

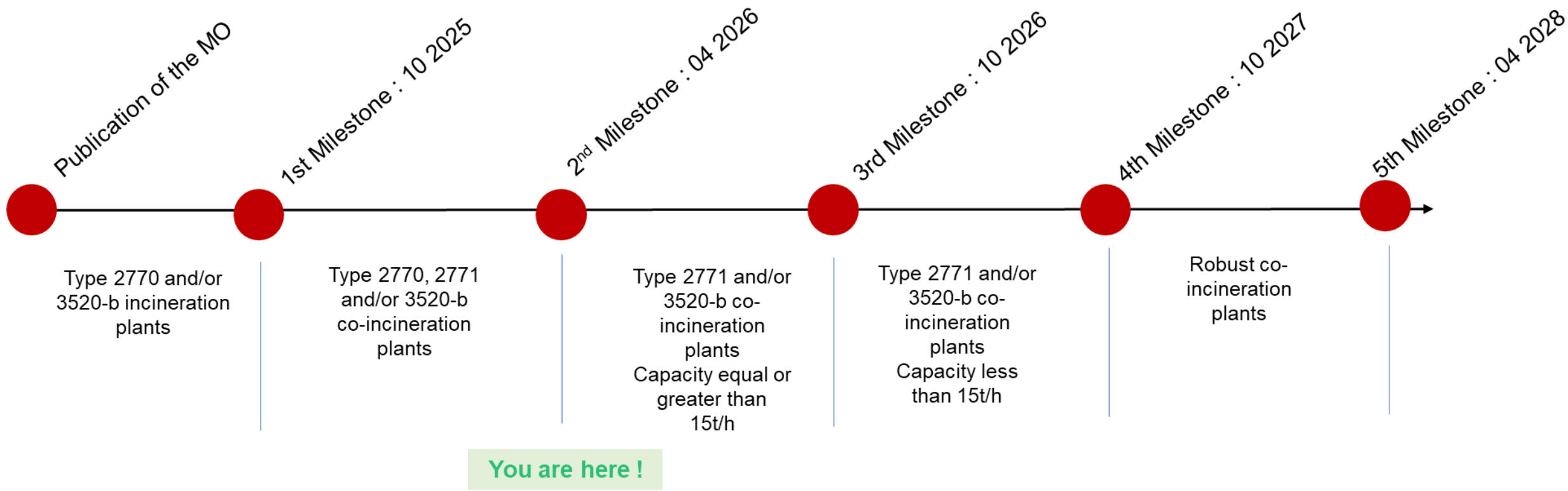
Industrial Feedback from the waste treatment sector: atmospheric emissions and health risks evaluation.

THH PFAS INTERNATIONAL CONGRESS ON PFAS, 17th June 2026

Regulatory context

Decree of 31 October 2024 on the analysis of per- and polyfluoroalkyl substances in atmospheric emissions from incineration, co-incineration and other thermal waste treatment plants

Deadlines for carrying out the sampling campaign according to the heading of the nomenclature of classified installations

