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## AIHA White Paper Findings: Emissions, Exposures and Health Risks

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# 2016 Winter Conference



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## **Seminar 51 - Electronic Cigarettes: An Emerging Issue for ASHRAE**

**AIHA White Paper Findings:  
Emissions, Exposures and Health  
Risks**

Orlando, Florida

# Learning Objectives

1. Describe the primary exposure concerns related to the use of e-cigarettes
2. Characterize some of the known air contaminants typically released from vaping, and describe the remaining knowledge gaps
3. Define the fundamental toxicological risks associated with vaping
4. Summarize the ways in which current ASHRAE Standards deal with tobacco smoking and related electronic devices

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# Acknowledgements

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## **Electronic Cigarettes in the Indoor Environment External Reviewers**

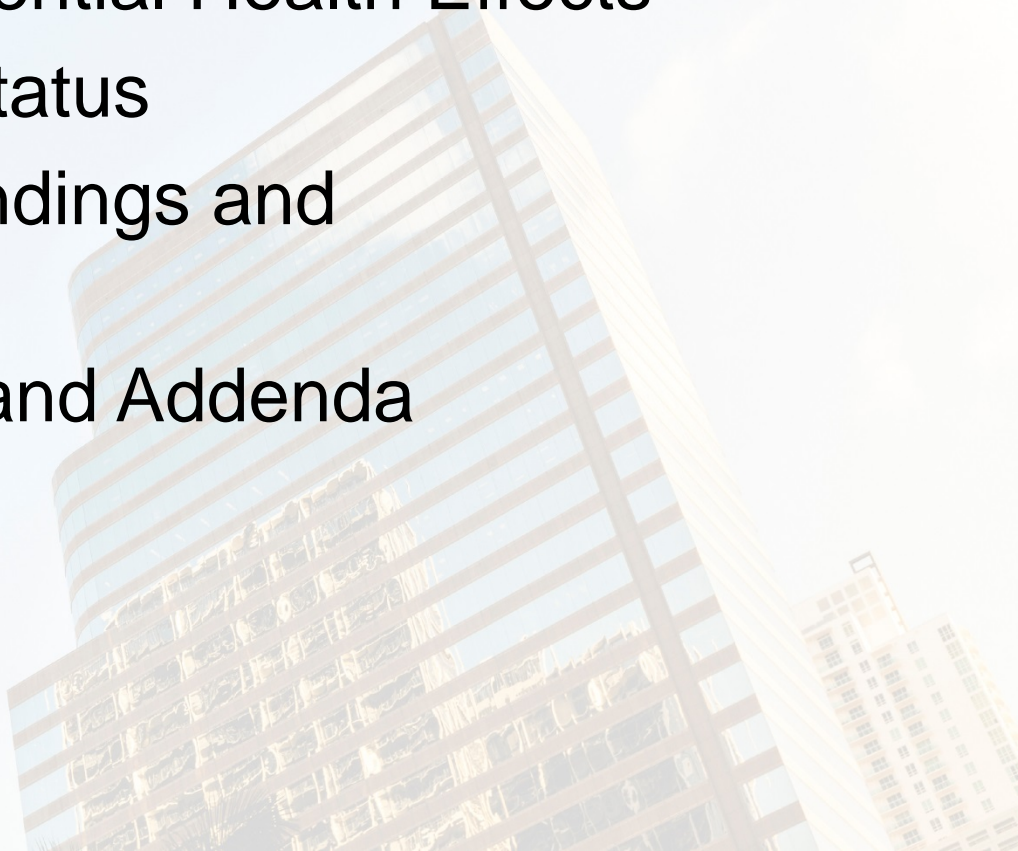
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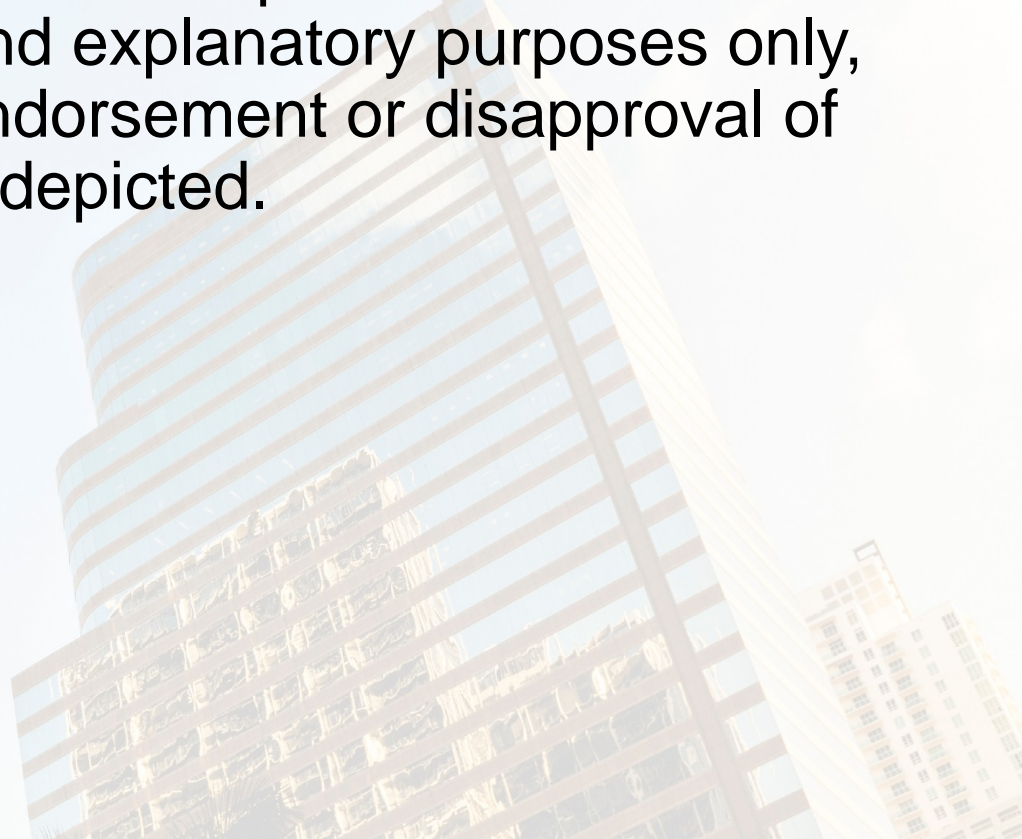
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# Outline/Agenda

