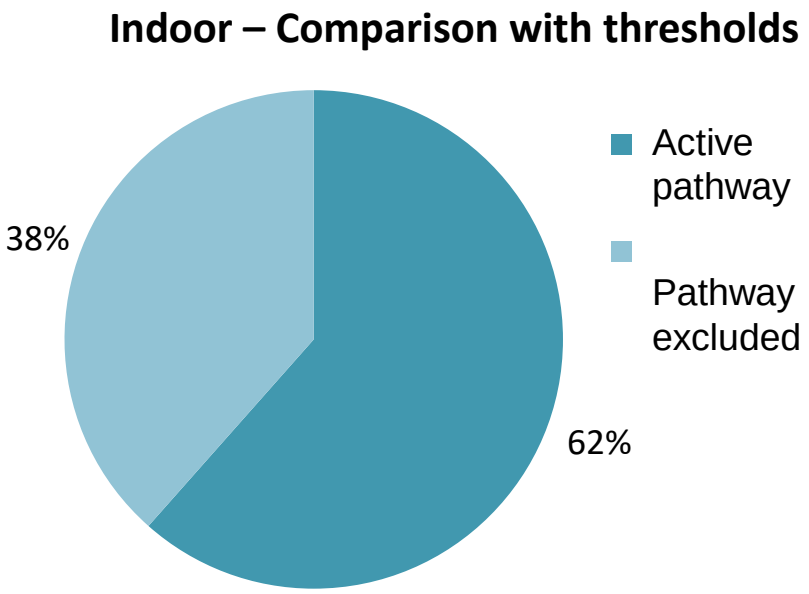
Case B

If **$C > C_{thresholds}$** even in a single monitoring campaign → **Active Pathway**
RA soil gas

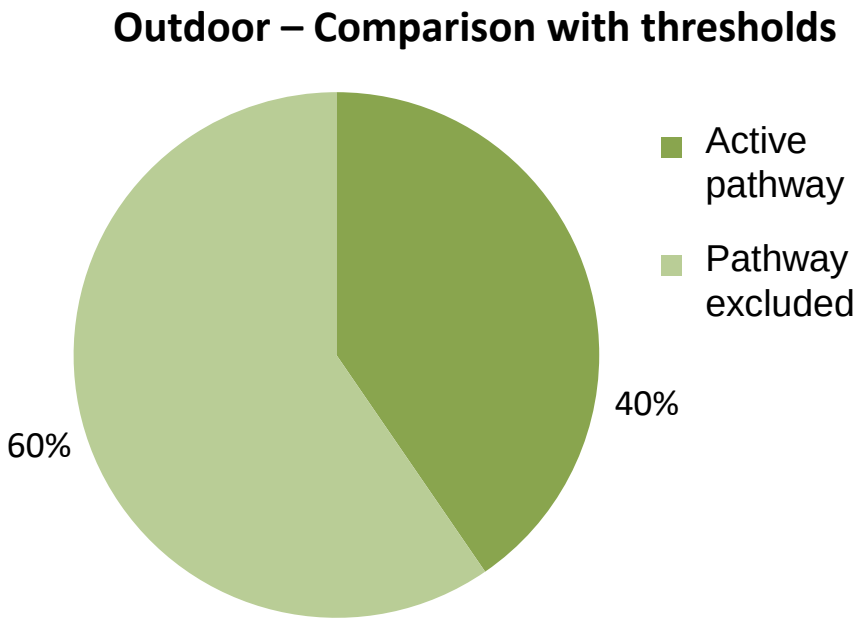
Definition of intervention needs
Definition of remediation goals

