NAPHTHALENE ASSAYS & IMPLICATIONS

The Model & Meaning Of Naphthalene's Reassessment As A Potent Carcinogen

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This presentation presents the observations of the author and does not necessarily reflect the views or policies of the U.S. Air Force

OUTLINE

- What Started All The Fuss?
- What is naphthalene?
- Is Its Cancer Designation Significant?

  IMPACTS! IMPACTS!
- What's the "state of the science"?
- Coming to an informed predicate for better risk assessment & risk management

WHAT STARTED ALL THE FUSS?

New Data - EPA Targets Naphthalene

- Two Important NTP Bioassays Started All The Fuss!
  - NTP 2-yr inhalation bioassays - cancer in rodents!
    - Mouse (1992) - cytotoxicity w lung neoplasia
    - ➔ **Rat (2000) - cytotoxicity w nasal neoplasia (rare!)**
    - ➔ **"reasonably anticipated to be a human carcinogen"**
- EPA-IRIS fast-tracked naphthalene's re-examination
  - Risk assessment model predicts **2 ppt** as E-6 *de minimus* risk!
  - Various stakeholders questions review's process and substance
  - Document release postponed

WHAT IS NAPHTHALENE?
Moth Balls

- Profile

  White solid & polyaromatic hydrocarbon of modest volatility, sublimes at room temperature - a natural constituent of fuels, lubes, asphalts.
- Industrial production & use

  Petroleum cracking, coal tar distillation, feedstock for plasticizers, azo-dyes, carbaryl, creosote constituent, octane improver
- Environmental Sources

  Fossil fuel exhaust, cigarette & wood smoke, asphalts & sealants, pesticide, some fruits/vegetables, shellfish, BBQ meats, breast milk
- Ingestion & metabolism & effects
  - Absorbed through all routes
  - Metabolized via cytochrome P450 - ~30 metabolites identified
  - Toxicity: hemolytic anemia, nausea/vomiting, CNS, kidney, liver effects, coma

WHAT IS NAPHTHALENE?

Occupational & Regulatory Guidelines*

* [Non-cancer reassessment also under way]

ACGIH	10 ppm (STEL=15)		
NIOSH	10 ppm (STEL=15; IDLH=250)		
OSHA	10 ppm		
AIHA (WEEL & ERPG)	n/a		
NAC-AEGL (AEGLs)	n/a		
EU (SCOEL)	“not feasible” (NTP & other bioassays)		
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EPA (drinking water)	0.1 – 0.7	mg/L	
EPA (non-cancer)	0.02	mg/kg/D	(RfD – lifetime)
	0.003	mg/m^3	(RfC – lifetime)
EPA (cancer – inh)	**0.0000107**	**mg/m^3**	**(2 ppt)****

****de minimus**

IS THE CANCER DESIGNATION SIGNIFICANT?

Impact: It Might Brand Our Fuels As Carcinogens!

- CHANGE TO JP-8 FROM JP-4 (1996)
  - Safety & logistics
- THE UNIVERSAL FUEL
  - Airplanes, helicopters, tanks, trucks, space heaters, stoves, generators, dust suppression … coolant …
  - Kerosene + additives = commercial Jet-A & JP-8
- ANNUAL CONSUMPTION

  USAF -> DoD -> Civ Av -> USA -> World Wide

  2.5 -> 5.5 -> 25 -> 30 -> 60 **BILLIONS OF GALLONS**
- **29CFR 1910.1000: If carcinogen content =/> 0.1%, the mixture considered carcinogenic**

  Crude oil >/=0.1% Gasoline 0-5%

  Jet fuel 1-3% Additives & blends </=10%

IS THE CANCER DESIGNATION SIGNIFICANT?
Impact: Economics of Removal

- Price impact to remove it from jet fuel?
  - Take benzene out of gasoline: 2-5 ¢/gal [per API]
  - Take naphthalene out of jet fuel: 15-50% increase [per API]

		27 ¢/gal	90 ¢/gal
• $1.80/gal [base price]			
• AF uses ~ 2.5 **B** gals	→	$ 675 M	$ 2250 M
• DOD uses ~ 5.5 **B** gals	→	$ 1485 M	$ 4950 M
• USA uses ~30 **B** gals	→	$ 8100 M	$ 27000 M

  - Any regulatory requirement would seem to meet OMB criteria for “highly significant” impact - triggering review