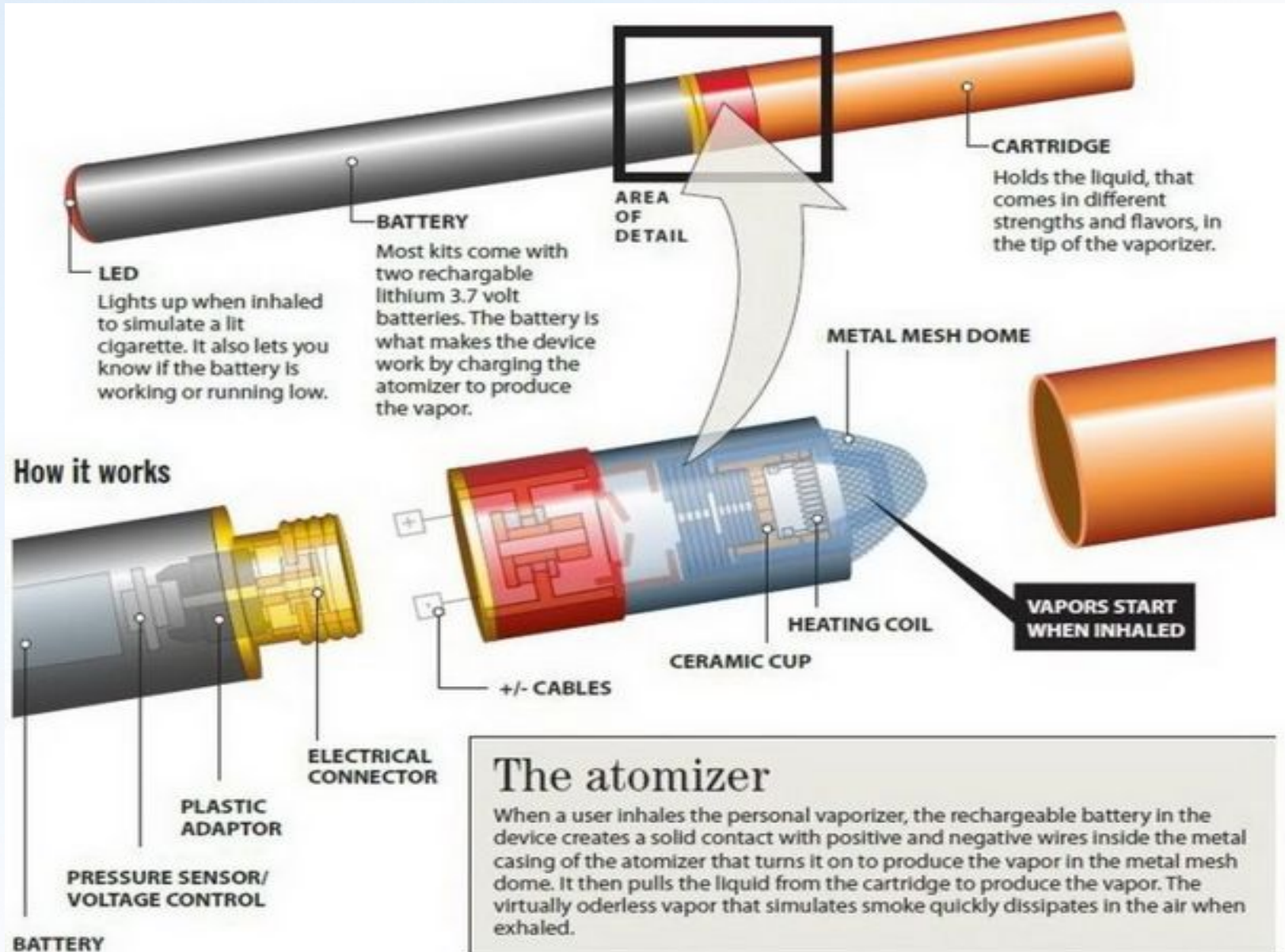
- Introduction to E-cigarettes
  - Components and Potential Health Effects
  - Current Regulatory Status
  - AIHA White Paper Findings and Recommendations
  - ANSI/ASHRAE 62.1 and Addenda
- 

