

# Public Workshop on Draft Inhalation Unit Risk Factors for Acrolein and Ethylene Oxide



Sacramento – June 2, 2026

Los Angeles – June 4, 2026

Fresno – June 10, 2026

# Workshop Agenda

- Welcome and Introductions
- OEHHA Technical Presentations
- Public Comments on OEHHA Draft IURs
- CARB Presentation
- Questions and Discussion
- Closing Remarks



# Welcome and Introduction



# Workshop Goals

Learn about OEHHA's draft Inhalation Unit Risk (IUR) values for Acrolein and Ethylene Oxide (EtO)

Collect comments on OEHHA's draft IUR documents

Understand CARB's next steps and actions



# Community agreements

**Respect All Perspectives**

**Share the Space**

**Ask Questions**

**Focus on Understanding**

**Honor Lived Experience and Science**

**Keep Comments Constructive**

**Our commitment:** We are here to share the information, be accountable, listen, learn, and create a respectful space for meaningful public participation in the scientific review process.



# **OEHHA Public Workshop Technical Presentation**



# OEHHA Public Workshop Technical Presentation

## Part 1

- Background on OEHHA and what we do
- Why we developed draft Inhalation Unit Risk Factors (IURs) for Acrolein and Ethylene Oxide (EtO)

## Part 2

- What is an IUR and how it can be used to protect public health
- The process of developing health guidance values

## Part 3

- Summary of the Acrolein IUR Technical Support Document and public comment
- Summary of the EtO IUR Technical Support Document and public comment





OEHHA's mission is to protect and enhance the health of Californians and our state's environment through scientific evaluations that inform, support and guide regulatory and other actions.



# OEHHA: What We Do

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

## Public Health Goals

Perfluorooctanoic Acid and  
Perfluorooctane Sulfonic Acid  
in Drinking Water

March 2024



Pesticide and Environmental Toxicology Branch  
Office of Environmental Health Hazard Assessment  
California Environmental Protection Agency



CalEnviroScreen



CalHeatScore



PROPOSITION 65  
*Your right to know!*

BIOMONITORING  
CALIFORNIA

GOOD CATCH  
CALIFORNIA  
*Your Fish Advisor*

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

## Air Toxics Hot Spots Program

Isoprene

Cancer Inhalation Unit Risk  
Factor

Technical Support Document for  
Cancer Potency Factors  
Appendix B

January 2025



Air and Site Assessment and Climate Indicators Branch  
Office of Environmental Health Hazard Assessment  
California Environmental Protection Agency



# AB 2588 – Air Toxics Hot Spots Information and Assessment Act

CARB maintains a list of Hot Spots chemicals and requires stationary sources (facilities), via air districts, to submit emissions inventory to them.

**OEHHA assists CARB and local air districts with the Hot Spots Program – including identifying, assessing, and communicating the health effects of toxic and potentially toxic substances.**

Air Districts collect emissions data, submit Health Risk Assessments (HRAs) for OEHHA review, and administer programs.



# Rationale for developing an IUR for Acrolein



The Study of Neighborhood Air near Petroleum Sources (SNAPS) was launched



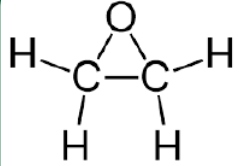
Air monitoring in Lost Hills detected elevated acrolein levels that drove non-cancer health risks



Classified as “probably carcinogenic to humans” by the International Agency for Research on Cancer



# Rationale for updating the IUR for Ethylene Oxide



EtO was designated a Toxic Air Contaminant in 1987 and a cancer value was adopted



New scientific evidence prompted US EPA to update their cancer value in 2016



Potential exposures to communities in California and across the nation



# OEHHA Develops Health Guidance Values

- OEHHA is the lead state agency for the assessment of health risks posed by environmental contaminants
- Use the best available science to develop an exposure level for a chemical below which there is no significant risk to human health
  - ▶ Examine evidence for cancer and non-cancer health effects
  - ▶ Use data from studies in animals and humans
  - ▶ Build in safety factors to protect sensitive individuals
  - ▶ Provide a benchmark against which we can compare exposure



# Types of Health Guidance Values

## Cancer: Inhalation Unit Risk Factors

- Estimate **lifetime cancer risks**
- Inhalation exposure to a concentration of **1 microgram per cubic meter**
- Can be converted to Cancer Slope Factor

## Non-cancer: Reference Exposure Levels

- Airborne concentrations below which we do not expect health effects
- **Acute** (1-hour, infrequent); **8-hour** (offsite worker); **Chronic** (lifetime)

Methods are outlined in OEHHA Guidance Documents for developing cancer (2009) and non-cancer (2008) HGVs

<https://oehha.ca.gov/air/air-toxics-hot-spots>



# What is an IUR?

- An IUR can be used to calculate the potential increase in a person's lifetime *risk* for developing cancer if they breathe in a certain *amount* of a chemical continuously over a long period of *time*.
  - *Risk* is the likelihood that a health outcome will occur. However, it does not mean a person **will** experience the outcome. It is a probability.
  - The *amount* of the chemical a person breathes in is their exposure. This depends on the concentration of the chemical in the air and the length of *time* a person is exposed. For the IUR,
    - The concentration is assumed 1 microgram per cubic meter ( $\mu\text{g}/\text{m}^3$ ).
    - It is assumed that a person is exposed for a lifetime (70 years).



# How is cancer risk estimated?

- Cancer risk is estimated by considering several things:
  - Cancer potency of the chemical
  - Exposure (concentration and duration)
  - Age-specific factors – children are not small adults
    - Breathing rates
    - Sensitivity to carcinogens



# Developing a cancer IUR



Literature review and data evaluation



IUR draft for public input (written comments & workshops)



Scientific Review Panel on Toxic Air Contaminants



Adoption and Implementation



# Developing a cancer IUR



## Literature review and data evaluation

- Occurrence and major uses in California
- Evaluate evidence of cancer-causing effects of the substance following inhalation exposure in humans and animals
  - Occupational and lab studies in humans and/or animals showing toxic effects
  - Evidence of genotoxicity or other characteristics of cancer-causing chemicals
- Establish an IUR based on scientific evidence and following OEHHA's methodology



# Developing a cancer IUR



IUR draft for public input (written comments & workshops)

- Collect written comments through our webpage - [oehha.ca.gov/comments](https://oehha.ca.gov/comments)
- In-person public workshops
  - At least two workshops
  - Interactive livestream is available
  - Recordings and slides are posted to OEHHA webpage



# Developing a cancer IUR



## Scientific Review Panel on Toxic Air Contaminants

- Draft is revised based on public comments and submitted to the Scientific Review Panel for Toxic Air Contaminants (SRP) for review
  - Nine appointed experts in various disciplines
  - Provide a technical review of Hot Spots documents
- A technical summary is presented to the SRP during a public meeting