IS THE CANCER DESIGNATION SIGNIFICANT?
IMPACT: ESOH

A

B

A. KC-135 Cold Weather Start

B. Aircraft Service Operations – confined space entry & exposure

C. Fuel Bladder Failure

C

IS THE CANCER DESIGNATION SIGNIFICANT?
Impact: ESOH Environmental Monitoring

- Where does the AF find naphthalene?
  - Search AFCEE's ERPIMS database:
    - Most AF bases detect naphthalene somewhere
    - Percent of samples w detects:
      groundwater, 63%; soil, 33%;
      Sediment, 2%; surface water, 2%
    - Common sites – underground storage tanks & pipelines, landfills, spills
- Can we analyze for it?
  - Most bases exceed proposed criteria for soil & water. Air?
    - Current analytical methods probably OK for soil: **820 ug/kg**
    - Current methods not sensitive enough for water: **0.04 ug/L**
    - Current methods not sensitive enough for air: **0.01 ug/m^3**

Adapted from Menzie Cure Assoc. [+] Mr. Phillip Hunter (HQ AFCEE)

IS THE CANCER DESIGNATION SIGNIFICANT?

IMPACT: AF Stewardship

- Safety & Operational Health Issues
  - Impacts on storage, transport, handling, use
  - Base-level occupational health programs affected
    - personnel training, engineering controls, PPE, monitoring air levels, medical surveillance, establishment regulated/restricted areas
  - ***Legacy issues from past exposures…***
- Environmental Restoration
  - Cleanup of 1000 sites w fuel at issue - cancer risk not addressed
  - ~50% AF sites w fuel contamination - common analyte at AF sites
  - ***Records Of Decision may reopen for review***
- Overall cost impact unknown – assumed to be large

IS THE CANCER DESIGNATION SIGNIFICANT?
Impact: National Emissions Compliance

- **EPA's *de minimus* risk estimate** — **2 ppt**

- Naphthalene in Cal So. Coast LA air shed — ~120 ppt
  - Fresno, CA – inside homes & schools — 89 ppt
  - outside — 41 ppt
- Airborne concentrations for most urban areas — ~50-100 ppt
- Canada – overall mean for urban & rural areas — 84 ppt
- European Union
  - Industrial median — 822 ppt
  - Creosote industry — > 37,600 ppt
  - Mothball manufacturing — > 620,400 ppt