# Disclaimer

- The information in this presentation was compiled from sources believed to be reliable for informational purposes only. Images of actual products are provided for example and explanatory purposes only, and do not constitute endorsement or disapproval of the use of the products depicted.

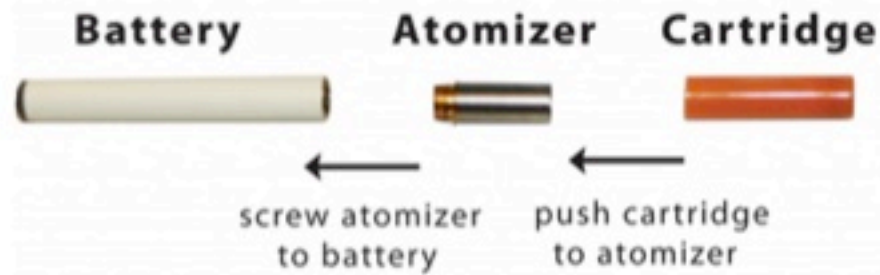


# Anatomy of an E-Cigarette





# First Generation ECs (‘cigalikes’)



- Disposable
- Re-chargeable with pre-filled cartridges



# Second Generation ECs



- Refillable with liquids



# Third Generation ECs ('mods')



# Statistics

- More than 460 different e-brands currently on the market.\*
- Over 7,700 unique e-cigarette flavors.\* \* As of January 2014
- China produces approximately 90 percent of the world's e-cigarettes.
- Chinese manufacturers are expected to ship more than 300 million e-cigarettes to the US and Europe this year.



# Statistics

- E-cigarette sales in the U.S. were estimated at \$2.2 billion in 2014.
- Sales expected to grow nearly 25% per year through 2018.
- In 2014, an estimated 2.5 million middle and high school students used e-cigarettes.
- There is some recent evidence that e-cigarette use can be a gateway to conventional cigarette use initiation during early adolescence.