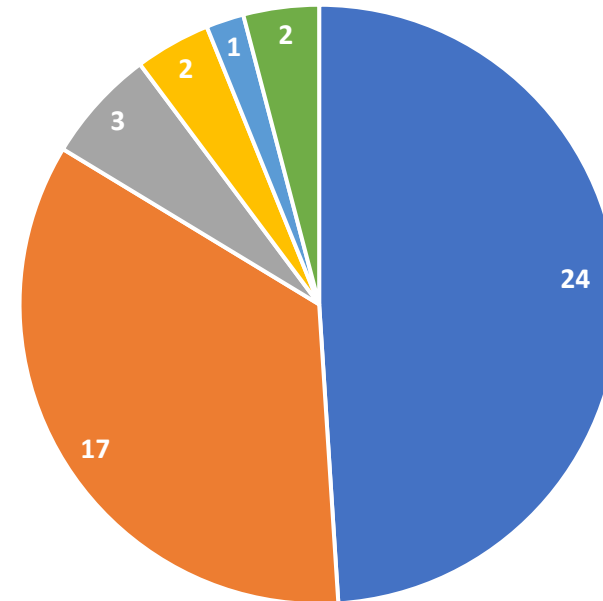


Substances of Interest

Substances mentioned in the ministerial order of October 24th, 2024

49 Substances

PFAS prescribed for sampling grouped in functional groups

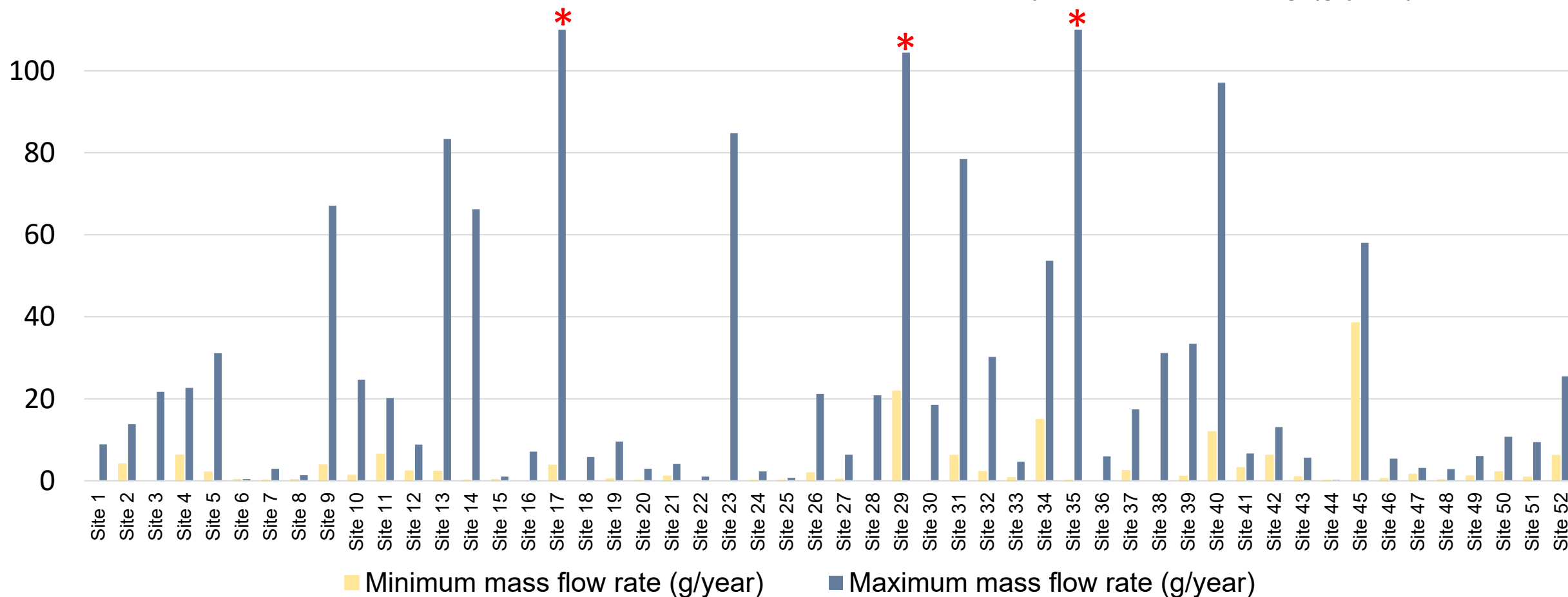


■ Carboxylic acids
■ Sulfamides
■ Oxide dimer acid

■ Sulfonic acids
■ Sulfamido acetic acids
■ ctane sulfonamido-ethanol

Take-aways and general trends

Minimum and maximum mass rate flows calculated for 8760 h/year of functioning (g/year)



(*) Emissions Superior to 100 g/year

Take-aways and general trends

	Minimum emissions	Maximum emissions
Average emissions per studied source (g/day)	0,006	0,08
Sum of emissions for all sites (g/day)	0,40	5,64
Average emissions per studied site (g/day)	0,008	0,12

Difficulty of interpretation of results in the absence of emission limit values

Health risks evaluation taking into account three representative sites of the waste treatment sector:

- Site A
- Site B
- Site C

Technical Guidelines



Steps of the assessment



- 1 Evaluation of health hazards
- 2 Environmental fate
- 3 Conceptual diagram
- 4 Exposure scenario
- 5 Evaluation of health risks

National reference for the evaluation of health risks resulting from emissions from industrial facilities for environmental permits

Inventory and Selection of TRVs

Definition of TRVs: values used to quantify the health risk after exposure to a toxic agent.