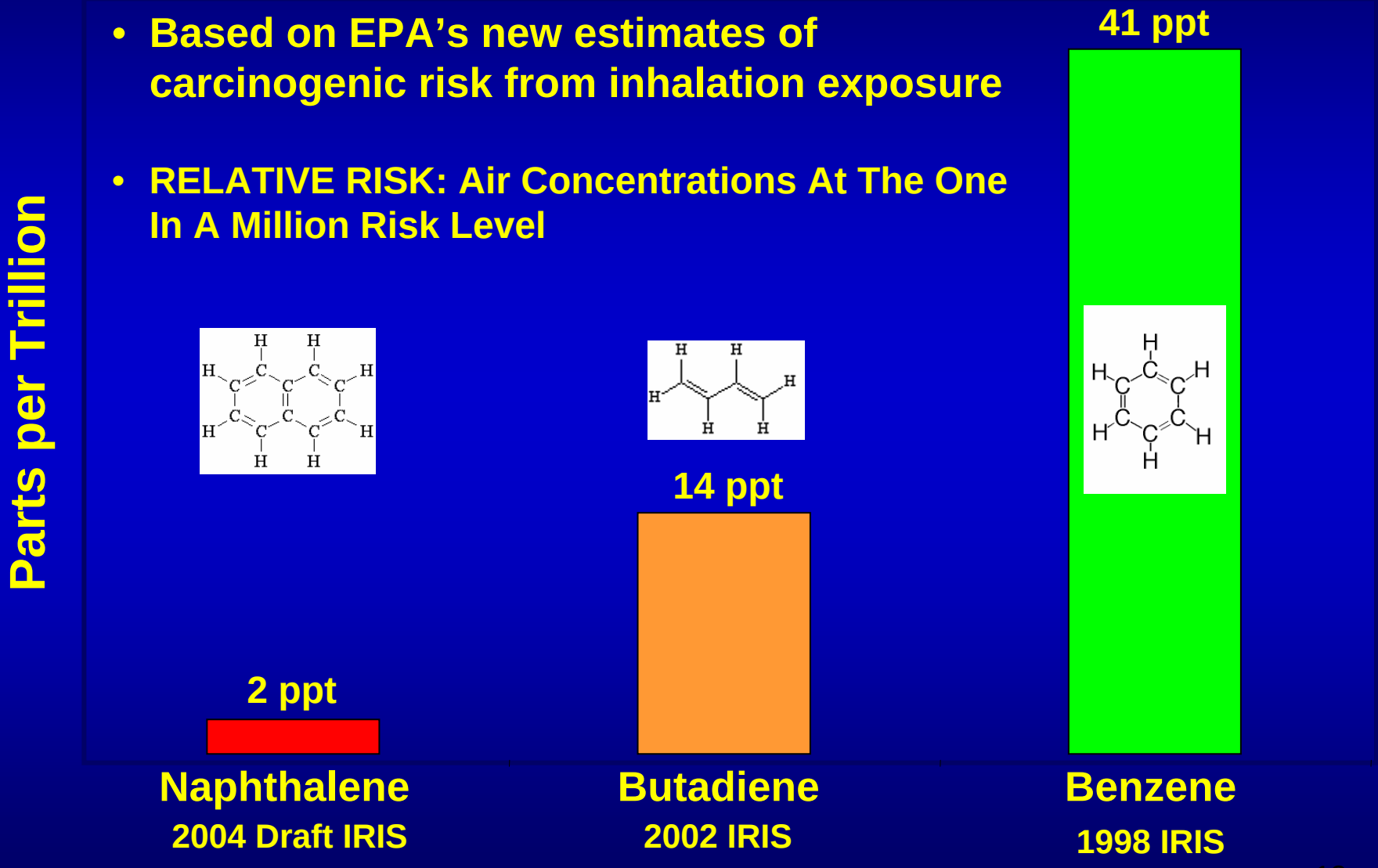
- **Can *<u>any</u>* major metropolitan area meet this standard ?**

STATE OF THE SCIENCE
Uncertainties Remain

- EPA conclusion per NTP bioassays
  - "reasonably anticipated to be a human carcinogen"
  - However, new draft assessment forthcoming – content unknown
- Naphthalene "State of the Science" Symposium
  - An accounting of what's known/unknown about the scientific issues attending naphthalene's CA potential to humans at *environmentally relevant doses.*
  - Goal - better informed risk assessment, management and policy.
- DOD response
  - "Issues, identified data gaps and possible studies to address areas of uncertainty associated with human cancer risks from the inhalation of naphthalene"
- Industry response
  - Executing $$M multi-faceted research plan to address the key gaps that remain in naphthalene's data base

STATE OF THE SCIENCE
INDUSTRY PERSPECTIVE

- **Based on EPA's new estimates of carcinogenic risk from inhalation exposure**
- **RELATIVE RISK: Air Concentrations At The One In A Million Risk Level**



Adapted from Dr. Cynthia Davin (EMBSI)

STATE OF THE SCIENCE
Epidemiologic Perspective - Where are the bodies?

- Yamane & D'Mello (AFIOH): Jet fuel exposure vs invasive cancer in AF population
  - *Preliminary assessment*: exploit existing dataset of cancer vs occupation
    - Jet fuel exposure ***not*** significantly associated w invasive cancer
- Dr. B. Magee (AMEC): Incidence of nasal cancer in the American population
  - EPA's potency factor for naphthalene in rats extrapolated to man
    - Predict ~2.5M lifetime cancers in man?
    - Annualized rate ~36,000/yr
    - Actual rate ~2,000/yr
  - Nasal cavity & paranasal sinus cancer – rare in man

- Is there a disconnect between animal studies and human experience?

Adapted from Yamane & D'Mello (AFIOH) [+] Magee (AMEC)

IS NAPHTHALENE IMPORTANT?
To DOD and to You!

- More informed data set key to a more informed evaluation – predicate for…
- **Risk Assessment – getting it right**
  - High stakes & limited data
  - Context - animal studies & human experience
- **Risk Management – doing it right**
  - Ubiquitous chemical in our every day environment
  - ESOH impacts diverse & wide spread – legacy issues
    - people; cleanup & restoration; current & past exposures
  - Balance responsibility & liability & cost

Questions?