# Primary Components

- Propylene Glycol/ Vegetable Glycerin
- Nicotine
- Flavorings



# Propylene Glycol/Vegetable Glycerin

- Used in theatrical fog
  - Exposure may contribute to both acute and chronic health issues, such as asthma, wheezing, chest tightness, decreased lung function, respiratory irritation, and airway obstruction
- Pyrolysis/heating glycerin forms acrolein, formaldehyde and acetaldehyde in the vapors



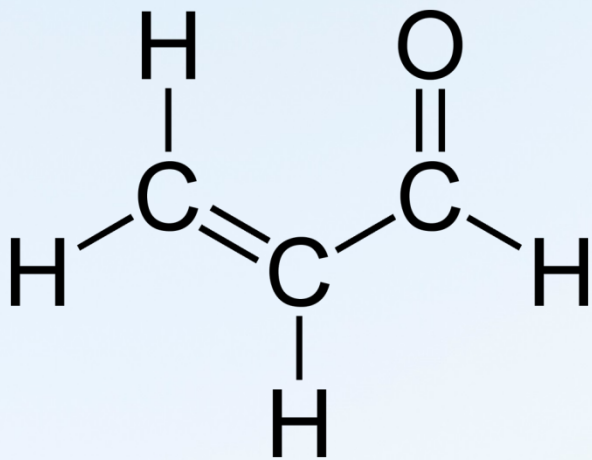


# Formaldehyde

- A known degradation product of propylene glycol and glycerin
- Found in vapor and in small amounts in some studies of some liquids
- Higher airborne concentrations with higher voltage second and third generation units
- Known human carcinogen



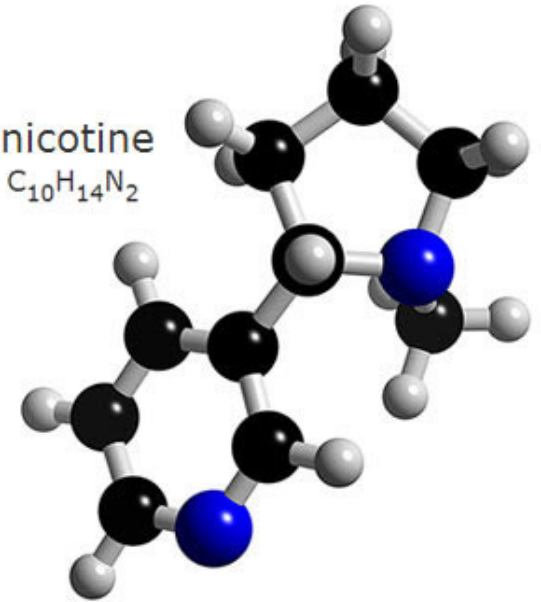
# Acrolein



- Causes irritation to the nasal cavity, damage to the lining of the lungs and is thought to contribute to cardiovascular disease in cigarette smokers
- Found in vapor only (formed as a result of heating process)

# Nicotine

nicotine  
 $C_{10}H_{14}N_2$



- Health Effects
  - Addictive
  - Teratogenic
  - Increases heart rate, respiratory rate, blood pressure, and level of alertness
- E-Cig Labeling
  - Some cartridges labeled as containing no nicotine did, in fact, contain detectable levels of nicotine (8/6)
  - Concentration and delivery inconsistencies (1/3)
- Nicotine found in the vapor, but lower than found emitted from conventional cigarettes (3/1)
- Nicotine has been the cause of an increase in emergency calls to poison control centers and at least one child's death

# Flavorings



# Flavorings and Additives

- Fruit and Bubblegum – targeting youth
- Other additives include drugs
  - Tadalafil (generic name for a drug used for erectile dysfunction)\*
  - Rimonabant (generic name for a weight-loss aid that has been withdrawn from the market due to serious side effects)\*
  - “Mary Jane”
  - Cocaine

\*FDA did order a warning letter to a company that advertised these

# Generally Recognized as Safe (GRAS)?



Diacetyl as a food additive is GRAS, but aerosolized exposures can cause bronchiolitis obliterans



# Diacetyl Health Effects

[Display Settings:](#)  Abstract

[Send to:](#)

[Int J Occup Environ Health](#). 2012 Jan-Mar;18(1):29-42.

## **Bronchiolitis obliterans and consumer exposure to butter-flavored microwave popcorn: a case series.**

[Egilman DS](#), [Schilling JH](#).