# Developing a cancer IUR



## Adoption and Implementation

- IUR document is then finalized following revisions based on SRP input and approval by the SRP
- Technical Support Document is released, and final values are adopted into the Air Toxics Hot Spots program for use in health risk assessments



## Air Toxics Hot Spots Program

### Acrolein

### Cancer Inhalation Unit Risk Factor

Technical Support Document for  
Cancer Potency Factors  
Appendix B

Public Review Draft

May 2026

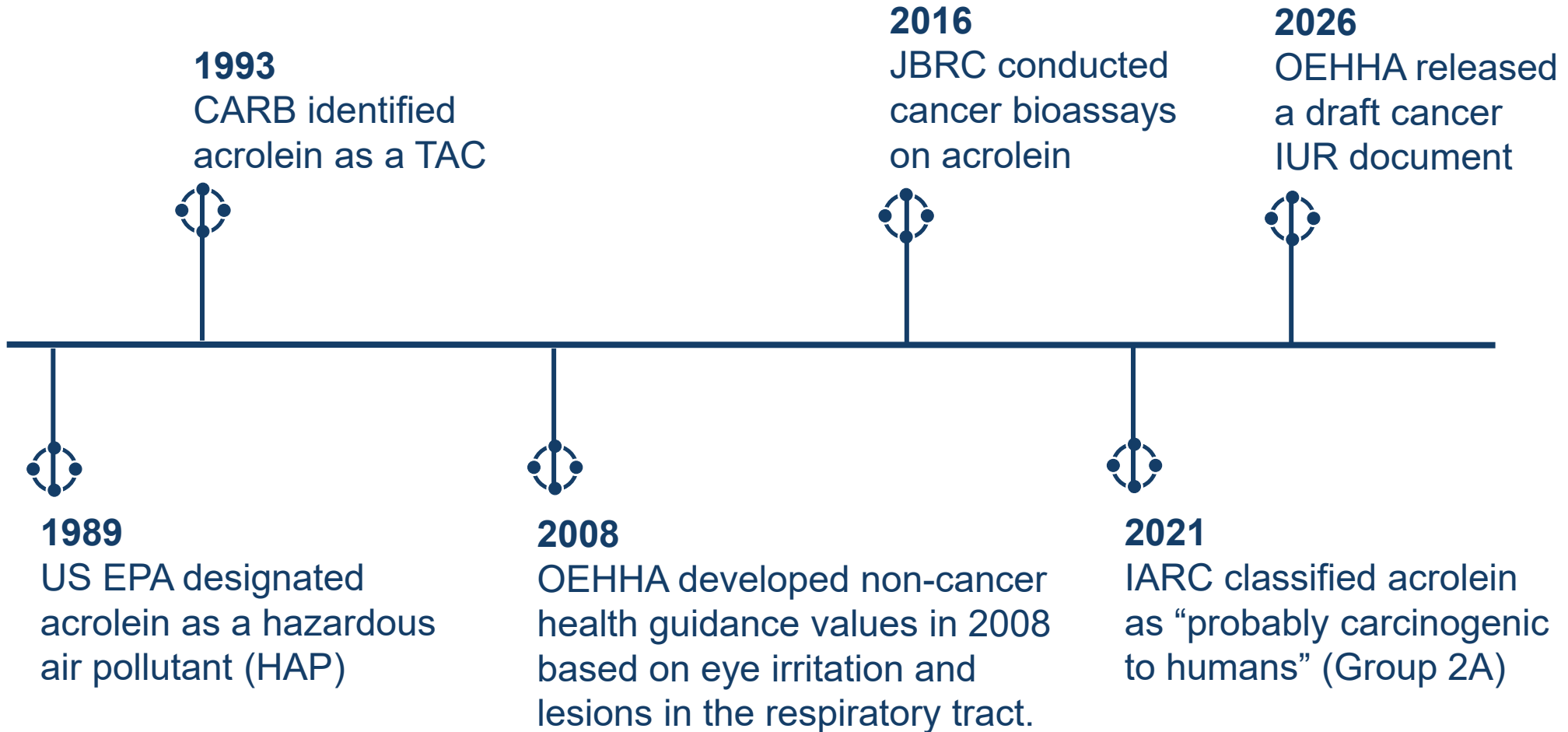


Air and Site Assessment and Climate Indicators Branch  
Office of Environmental Health Hazard Assessment  
California Environmental Protection Agency

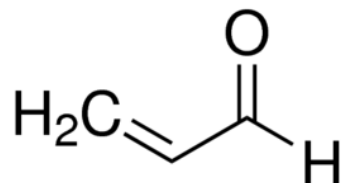
# Technical Summary of the Draft IUR for Acrolein



# Acrolein



# Properties, Uses, and Sources of Acrolein



Colorless to yellowish liquid with irritating odor

Boiling point: 52 to 53°C at 760 mm Hg

Vapor pressure: 217.5 mm Hg @ 20°C

Used in oil and natural gas production processes

Prevent growth of underwater plants and algae and as a disinfectant



Combustion of fuels, in wildfire smoke



Refineries, oil and gas operations, hazardous waste sites



Tobacco smoke and e-cigarette vapor



Formed from other chemicals in the atmosphere



Cooking through heating of oils



# Absorption and Metabolism of Acrolein

Up to 98% of inhaled amounts can be absorbed in the upper respiratory tract

- In humans, oral breathing can also deliver more acrolein to the lower respiratory tract

Acrolein is metabolized via glutathione and eliminated from the body via urine

- Half life of ~8-12 hours following oral exposure
- Metabolites of acrolein have been detected in urine samples of Californians

Acrolein can be produced within the human body at low levels and is detectable in exhaled breath in healthy non-smokers

- The breakdown of certain chemicals in the body (lipids and polyamines) is a source of endogenous acrolein



