Ambient Air Monitoring Methods

An Overview

Presentation for the CEWG

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The Challenge

"No single method can address all possible questions about a given aerosol, nor can any single method answer a given question for all possible aerosols." [1]

[1] Mary E. Eide and Dean R. Lillquist, "Sampling and Sizing of Airborne Particles," in The Occupational Environment: Its Evaluation, Control, and Management, 3rd Ed., 2011

A Wide Range and Complexity of Applications

Crucial Considerations

- Understand the capabilities and limitations of the methods being considered
- Follow written procedures and protocols
- Document carefully and completely

→ Proper selection of a method & meaningful results

What is Monitored?

- An ambient air monitoring method typically is selected based on an interest in a specific substance or in a class (category) of substances
  - Underlying this selection is a knowledge or prediction of background conditions and/or of emissions of substances from point, area, or mobile sources in the vicinity of a particular location
- One method cannot identify and quantify all or even most of the many substances in ambient air
  - Widely varying chemical, physical, and other properties among substances

Essential Requirements of a Method

- Validated / standardized (e.g., EPA, NIOSH, ASTM, ANSI,…)
  - Expected to be reliably accurate, precise, & free of bias
  - Modifications to methods also must be validated
- Specificity
  - Able to identify the substance(s) of interest
- Sensitivity
  - Able to quantify substance(s) at sufficiently low levels
    - Lowest detectable value (limit of quantitation) that is below the applicable regulatory, screening, or recommended level
- Insignificant or no interferences
  - Either positive or negative

One- or Two-Step Process

- Air sampling or measurement of ambient air
  - Preparation of equipment
  - Sampling or direct measurement of air
    - Often involves pumping air, at a known rate & volume, into:
      - Different types of collection media (e.g., a filter for particles) or containers (e.g., a canister for volatile organic compounds)
      - An analyzer (e.g., ozone)
    - Open-path direct measurement/analysis of air (e.g., OP-FTIR)
  - Retrieving, preparing, and shipment of samples
  - Calibration of air-sampling and direct-measurement equipment, using traceable standards
- Laboratory analysis
  - Lab accredited in type of analysis being conducted
    - Follows recognized QA/QC processes; successfully participates in an inter-laboratory performance/proficiency verification program

Monitoring Time Intervals

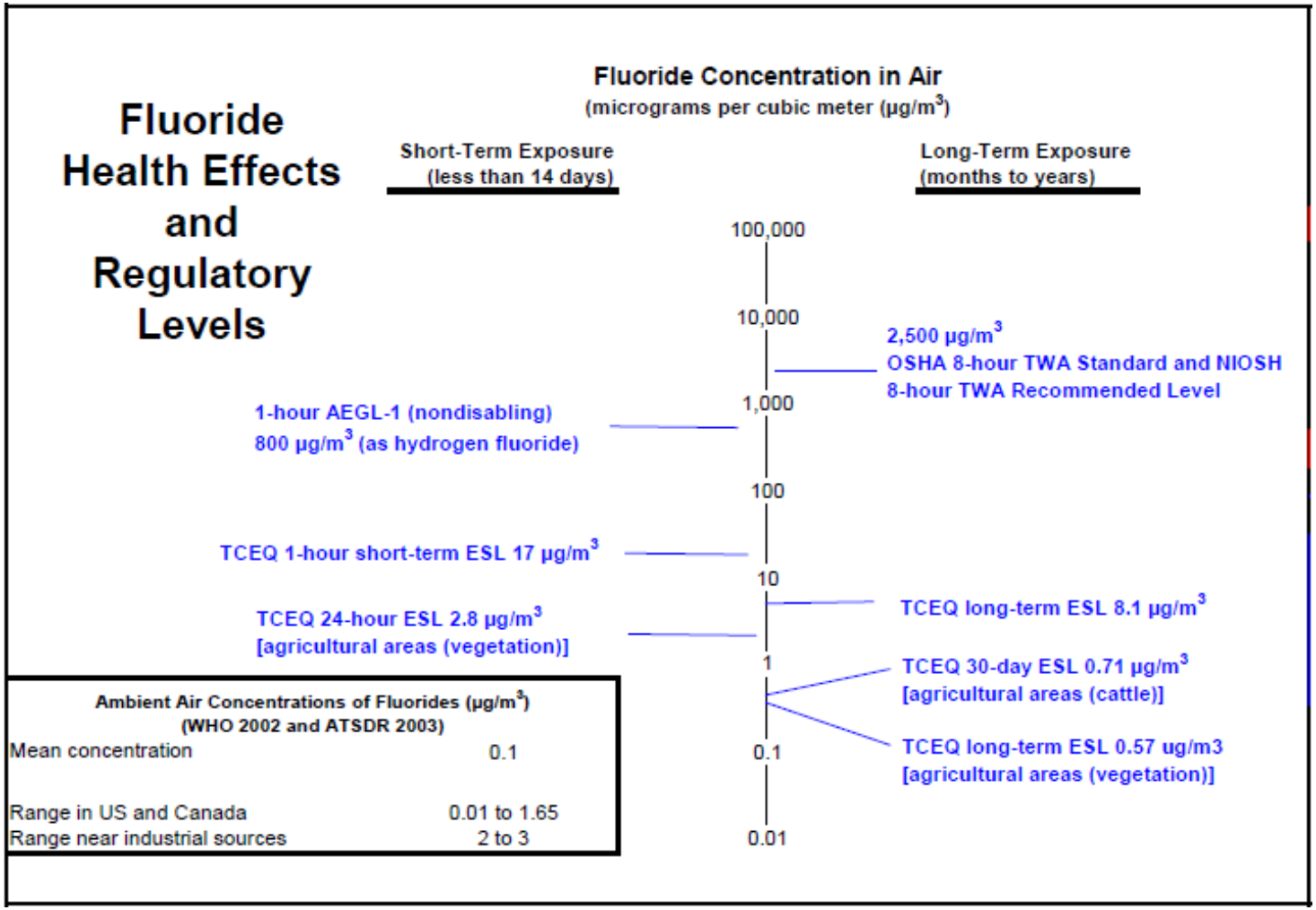
- "Real-time" (direct reading) air measurement
  - Continuous updates of measurements in display
    - Response time ranging from almost instantaneous to a slight/short delay
    - Necessary if 'peak' or 'ceiling' limits/regulations exist
- Integrated air sampling
  - Average concentration over a desired time interval
    - One-hour, eight-hour, 24-hour, monthly, or yearly
      - Applicable to most ambient air regulations and screening levels
    - Real-time also can provide average interval values
- Grab air sampling
  - Rapid collection of air samples (e.g., 15-sec. canister)