Department of Family Medicine, Brown University, Providence, Rhode Island, USA. [degilman@egilman.com](mailto:degilman@egilman.com)

### **Abstract**

Respiratory exposure to diacetyl and diacetyl-containing flavorings used in butter-flavored microwave popcorn (BFMP) causes lung disease, including bronchiolitis obliterans (BO), in flavorings and popcorn manufacturing workers. However, there are no published reports of lung disease among BFMP consumers. We present a case series of three BFMP consumers with biopsy-confirmed BO. We review data relating to consumer exposures, estimate case exposures, and compare them to diacetyl-containing flavoring-exposed manufacturing workers with lung disease. These consumer cases' exposure levels are comparable to those that caused disease in workers. We were unable to identify any other exposures or diseases known or suspected to cause BO in these cases. BFMP poses a significant respiratory risk to consumers. Some manufacturers have substituted diacetyl with other alpha-diketones that are likely to pose a similar risk. Simple consumer practices such as cooling the popcorn bag would eliminate the risk of severe lung disease.



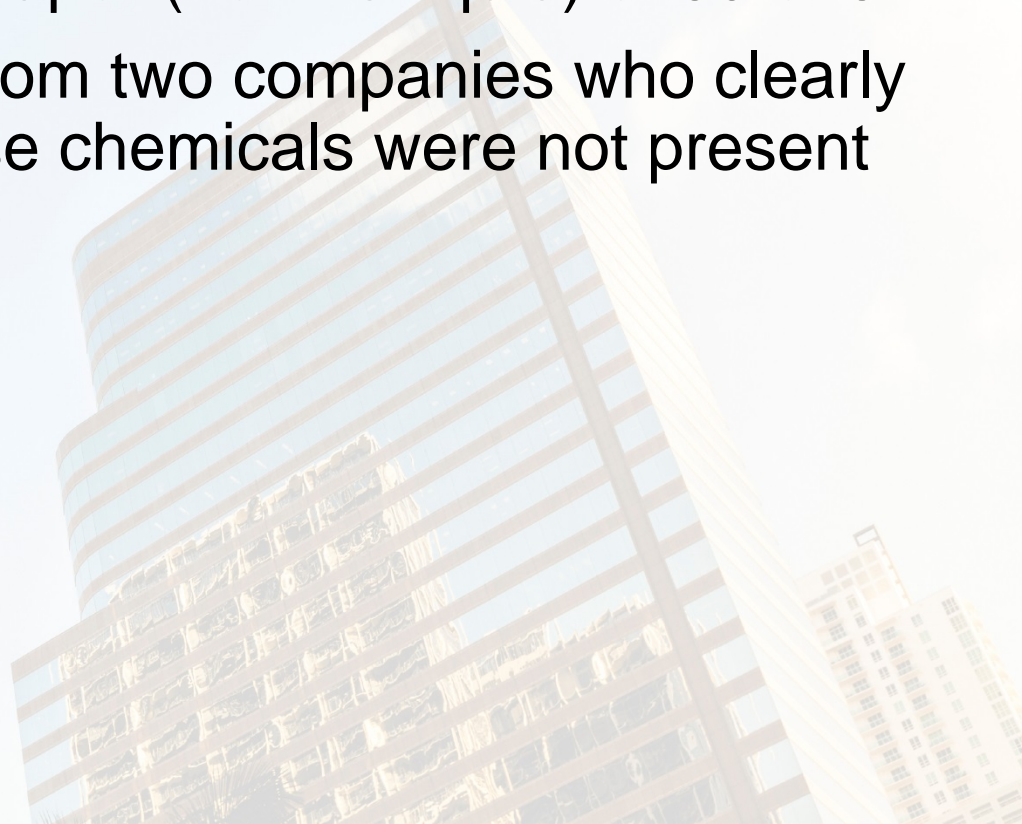
# Diacetyl and Acetyl Propionyl

- Diacetyl and acetyl propionyl are GRAS but are associated with respiratory disease when inhaled
  - The risks associated with inhalation of acetyl propionyl may be as high as from diacetyl based on inhalation studies with rats
- 159 samples purchased from 36 manufacturer and retailers in 7 countries
  - Diacetyl and acetyl propionyl were found in 74.2% of samples
  - Even found in samples (in the liquid form) from manufacturers who clearly stated that these chemicals were not present
- Authors estimated an average user's consumption "would result in 490 times higher daily intake compared to the NIOSH limit" (based on 5 ppb for an 8-hour exposure)



# New Diacetyl Study (12/8/15)

- 51 flavors of e-liquid were evaluated – cherry, java, peach, pina colada, apple, etc.
- Diacetyl detected in the vapor (not the liquid) of 39 of 51
- Even found in samples from two companies who clearly stated in writing that these chemicals were not present