# Evidence of Cancer

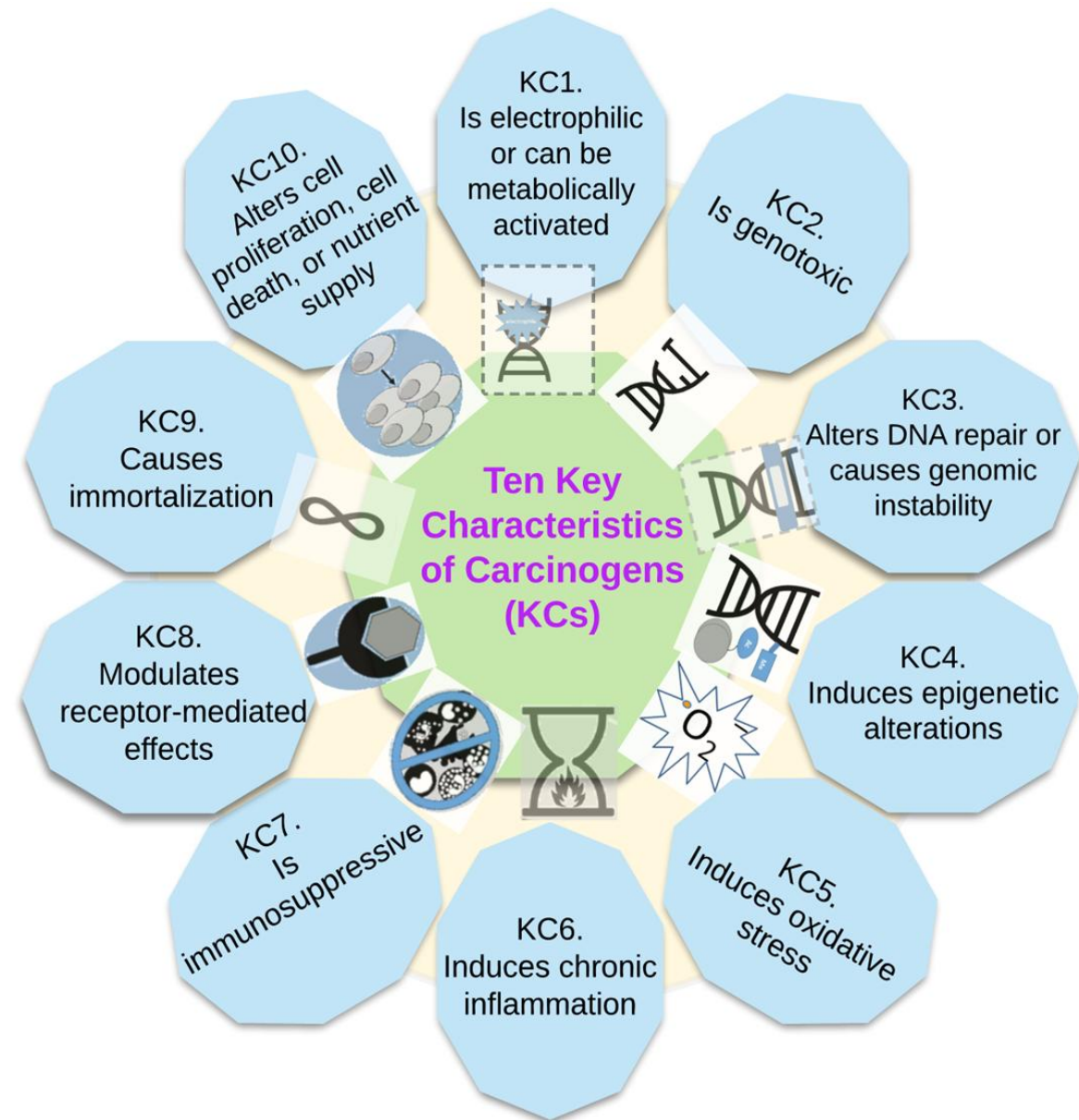
- In 2021, IARC classified acrolein as “probably carcinogenic to humans” (Group 2A)
  - Sufficient evidence in experimental animals, with strong evidence that acrolein exhibits multiple key characteristics of carcinogens (KCs)
  - In cancer studies in rodents, acrolein caused tumors in the nasal cavity, uterus, and lymph nodes
- No human studies provided the information needed to develop an IUR
- Acrolein IUR is developed based on animal studies



# Summary on mechanistic data

IARC found that acrolein exhibits multiple Key Characteristics of Carcinogens (KCs):

1, 2, 3, 5, 6, 7, and 10



Images of the KCs are adapted from Guyton et al. (2018) & Smith et al. (2020) with modifications by OEHA. See also Preamble to the IARC monographs (IARC 2019).

# Rodent Carcinogenicity Studies

## 1. Matsumoto et al. (2021); JBRC (2016)

- Male and female F344/DuCrI CrIj (SPF) rats
- Male and female B6D2F1/CrIj (SPF) mice
- 104 weeks exposure (6 hours/day, 5 days/week)
- 50 animals/group/sex

## 2. Feron and Kruysse (1977)

- Male and female Syrian Golden hamsters
- 52 weeks exposure (7 hours/day, 5 days/week) followed by a 29-week post-exposure period in clean air
- Single acrolein-only group [9.2 mg/m<sup>3</sup> (4 ppm) of acrolein], 18 hamsters/group/sex
- Also included groups with acrolein and other carcinogens



# Evidence of Cancer in Experimental Animals

## (Matsumoto et al. 2021; JBRC 2016)

- Female rats: increases in two types of rare nasal cavity tumors
  - Nasal cavity: A type of cancer of cells that are part of the surface of the nasal cavity (Squamous cell carcinoma)
  - Nasal cavity: A rare tumor made of muscle cells (Rhabdomyoma)
- Female mice: increases in three types of tumors at three sites
  - Nasal cavity: A benign gland-type tumor that grows inside the nose (Adenoma)
  - Uterus: a rare cancer of the immune cells in the uterus (Histiocytic sarcoma)
  - Lymph node: A cancer that starts in the lymph nodes, which are small glands that help your body fight infections (Malignant Lymphoma)



# IUR Derivation: Tumors modeled

(Matsumoto et al. 2021; JBRC 2016)

- Female Rats: combined incidences for rhabdomyomas and nasal squamous cell carcinomas in female rats
- Female Mice: incidences of nasal cavity adenomas and malignant lymphomas of the lymph nodes in female mice



# IUR Derivation: Average Daily Doses (ADD) (Matsumoto et al. 2021; JBRC 2016)

$$C = \text{Chamber concentration (ppm)} \times \frac{2.29 \text{ mg/m}^3}{1 \text{ ppm}} \times \frac{6 \text{ hrs}}{24 \text{ hrs}} \times \frac{5 \text{ days}}{7 \text{ days}} \times \frac{\text{weeks on study}}{104 \text{ weeks}}$$

$$\text{ADD} = \text{IR} \times C / \text{BW}$$

Species and Sex	Chamber Concentration	Lifetime ADD (mg/kg-day)
Female rats	0	0
	0.2 mg/m <sup>3</sup> , 0.1 ppm	0.047
	1.1 mg/m <sup>3</sup> , 0.5 ppm	0.24
	0.9 mg/m <sup>3</sup> , 0.4 ppm	0.95
Female mice	0	0
	0.2 mg/m <sup>3</sup> , 0.1 ppm	0.052
	0.9 mg/m <sup>3</sup> , 0.4 ppm	0.21
	3.7 mg/m <sup>3</sup> , 1.6 ppm	0.82



C, time-adjusted chamber concentration; IR, inhalation rate; BW, bodyweight; ppm, parts per million

# IUR Derivation: Determination of Cancer Slope Factor

- Linear extrapolation
- Determined the Cancer Slope Factor (CSF) using the Multistage Cancer Model in US EPA's Benchmark Dose Software (BMDS)
  - Used a Benchmark Response (BMR) of 5% extra risk to calculate Benchmark Dose (BMD)
  - The 95% lower confidence bound on the effective dose producing 5% response ( $BMDL_{05}$ ) is used to calculate cancer potency
  - $CSF = 0.05 / BMDL_{05}$
  - Multisite tumor analysis when applicable (female mice)