Types of Effects

- Threshold TRVs
- Non-Threshold TRVs

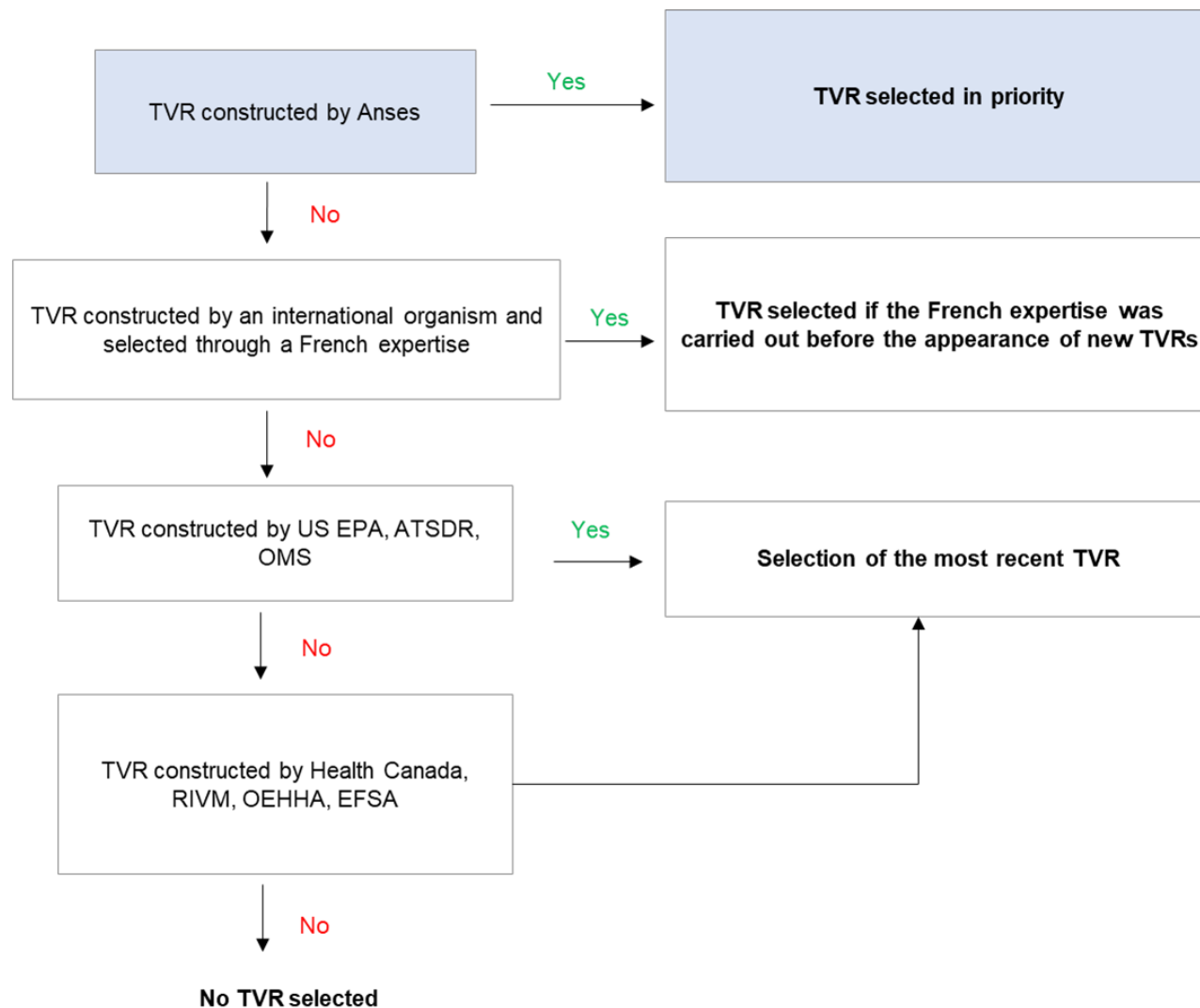
Duration of Exposure

- Acute : hours → days
- Chronic : ≤ 1 year

Exposure routes

- Inhalation
- Ingestion
- Cutaneous

Procedure for the Selection of TRVs



Results of TRVs Inventory

Main results:

- Several TRVs for ingestion;
- Some TRVs for inhalation;
- No TRVs for the cutaneous route;
- Several PFAS without any TRVs.