C = soil gas representative concentration of the single monitoring campaign

Pathway Exclusion



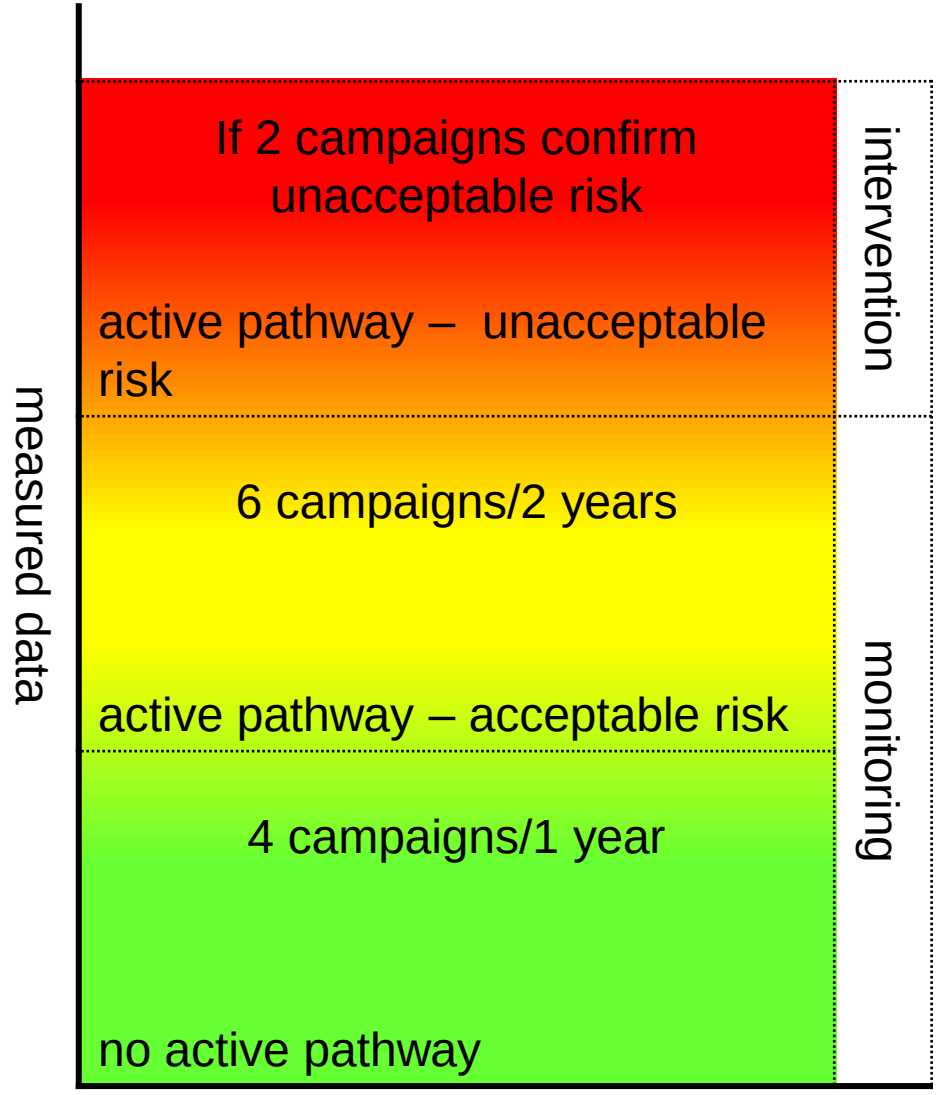
Test of the procedure on 12 sites



- 65 indoor sampling
- 47 outdoor sampling
- Chemicals: BTEX, Petroleum Hydrocarbons, Chlorinated Solvents, Naphtalene, ecc.

Definition of the minimum number of campaigns

- at least 4 campaigns (representative of the seasonality of one year) for **the exclusion of the volatilization pathway** (comparison with threshold values);
- from 4 to 6 campaigns (representative of the seasonality of one or two year) **for evaluation of risks** (RA soil gas);



Evaluation of the monitoring campaigns

- For the first year of monitoring (4 campaigns) a **10% of uncertainty has been set related to the seasonal representativeness of the single campaign**.

- If during **the first year** of monitoring **anomalous situations** (e.g. unacceptable risks) are registered, **the related campaigns should be repeated** in order to assess if the anomalies indicate a real problem or if they can be managed in the context of time variability of the data.
- For monitoring campaingns after the first year **the repetition of one or more campaingns in the same season** may be considered sufficiently representative to avoid the application of the uncertainty.