# IUR Derivation: Extrapolation to Human CSF

- Rodent CSFs ( $CSF_a$ ) were converted to human equivalents ( $CSF_h$ ) by multiplying an interspecies scaling factor, which is the ratio of human to animal body weights raised to the 1/4 power

$$CSF_h = CSF_a \times (BW_h / BW_a)^{1/4}$$

- The above interspecies scaling factor accounts for
  - pharmacokinetic differences (*e.g.*, metabolism)
  - pharmacodynamic considerations (*i.e.*, tissue responses to chemical exposure)



# BMDS modeling results for female rats and mice

(Matsumoto et al. 2021; JBRC 2016)

Sex Species	Tumor Site	BMD (mg/kg-d)	BMDL (mg/kg-d)	Goodness-of-Fit <i>p</i> -value	Animal CSF (mg/kg-d) <sup>-1</sup>	Human CSF (mg/kg-d) <sup>-1</sup>
<b>Female Rats</b>	Nasal Cavity: SCC & R	0.704719	0.443972	0.991	0.113	0.476
<b>Female Mice</b>	Nasal cavity: Adenoma	0.421449	0.278521	0.954	0.208	1.47
	Lymph node: Malignant lymphoma	0.502487	0.154967	0.257	0.374	2.64
	Multisite	0.361	0.148	NA	0.392	<b>2.76</b>



NA, not applicable; SCC, squamous cell carcinoma; R, Rhabdomyoma

# IUR Calculation: Final Step

- The multisite tumor  $CSF_h$  in female mice (Matsumoto et al. 2021) was chosen by OEHHA as the critical data set from which to derive the acrolein IUR
- Inhalation unit risk (IUR) =  $(CSF_h \times BR)/(BW \times CV)$

$$\begin{aligned} IUR &= (2.8 \text{ (mg/kg-day)}^{-1} \times 20 \text{ m}^3/\text{day}) / (70 \text{ kg} \times 1000 \text{ } \mu\text{g}/\text{mg}) \\ &= \mathbf{7.9 \times 10^{-4} \text{ (}\mu\text{g/m}^3\text{)}^{-1} [3.4 \times 10^{-4} \text{ (ppb)}^{-1}]} \end{aligned}$$



# Public Comments

## Draft Hot Spots IUR for Acrolein

- Public comment period extended to July 29, 2026
- Comments may be submitted electronically through the following link:  
<https://oehha.ca.gov/comments>.
- Comments can also be submitted in writing to:  
Rima Woods, Chief of the Air Toxicology and Risk Assessment  
Section, at [Rima.Woods@oehha.ca.gov](mailto:Rima.Woods@oehha.ca.gov)



**Public Comments on  
Acrolein IUR  
Technical Support Document**

**00:02:00**



# Break



## Air Toxics Hot Spots Program

### Ethylene Oxide

### Cancer Inhalation Unit Risk Factor

Technical Support Document for  
Cancer Potency Factors  
Appendix B

Public Review Draft

May 2026

### Ethylene Oxide

Air and Site Assessment and Climate Indicators Branch  
Office of Environmental Health Hazard Assessment  
California Environmental Protection Agency

# Technical Summary of the Draft IUR for Ethylene Oxide



# Update to the Ethylene Oxide Cancer IUR

- EtO is an irritant, a reproductive and developmental toxicant, and a carcinogen
- Designated a Toxic Air Contaminant in 1987 and an IUR was adopted
- OEHHA started work on updating the EtO cancer IUR under the Air Toxics Hot Spots program in 2022 by leveraging work done by US EPA
- OEHHA is now releasing an updated draft IUR for EtO

May 2022	SRP provided positive feedback on OEHHA's plan to adapt US EPA's 2016 assessment
April 2023	OEHHA released a draft document for public comment
February 2024	SRP provided input on the scientific issues in the Draft Cancer Risk Assessment of EtO
Activities since the SRP meeting	Revised the draft document based on newly available scientific information, public comments received, input from SRP, and discussions with various stakeholders

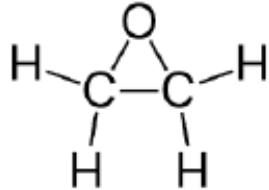


# EtO is a well-established carcinogen

- OEHHA (1987) – “known to the state to cause cancer” for the purposes of Proposition 65
- IARC (2012) – “carcinogenic to humans” based on limited evidence in humans and sufficient evidence in animals supported by strong evidence of a genotoxic mechanism
- US EPA (2016) – “carcinogenic to humans” based on strong (but less than conclusive) human evidence, extensive evidence in animals, clear evidence of genotoxicity with a mutagenic mode of action, and strong evidence that key precursor events are anticipated to occur in humans and progress to tumors
- NTP (2021) – “known to be a human carcinogen”



# Properties, Uses, and Sources of EtO



Colorless gas with a sweet odor

Boiling point: 51°C at 760 mm Hg

Vapor pressure: 1,095 mm Hg @ 20°C

Sterilization of medical and lab equipment

Production of other chemicals

Fumigation of agricultural products



Combustion of fuels, in wildfire smoke



Tobacco smoke and e-cigarette vapor



Incomplete combustion of fuel from mobile sources



Produced in small amounts by vegetation and other natural processes



# Summary of OEHHA's Updated Draft IUR for EtO

## Starting Point

- US EPA (2016) assessment – studies published since EtO IUR development in 1987

## OEHHA Effort

- Focused search for studies published since US EPA's 2016 assessment and evaluated new studies
- Evaluated quality of studies that may be useful for developing an IUR
- Assessed US EPA's approach, endpoints, and dose-response model selection
- Used the best available science to derive a draft updated IUR for EtO



# Absorption and Metabolism of EtO

EtO is efficiently absorbed in the respiratory tract

- Influenced primarily by ventilation rate and EtO air concentration due to solubility in blood

EtO is metabolized via hydrolysis and glutathione, and is eliminated from the body via urine and exhaled breath

- Half life depends on its concentration in the body

EtO can be produced within the human body at low levels

- Formed by conversion of ethylene in the body



# Endogenous Production of EtO

- Endogenous EtO:
  - Is produced by Cytochrome P450-mediated conversion of ethylene
  - Contributes to adduct levels, such as hemoglobin adduct N-2-hydroxyethylvaline (HEV), in humans and other species
- Endogenous ethylene is produced by:
  - Oxidation of methionine and hemoglobin
  - Lipid peroxidation of fatty acids
  - Metabolism of intestinal bacteria
- Percentage of ethylene converted to EtO:
  - Unknown for endogenous ethylene
  - ~3% for exogenous ethylene