35 PFAS without any available TRVs:

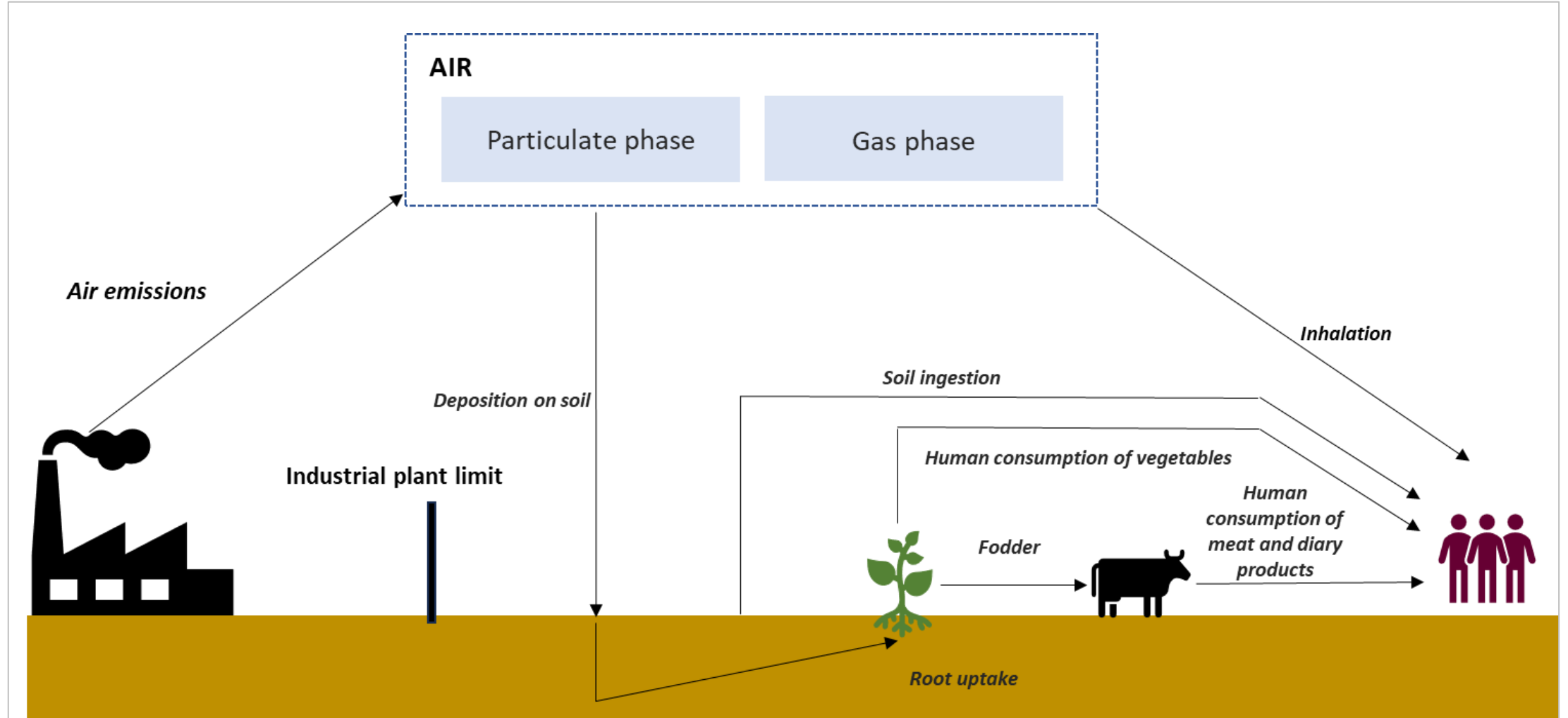
PFHxDA, PFODA, PFPeS, PFHpS, PFNS, PFUnDS, PFDoDS, PFTrDS, FOSA, N-MeFOSA, N-EtFOSA, N-MeFOSE, N-EtFOSE, N-MeFOSAA, N-EtFOSAA, 4: 2 FTSA, 8: 2 FTSA, 10: 2 FTSA, ADONA, HFPO-DA (GenX), 9CI-PF3ONS (F-53B majeur), 11CI-PF3OUdS (F-53B mineur), NFDHA, PFEESA, PFMBA, PFMPA, PFecHS, 8: 2 FTUCA (FOUEA), 10: 2 FTCA (10: 2 FDEA), 8: 2 FTCA (8: 2 FOEA), 6: 2 FTUCA (6: 2 FHUEA), 6: 2FTCA (6: 2 FHEA), 3: 3 FTCA (FPrPA), 5 : 3 FTCA (FPePA), 7: 3 FTCA (FHpPA).

→ **No health risk assessment possible: substances not taken into account for the health risk assessment.**

Examples of TRVs

Substance	TRV - Chronic exposure				
	Type of TRV	Value	Unit	Target for critical effect	Source
PFBA	Threshold VRT	0.024	mg/kg/d	Hepatic effects: increase in absolute and relative liver mass and hypertrophy	Anses (2017)
PFOA	Threshold VRT	0.000003	mg/kg/d	Skeletal alterations in adult offspring	ATSDR (2021) and Washington DOH (2021)
	Non-threshold TRV	29300	1/(mg/kg/d)	Kidney cancer	US EPA (2024)
PFOS	Threshold VRT	0.000002	mg/kg/d	Delayed eye opening (F1) and transient weight loss	ATSDR (2021)
	Non-threshold TRV	39.5	1/(mg/kg/d)	Hepatocellular tumors and pancreas in males	US EPA (2024)
TFA	Threshold TRV	0.05	mg/kg/d	Effects on development	EFSA (2017)