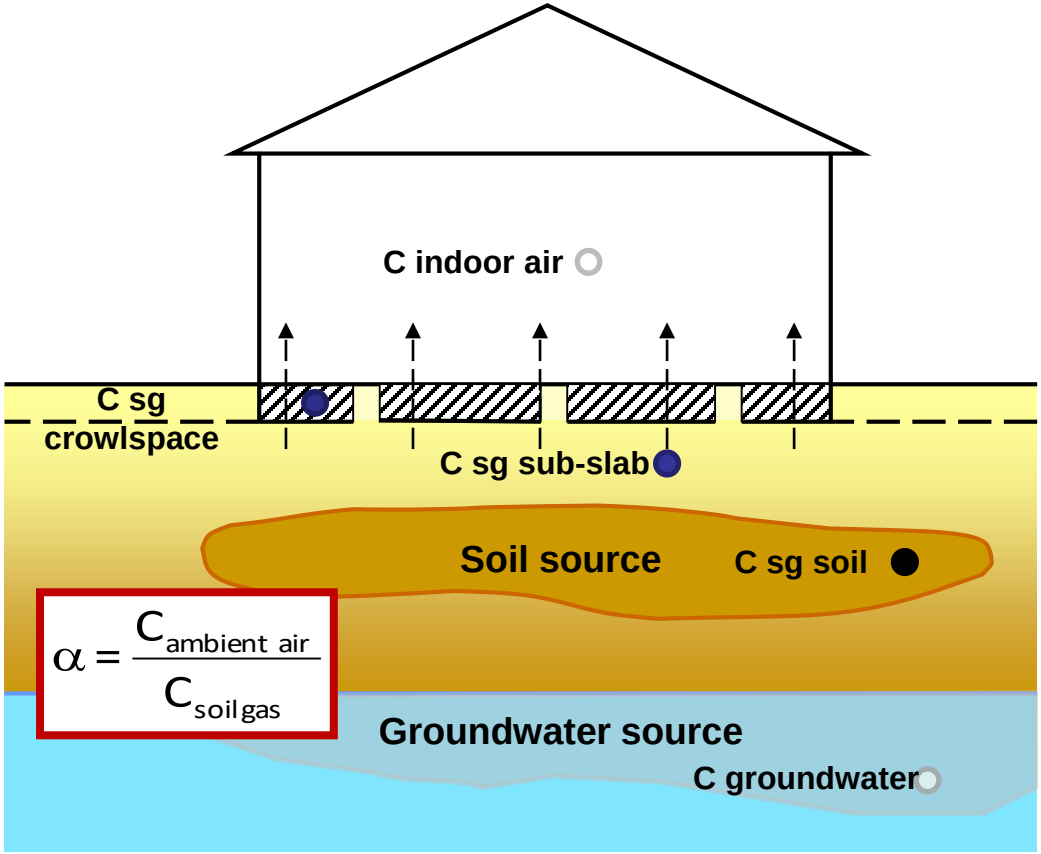
Update of Exposure Parameters

Exposure Parameters – Residential/Recreational Use

Exposure Parameters	Residential				Recreational			
	Child (0-6 years)	Adolescent (7-16 years)	Adult (17-65 years)	Elder (>65)	Child (0-6 years)	Adolescent (7-16 years)	Adult (17-65 years)	Elder (>65)
Exposure Frequency (days/year) – EF	350	350	350	350	350	350	350	350
Daily Exposure Frequency Indoor (h/day) – EF_{g_indoor}	19,8	19,6	18,0	22,4	0,4	0,6	1,4	1,4
Daily Exposure Frequancy Outdoor (h/day) – $EF_{g\_outdoor}$	0,7	0,5	0,9	1,9	0,6	0,9	0,8	0,6
Exposure Duration (years) – ED	6	10	14	5	6	10	14	5
Averaging Time non carcinogenics (years) – AT_{non_canc}	6	10	14	5	6	10	14	5
Averaging Time carcinogenics (years) – AT_{canc}	70	70	70	70	70	70	70	70
ADAF (adim)	5	3	1	1	5	3	1	1

2012 Study of Central Statistics Institute (ISTAT) «Use of time» on the way of life of 18.250 families

The USEPA Vapour Intrusion Database



- USEPA Vapour Intrusion Database includes **indoor air VOC measures** performed simultaneously with:
  - crowlspace and sub-slab soil gas and soil gas in soil;
  - groundwater sampling.
- The database includes **2929 paired data** from **913 buildings** both in **residenzial** and **non residenzial** context.

- Monitored substances are **primarily chlorinated compounds** in unsatured soil and groundwater, but the database includes alslo **some cases of contamination from petroleum hydrocarbons (BTEXS)**.

