

Hydrogen Sulfide (H<sub>2</sub>S) —  
New issues in  
U.S. EPA Regulation and Toxicology

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# Why do we care about hydrogen sulfide (H<sub>2</sub>S)?

- Used as an odor indicator
- Often drives EPA-style health risk assessments, because of its very stringent RfC
- Low level-exposures are asserted, by some, to cause “irreversible brain damage”



# Federal regulation of H<sub>2</sub>S

- Background (Congress; U.S. EPA)
  - Hazardous Air Pollutant (HAP) or not?
  - Reportable under Right to Know laws or not?
- EPA Proposal of February 2010 *re* H<sub>2</sub>S
- Toxicology of low-level exposures



# Hazardous Air Pollutant (HAP), history

1970: Congress creates the Clean Air Act

➤ Under Section 112 of the Act, EPA must list, then regulate Hazardous Air Pollutants (HAP's)

➤ Congress defines a HAP as:

A chemical that causes or contributes to ambient air pollution, which pollution could result in serious disease or death

➤ Over the next 20 years, EPA lists seven chemicals as HAP's



# Original HAP's 1970 - 1990

Arsenic

Asbestos

Benzene

Beryllium

Mercury

Radionuclides

Vinyl chloride



# Congress under significant pressure to amend the CAA

➤ 1990: Congress amends CAA

➤ Creates a HAP list of its own

➤ Lists 189 chemicals

➤ H<sub>2</sub>S is on the list

But only because of a clerical error?



## Backstory *re* H<sub>2</sub>S as a HAP

- Oil & gas industry, others concerned about regulation of sour crude, sour gas, petroleum refineries, other sources
- Industry lobbies Congress in 1990
- In 1991, Joint Resolution of Congress removes H<sub>2</sub>S from list
- Not every stakeholder is pleased
  - NRDC and State of New York take action on a related front



In 1986, Community Right-to-know Act passed

- This Act creates the Toxics Release Inventory (TRI)
- NRDC/New York petition EPA, arguing that H<sub>2</sub>S should be a TRI-reportable chemical
- 1993: U.S. EPA agrees
  - but then issues an administrative stay which has lasted 17 years



- Feb. 2010: EPA *proposes to lift the stay* regarding H<sub>2</sub>S and reporting to the TRI
  
- Many comments received on this proposal
  - Potentially regulated community says it is unjustified and/or infeasible
  - Sierra Club, NRDC, others say it is long overdue
  
- I expect that H<sub>2</sub>S will indeed become a reportable chemical



## Toxicology/Regulatory policy

- H<sub>2</sub>S in air dangerous/deadly at high concentrations
- Workplace guidelines/standards to protect health
  - Most stringent (ACGIH)= 1,000 parts per billion (ppb)
- EPA “reference concentration” (RfC; safe level) for ambient air = 1.4 ppb
  - Near large sources of H<sub>2</sub>S, ambient air concentrations can range up to 30 ppb
  - Why is the RfC so low?

## Basis for RfC

Laboratory rats exposed to H<sub>2</sub>S in air for 6 hours/day, 7 days/week, 10 weeks [ Brenneman *et al.* (2000)].

At 80,000 and 30,000 ppb, loss of olfactory neurons  
At 10,000 ppb, no observed effects (NOAEL)

EPA then applies *five* different adjustments/safety factors to this NOAEL rat to derive its RfC of 1.4 ppb

## Basis for RfC, continued

1. Divide  $\text{NOAEL}_{\text{rat}}$  by 4, to account for 6 hours exposure v. 24 hours in a day. Thus, “predicted”  $\text{NAEL}_{\text{rat}} = 2,500$  ppb. (Haber’s Law)
2. Divide  $\text{NAEL}_{\text{rat}}$  by 5.4 to account for rat: human breathing volume differences. Thus,  $\text{NAEL}_{\text{human}} = 460$  ppb.
3. Divide  $\text{NAEL}_{\text{human}}$  by 10 to account for interindividual sensitivities
4. Divide again by 10 to account for subchronic exposure
5. Divide again by 3 to account for possibility that humans are more susceptible than rats.

## Basis for RfC, continued

Are all of these safety factors needed?

➤ I do not think so

➤ Haber's law

*concentration x time = equivalent toxic potency*

*does not apply* to human physiologic response to H<sub>2</sub>S

➤ Humans are *less* sensitive than rats, due to differences in anatomies of nasal passages

➤ Workers *do* lose olfactory neurons, but only at H<sub>2</sub>S concentrations > 100 ppm (100,000 ppb)

## Additional issues re H<sub>2</sub>S in ambient air

### Community-based studies near H<sub>2</sub>S sources

- Kilburn, Legator, *et al.* report neurobehavioral changes in people exposed to ppb-levels
  - Studies are peer-reviewed, but have substantial methodological flaws/limitations
  - Regardless, the idea that ppb-levels of H<sub>2</sub>S causes irreversible brain damage is often raised in public meetings



## Additional issues re H<sub>2</sub>S in ambient air, continued

- Sierra Club *et al.* (2010) request that EPA include MSW landfills in its national inventory of H<sub>2</sub>S sources
- I expect that EPA will propose to put H<sub>2</sub>S (back) on the list of HAP's
- More generally, health concerns will accompany nuisance concerns whenever H<sub>2</sub>S is expected/detected in ambient air



## Suggested reading

EPA's February 2010 proposal and docket (H<sub>2</sub>S and TRI)

<http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-TRI-2009-0844>

EPA's *Toxicological Review of Hydrogen Sulfide* (June 2003)

<http://www.epa.gov/IRIS/toxreviews/0061tr.pdf>

Fiedler *et al.* (2008) Sensory and cognitive effects of acute exposure to hydrogen sulfide. *Environ Health Perspect.* 116:78-85.

Marshall *et al.* (2009) Provisional Advisory Levels (PALs) for hydrogen sulfide. *Inhal Toxicol.* Dec;21 Suppl. 3:56-72.