# Genotoxicity

- EtO genotoxicity has been extensively reviewed and well established

*US EPA (2016)*

Clear evidence of genotoxicity

Sufficient weight of evidence to support a mutagenic mode of action

*IARC (1994, 2008, 2012)*

Strong evidence for a genotoxic mechanism

Consistent mutagenic and clastogenic action

*ATSDR (2022)*

Demonstrated genotoxicity

- 3 additional studies since US EPA (2016) review – findings are consistent with overall evidence



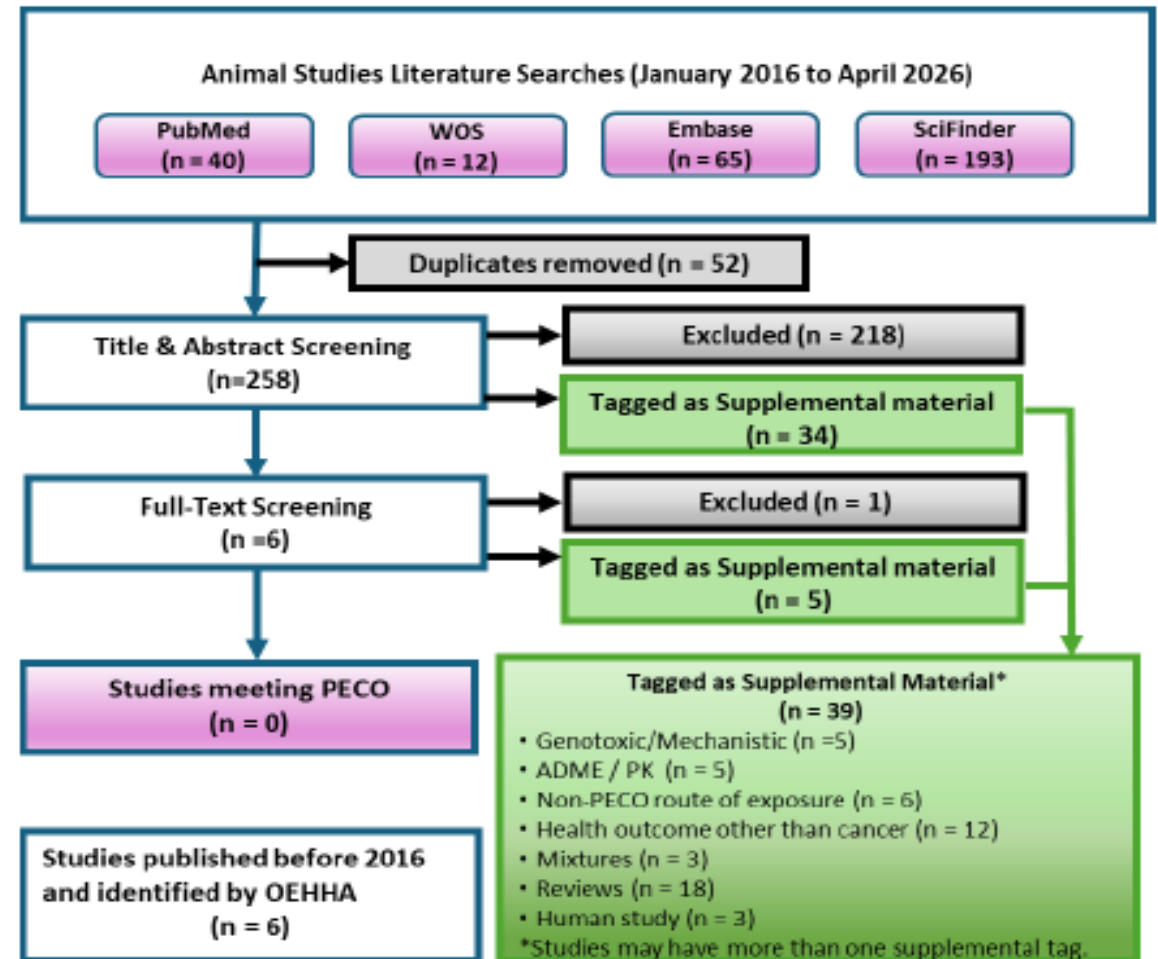
# Literature Searches

- OEHHA reviewed the US EPA IRIS assessment on EtO and identified three human studies with quantitative exposure estimates.
- OEHHA focused its new literature searches on identifying studies published since the 2016 US EPA review.
- OEHHA performed two separate searches; one for identifying studies in humans and the other for identifying animal cancer studies.
- Populations, Exposures, Comparators, and Outcomes (PECO) criteria were used to screen the search results to identify studies suitable for dose-response assessment



# Evidence of Cancer in Experimental Animals

- No new animal bioassays were identified by OEHHA's literature search covering 2016 to 2026
- All animal carcinogenicity studies included for IUR development were identified by US EPA (2016)



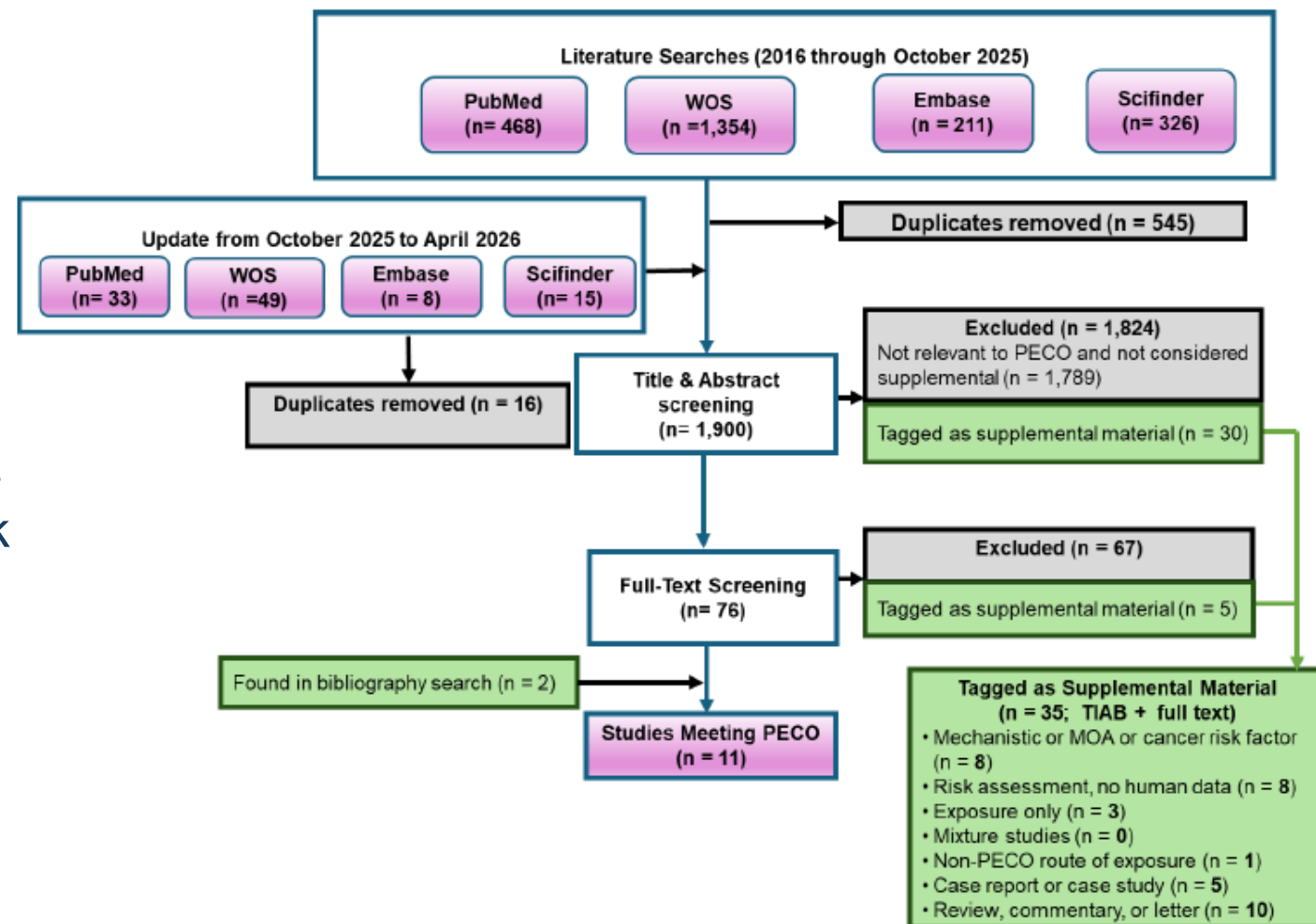
# Evidence of Cancer in Experimental Animals