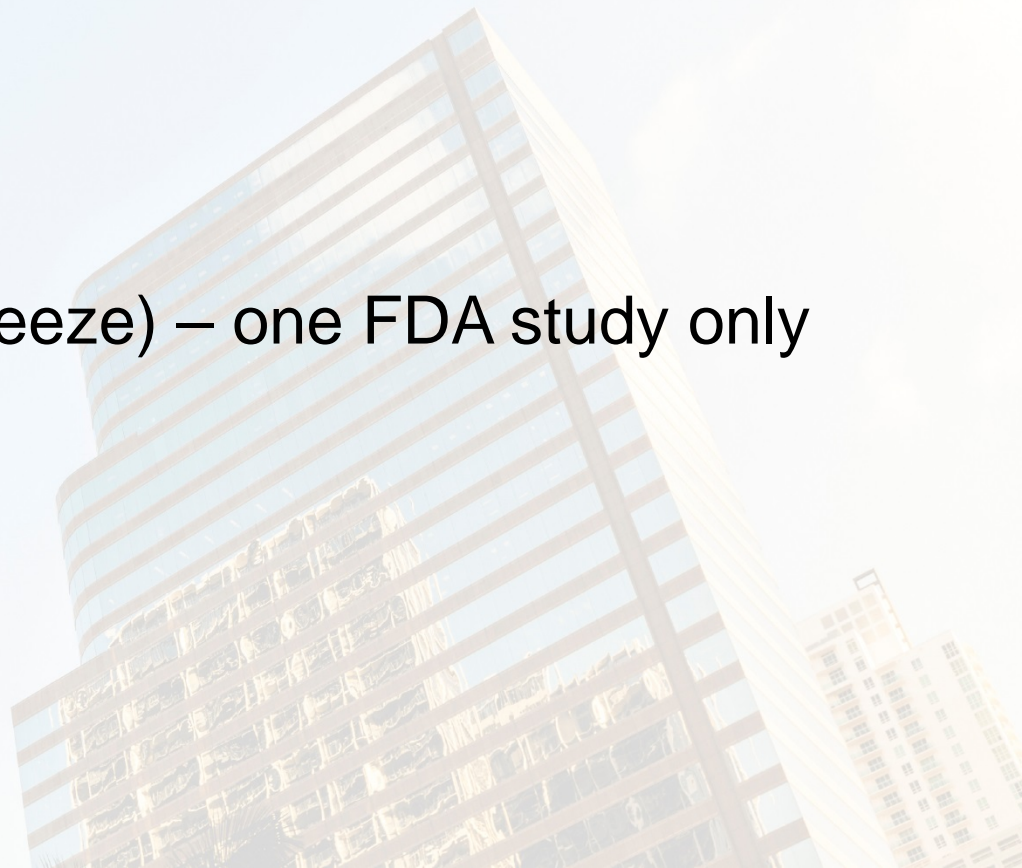


# Flavoring Concerns

- No research on potential health effects of aerosolized vapor exposure
- No research on pyrolyzation products of flavorings
- Benzaldehyde has been detected in cherry flavoring
- Methyl anthranilate was detected in grape flavoring
- 1-hexanol was detected in apple flavoring
- Manufacturing of many flavoring sources are outside the US (China) with limited quality control