Conceptual Diagram



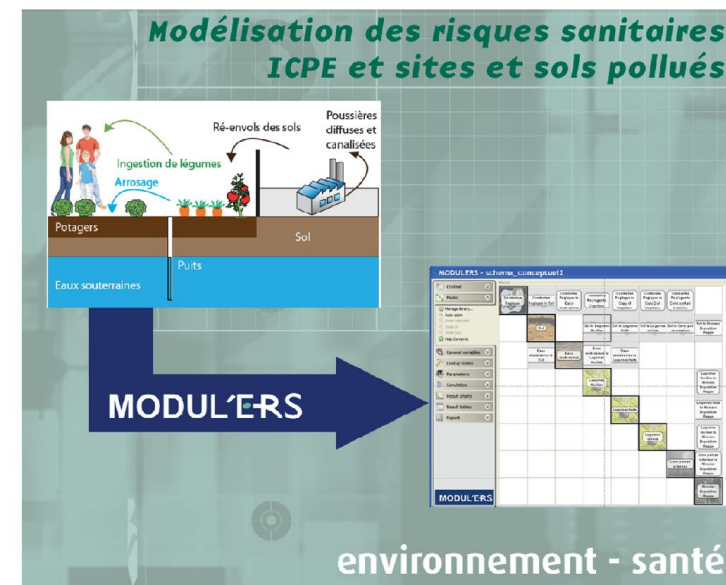
Definition of Risk Levels and Modeling of Environmental Levels

Circular of August 9th 2013, relating to the prevention and management of health risks for industrial facilities

- Threshold effects → Hazard quotient (HQ) < 1
- Non-threshold effects → Individual excess risk (IER) < 10^{-5}

Modeling of environmental levels

- Calculations carried out based on ADMS and ARIA IMPACT models.
- Transfers through the food chain were calculated by using the INERIS MODUL'ERS model.



Modeling by using equations from MODULERS

Predicted concentrations in the air

Air concentration ranges ($\mu\text{g}/\text{m}^3$)

Site A

6,38E-09 (PFOS) - **4,31E-08** (6: 2 FTSA)

Site B

2,2E-10 (PFHxA) - **7,33E-09**(6: 2 FTSA)

Site C

4,61E-06 (PFNA, PFDA, PFUnDA) - **3,69E-06** (6: 2 FTSA)

Levels measured by ATMO AURA

- Lyon: 6E-08 (PFHxS) à 2,8E-06 (6:2 FTSA) $\mu\text{g}/\text{m}^3$
- Pierre-Bénite: 8E-08 (PFHxS) à 1E-04 (6:2 FTSA) $\mu\text{g}/\text{m}^3$

Sum of all hazard quotients per plant

	Total hazard quotients for inhalation	Reference threshold for HQ
Site A	2,7E-06	1
Site B	1,5E-06	1
Site C	5,4E-05	1

- HQ for inhalation are inferior to the unity.
- For all studied facilities, inhalation of PFAS does not seem to be a major pathway contributing to health risks.

Threshold risks levels

	Total hazard quotients for ingestion ($\sum 15 \text{ PFAS HQ}_{\text{ing}}$)	Reference threshold for HQ
Site A	1,5E-02	1
Site B	4,2E-02	1
Site C	8,3E-02	1

- HQ for ingestion are inferior to the unity.
- The contribution of the ingestion of foodstuffs seems to be the major pathway contributing to health risks for PFAS.

Non-threshold risks levels

Facility	Total hazard EIR for ingestion (Σ PFOA + PFOS EIR _{ing})	Reference level
Site A	4,9E-09	1E-05
Site B	6,1E-07	1E-05
Site C	3,4E-06	1E-05

- EIR for ingestion are inferior to the reference value of 1E-05.
- EIR is the indicator that seems to contribute the most to the risk.

Main take-aways and outlook

Emissions of PFAS and impact on air concentrations:

- Individual PFAS emissions for all considered facilities range from 6E-03 g/day to 8E-02 g/day;
- An average waste treatment plant generates PFAS concentrations in the air lower than those measured by ATMO AURA around Lyon and Pierre-Bénite.

Risk evaluation:

- Inhalation does not seem to contribute significantly to health-risks associated with PFAS;
- For ingestion, cancerous risk translated by EIR indicator seems to be the major contributor to health risks.

General conclusion:

For all sites studied, adopting a conservative approach, the health risk assessment demonstrates compliance with the risk acceptability criteria.