- OEHHA reviewed the previously available cancer studies in animals
  - Male and female B6C3F<sub>1</sub> mice (NTP 1987)
  - Male and female Fischer 344 rats (Snellings et al. 1981, 1984; Garman et al. 1985)
  - Male F344 rats (Lynch et al. 1984)
  - Female Sprague-Dawley rats (Dunkelberg 1982)
- Current IUR, developed in 1987, is based on leukemia in female rats (Snellings et al. 1984)
- Evidence from studies in humans is more relevant and more sensitive than animal studies for deriving an IUR for EtO



# Evidence of Cancer in Humans

- 11 human studies were identified that meet the screening criteria
  - Bulka et al. 2016; Chen 2018
  - Jain 2020
  - Chen et al. 2024; Garcia et al. 2015\*;  
Hart et al. 2018; Ish et al. 2025; Jones et al. 2023; Kelly-Reif et al. 2025; Park 2020; Valdez-Flores et al. 2025



\*Garcia et al. (2015) was not included in USEPA's review (2016).



# Evidence of Cancer in Humans

- OEHHA reviewed the US EPA's 2016 assessment and identified three sets of studies that provided information useful for cancer dose-response assessment:
  - National Institute for Occupational Safety and Health (**NIOSH**) cohort: Steenland et al. (2003; 2004), (new) Kelly-Reif et al. (2025)
  - Union Carbide Corporation (**UCC**) cohort: Swaen (2009), (new) Valdez-Flores et al. (2025)
  - **Swedish study**: Mikoczy et al. (2011)
- The NIOSH retrospective cohort studies of lymphoid cancer mortality and breast cancer incidence were determined by OEHHA to be of high study quality and the most sensitive and valid epidemiologic studies for IUR calculations.



# Quantitative Cancer Risk Assessment

- OEHHA reviewed both human and animal studies identified suitable for dose-response
- OEHHA's draft updated EtO IUR is based on US EPA's 2016 analysis of the exposure-response relationship
  - NIOSH study (Steenland et al. 2003; 2004) is of high quality and is the best available study for exposure-response analyses
  - Two-piece linear spline model is the most appropriate for assessing the EtO cancer risks
  - No new scientific information necessitating modification to the IUR developed by the US EPA (2016)



# Epidemiological Study in Humans

## NIOSH (Steenland et al. 2003, 2004)

- The NIOSH retrospective cohort study
  - Included 17,530 workers from 14 US sterilization facilities in exposure-response analyses
- High quality study
  - Quantitative exposure estimates for individual workers
  - Large cohort size
  - Inclusion of women
  - Multiple study locations
  - Absence of important co-exposures
- OEHHA evaluation



# Epidemiological Study in Humans

## NIOSH (Steenland et al. 2003, 2004)

- EtO-exposed group: sterilizing medical supplies, treating spices, and/or manufacturing/testing medical sterilizers
- Endpoints:
  - Lymphoid cancer mortality (i.e., non-Hodgkin lymphoma, myeloma, and lymphocytic leukemia)
  - Breast cancer in females
- Exposure assessment:
  - Workplace EtO concentrations measured 1976-1985
  - Estimated using a validated multiple regression exposure model
- Follow-up: through 1998 (lymphoid cancer) and 2021 (breast cancer, with additional follow up reported by Kelly-Reif et al. 2025)



# US EPA – Modeling Considerations

- Extra risk =  $(R_x - R_o)/(1 - R_o)$ 
  - $R_x$  is the lifetime risk in the exposed population
  - $R_o$  is the lifetime risk in an unexposed population (i.e., the background risk)
- Risk estimates were calculated using the  $\beta$  regression coefficients and a life-table analysis that accounts for competing causes of death
  - Life-table analysis
  - Up to age 85
  - Occupational vs environmental