Example: Soluble Fluorides in Ambient Air
What would be monitored?

- Fluorides in the air can exist in different forms:
  - Gaseous (i.e., gases)
    - Gas could be a soluble fluoride (e.g., hydrogen fluoride (HF))
      - HF barely is a gas at room temperature (has a relatively low boiling point)
    - Gas could be a non-soluble fluoride (e.g., sulfur hexafluoride (SF_6)) with a low biologic activity (i.e., low risk to health & vegetation)
  - Aerosol (i.e., solid particles and liquid droplets)
    - Solid could be a soluble fluoride compound (e.g., sodium fluoride) or another type of solid with fluoride (gaseous or aerosol) adsorbed onto the solid's surfaces
    - Solid could be a non-soluble fluoride compound (e.g., calcium fluoride) that has a low biologic activity
    - Water droplets could contain solid fluoride compounds and/or gaseous fluorides that have dissolved into the water
    - Condensation droplets of HF: possible at lower air temperatures?

Fluorides Example, cont.

What are the measurement levels of interest?



Source: Figure 1, Hydrogen Fluoride and Other Soluble Inorganic Fluorides, TCEQ, 2009

Fluorides Example, cont.
Monitoring requirements & possible methods

- Distinguish between and quantify:
  - Gaseous and aerosol fluorides, as soluble & non-soluble
- Sufficiently low limit of quantitation (LOQ)
  - Comparison to ATSDR MRL, CA REL, TCEQ ESLs/ReVs, …
- Modified NIOSH method # 7902
  - LOQ (as F): 0.38 µg/m^3 gaseous & 1.7 µg/m^3 aerosol, with a 24-hour air sample
- Modified EPA Compendium Method IO-4.2
  - LOQ with a 24-hour sample ~1/10^{th} of #7902, but method is considerably more complex and less portable
- Direct reading instruments (HF only); LOQ ~1 µg/m^3

TCEQ Comparison Levels

Table 1-1. Application of ESLs, ReVs, and URFs in Various TCEQ Program Areas			
	Air Permitting	Air Monitoring	1993 Risk Reduction Rule and 1999 Texas Risk Reduction Program
Short-term Exposure	Short-Term ESL[a]	Acute ReV	NA
		$^{acute}ESL_{odor}$	NA
		$^{acute}ESL_{veg}$	NA
Long-term Exposure	Long-Term ESL[b]	Chronic ReV	Chronic ReV
		URF	URF
		$^{chronic}ESL_{veg}$	NA

[a] Lowest value of $^{acute}ESL_{generic}$, $^{acute}ESL$, $^{acute}ESL_{odor}$, or $^{acute}ESL_{veg}$ (Figure 1-1)

[b] Lowest value of $^{chronic}ESL_{linear(c)}$, $^{chronic}ESL_{linear(nc)}$, $^{chronic}ESL_{nonlinear(c)}$, $^{chronic}ESL_{nonlinear(nc)}$ or $^{chronic}ESL_{veg}$ (Figure 1-2)

NA - Not applicable

Source: Guidelines to Develop Effects Screening Levels, Reference Values, and Unit Risk Factors, TCEQ, 2006