Attenuation Factor estimate

Statistics	alfa	
	soil gas from soil (external)	soil gas sub-slab (indoor)
Min	1,32E-06	1,97E-04
5 percentile	9,29E-06	6,38E-04
25 percentile	3,83E-04	1,58E-03
50 percentile	2,15E-03	2,94E-03
75 percentile	8,57E-03	6,38E-03
95 percentile	1,25E-01	2,75E-02
Max	4,10E-01	8,82E-02
Mean	2,38E-02	7,13E-03
StdDev	6,08E-02	1,42E-02
UCL95 mean	3,45E-02	1,12E-02

Derivation of thresholds $\alpha_c = 0,1$

Attenuation factors apply to both indoor and outdoor evaluations

- Site specific Risk evaluation for soil gas (UCL 95 of the mean)

Correlation with depth

Depth	alfa (external soil)
< 2,5m b.g.s.	5,93E-02
2,5-4 m b.g.s.	3,11E-03
4-9 m b.g.s.	1,97E-03
≥ 9 m b.g.s.	1,89E-03

Correlation with soil texture

Soil Texture	alfa (sub-slab indoor)	alfa (external soil)
Very Course	1,53E-02	5,31E-02
Course	1,25E-02	1,23E-02
Fine	1,02E-02	2,86E-03

Evaluation of biodegradation effects

- For petroleum hydrocarbons potential biodegradation effects should be considered.

Depth	alfa (external soil) with biodegr.	alfa (sub-slab) with biodegr.
< 2,5m b.g.s.	1,68E-02	3,17E-03
2,5-4 m b.g.s.	3,56E-05	-
4-9 m b.g.s.	2,25E-05	-
≥ 9 m b.g.s.	2,16E-05	-

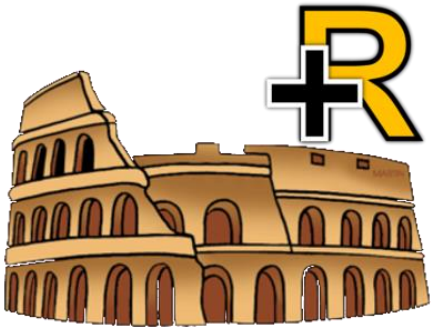
- Application of the results of tridimentional models (Abreu and Johnson, 2005) taken as a reference in USEPA documents (USEPA, 2013)

Attenuation factors considering biodegradation may be applied to:

- **BTEXS** ed Hydrocarbons **C≤12** contamination;
- **Oxigen content measured in gases more than 4%**; in the case of presence of pavement outdoor and around the building, the presence of oxygen must also be assessed below the pavement;
- **Buildings with surface less than 140 m^2**; for buildings with a higher surface sub-slab samples should be performed to verify the applicability of biodegradation.

Simplification of the risk evaluation

- The definition of the "alpha" attenuation factors simplifies the calculation methods and reduces the input parameters needed.
- Use of the inhalation toxicity parameters in terms of concentration (Reference Concentration and Unit Risk Factor) reduces input parameters for exposure assessment.
- To test the software: *antonella.vecchio@isprambiente.it*

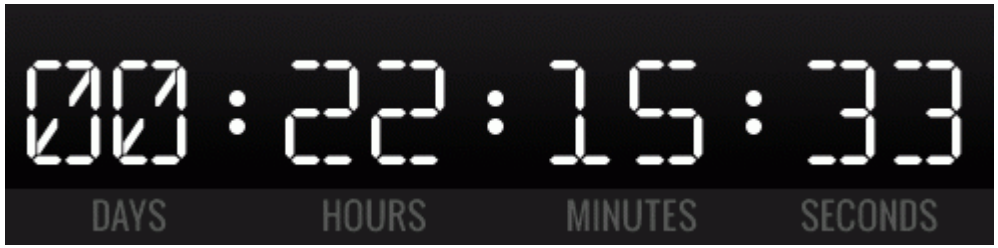


Software Rome Plus

Evaluation of Risks from soil gas Evaluation of Risks from flux measures

Future developments

- The approach proposed by the documents of WG 9 bis may overcome many critical issues in the management of vapour monitoring results for risk assessment.
- Some proposals for future developments emerged from the discussion:
  - Test the applicability of **passive samplers** for soil gas;
  - **Improve analytical methods** for some chemicals not yet investigated by SNPA;
  - Collect case studies of vapour monitoring to create a **National Database** similar to the USEPA VI DB;
  - Validate **new transport models from soil and groundwater**, in order to avoid the extensive use of vapour monitoring;
  - Update, on the basis of the National Database, the **proposed attenuation factors**.



Many thanks to…

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Working Group 9 Bis

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- Gianni Formenton, Federico Fuin, Giorgia Giraldo (ARPA Veneto)

Thank you for your attention!!!

REMTECH Europe

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*Abstract submission by **30 May 2019** –*

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