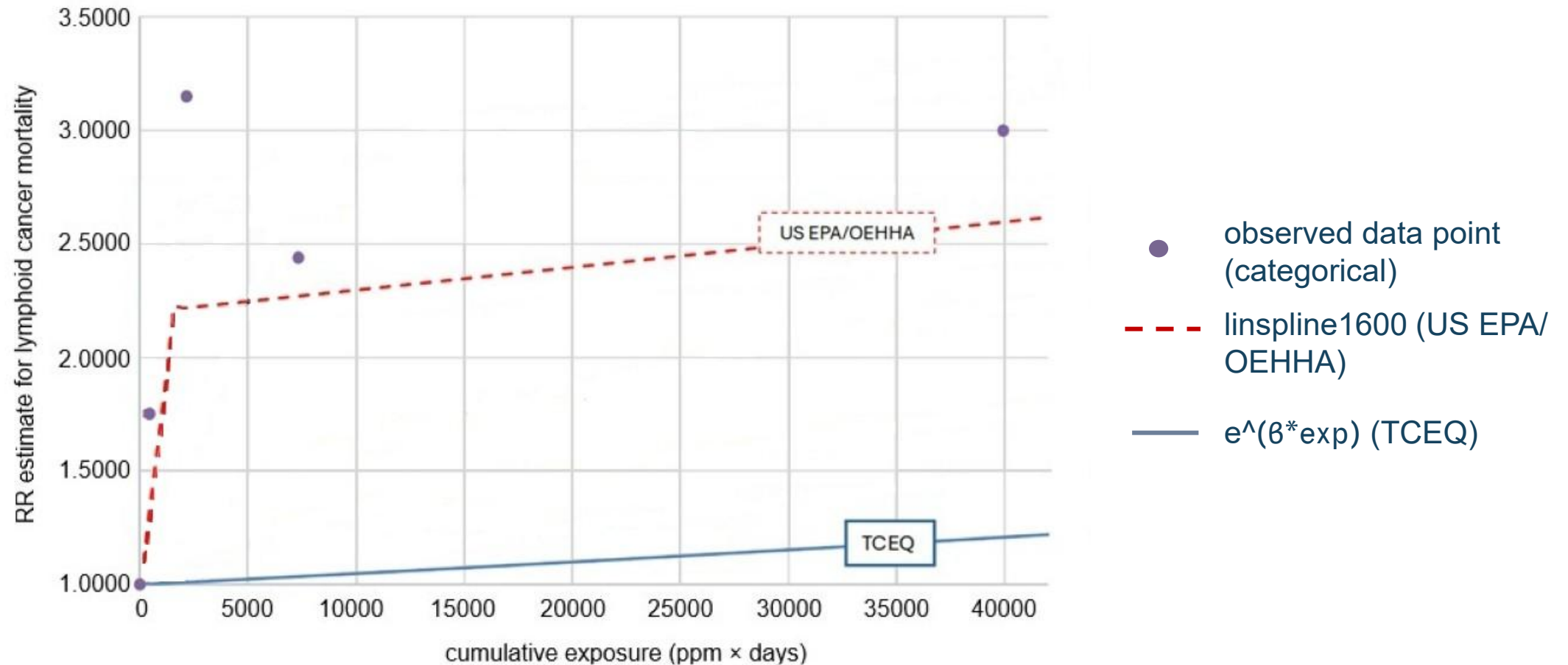


# Lymphoid Cancer Exposure-Response

- Assessment included various exposure-response models, lag periods, and mathematical transformations of the exposure variable
- US EPA (2016) concluded the two-piece linear regression spline model with a knot at 1,600 ppm-days provided the best biologically plausible fit to the data, especially in the lower exposure region
- OEHHA found that none of the other models evaluated fit the study data better than the two-piece linear spline model



# Relative risk estimates for lymphoid cancer from occupational EtO exposure (US EPA 2016)



# Lymphoid Cancer IUR

- $LEC_{01}$  (lower 95% confidence limit on the  $EC_{01}$ , the estimated effective concentration associated with 1% extra risk) for excess lymphoid cancer incidence
  - Determined using a life-table analysis and the lower spline segment from a two-piece linear spline model
  - Used to calculate the IUR via linear low-dose extrapolation from the  $LEC_{01}$
- IUR for lymphoid cancer incidence = **5.26 (ppm)<sup>-1</sup>**

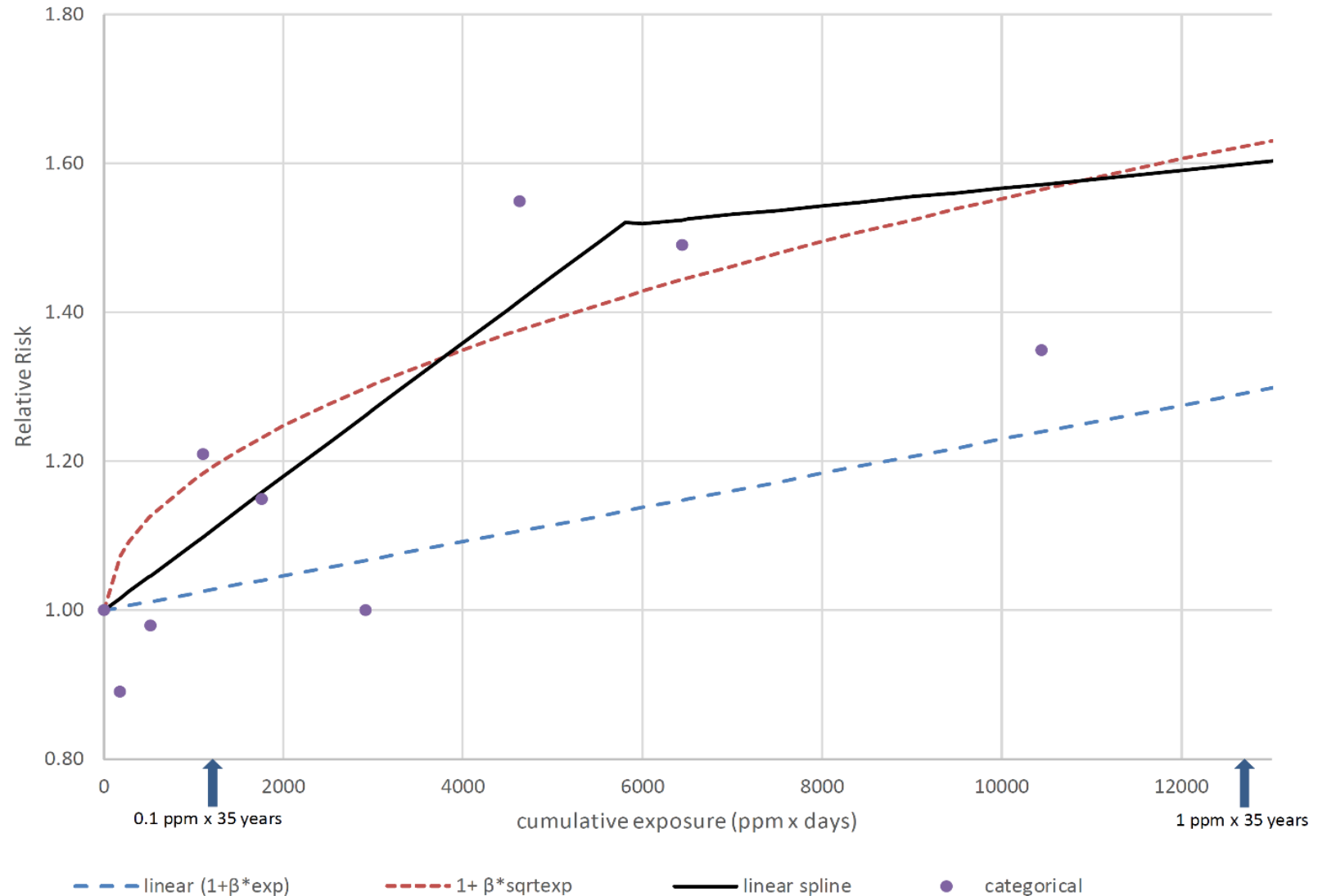


# Breast Cancer Exposure-Response

- Model selection (US EPA): Two-piece linear spline regression model
- OEHHA's evaluation:
  - Included several other exposure-response models
  - Determined none of the models had a better visual fit or lower  $p$ -values than the two-piece linear spline regression model
  - Concluded that US EPA's two-piece linear spline model is the most appropriate exposure-response model for estimating the lower-exposure breast cancer risks of EtO
  - Kelly-Reif et al. (2025): strengthens previous findings on elevated breast cancer risks with cumulative EtO exposure



# Relative risk estimates for breast cancer from occupational EtO exposure (US EPA 2016)



# Breast Cancer IUR

- $LEC_{01}$  for excess breast cancer incidence
  - Same life-table approach as with lymphoid cancer
  - Lower spline segment from the two-piece linear spline model for breast cancer and linear low-dose extrapolation
  - Risks at lower exposures estimated by linear extrapolation from the  $LEC_{01}$
- IUR for breast cancer incidence = **1.48 (ppm)<sup>-1</sup>**



# Total Cancer Risk Estimates

## Draft Updated EtO IUR

- US EPA combined the unit risk estimates for lymphoid and breast cancer
- Adult-based EtO Cancer IUR:
  - $3.0 \times 10^{-3} (\mu\text{g}/\text{m}^3)^{-1}$  [ $5.5 \times 10^{-3} (\text{ppb})^{-1}$ ]
  - Combined lymphoid cancer in males and females and breast cancer in females
- The IUR describes the excess cancer risk associated with lifetime (70 years) inhalation exposure to an EtO concentration of  $1 \mu\text{g}/\text{m}^3$ .
- Corresponding CSF is  $11 (\text{mg}/\text{kg}\text{-day})^{-1}$

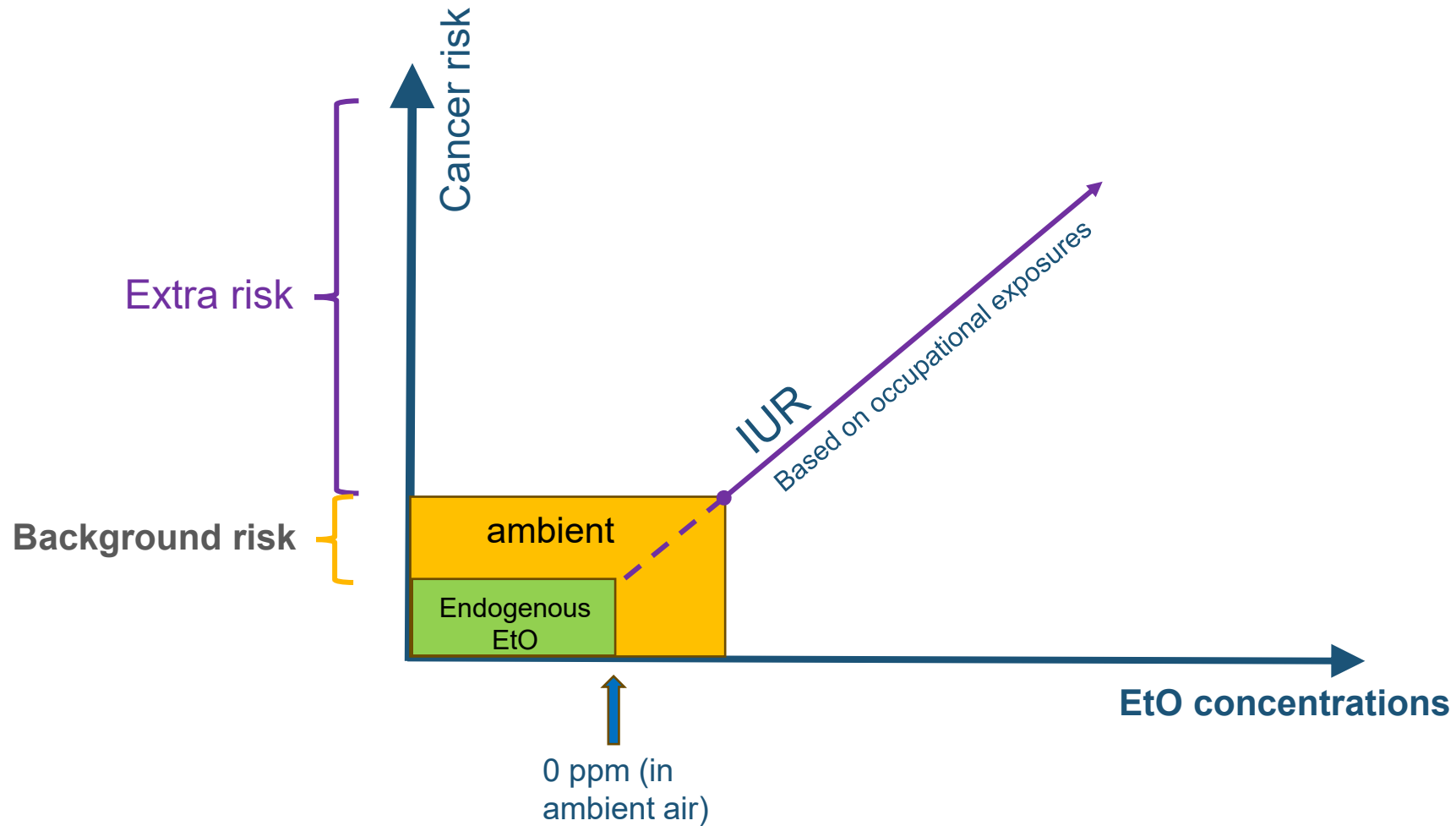


# Consideration of New Scientific Information

- Kelly-Reif et al. (2025)
  - An extended follow up of breast cancer mortality in the NIOSH cohort
  - Supports previous findings in this cohort that EtO is associated with breast cancer
- Valdez-Flores et al. (2025)
  - Update to an existing human study on the Union Carbide cohort
  - Does not fix the major problems with this cohort (e.g., concerns about the quality of the EtO exposure information, the exclusion of female participants, the potential impact of other chemical exposures, and the small number of cancer patients)
- Picciotto et al. (2026)
  - Provides fairly strong evidence that the healthy worker survivor effect exists in the NIOSH cohort
  - This effect likely biased the relative risk estimates towards the null



# IUR for EtO – ambient and endogenous levels



# Public Comments

## Draft Hot Spots IUR for EtO

- Public comment period extended to July 29, 2026
- Comments may be submitted electronically through the following link:  
<https://oehha.ca.gov/comments>.
- Comments can also be submitted in writing to:  
Rima Woods, Chief of the Air Toxicology and Risk Assessment  
Section, at [Rima.Woods@oehha.ca.gov](mailto:Rima.Woods@oehha.ca.gov)



# Public Comments on Ethylene Oxide IUR Technical Support Document

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# CARB Presentation



Public comment period extended to July 29, 2026

Comments may be submitted electronically through the following link: <https://oehha.ca.gov/comments>

Comments and question for CARB can be sent to [airtoxics@arb.ca.gov](mailto:airtoxics@arb.ca.gov)