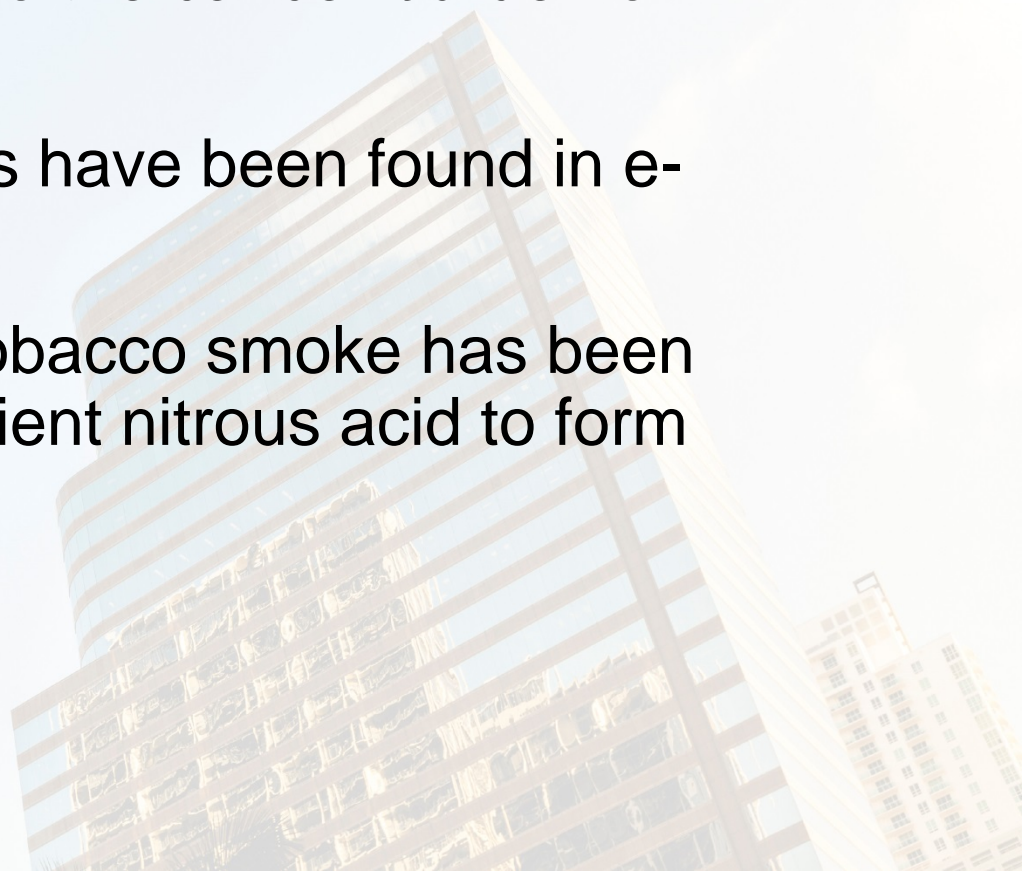
# Additional Potential Exposures

- Tobacco-Specific Nitrosamines (TSNAs)
- Acetic Acid
- BTEX
- Isoprene
- Diethylene Glycol (antifreeze) – one FDA study only



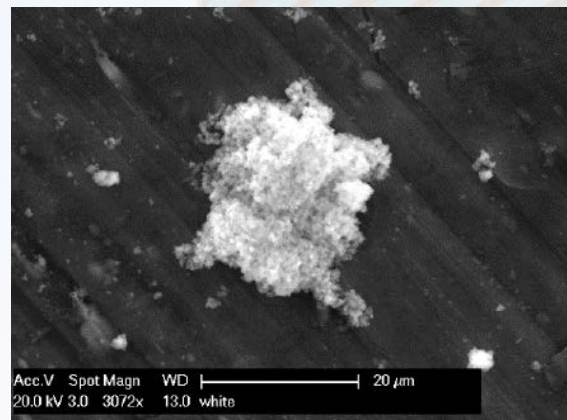
# Tobacco-Specific Nitrosamines (TSNAs)

- Some TSNAs are known human carcinogens and are suspected to contribute to the cancer burden of smokers
- Small amounts of TSNAs have been found in e-liquids and vapor
- Residual nicotine from tobacco smoke has been shown to react with ambient nitrous acid to form TSNAs over time
  - Third-hand exposure?



# Additional Potential Exposures

- Tin
- Lead
- Nickel
- Zinc
- Copper
- Chromium
- Silicon fibers
- Nanoparticles



# Second-Hand Exposure Concerns

- Nicotine (teratogen and addictive)
- Flavorings (nut and other allergies)
- Formaldehyde (carcinogen)
- Acrolein (listed as a Hazardous Air Pollutant by the EPA)
- Acetaldehyde (possible human carcinogen)
- Fine/Ultrafine Particles
- Tin, Lead, Nickel, Chromium



# Cloud Chasing



<https://www.youtube.com/watch?v=ZgouBVNItQA>



# Some User-Reported Health Effects

- Mouth and throat irritation
- Dry cough
- Nausea
- Dizziness
- Changes in heart rhythm
- Changes in blood pressure



**IT'S NOT JUST "HARMLESS WATER VAPOR"**

**E-cigarette aerosol contains at least 10 chemicals on California's Prop 65 list of chemicals known to cause cancer, birth defects or other reproductive harm.**

ACETALDEHYDE  
CADMIUM  
ISOPRENE  
LEAD  
NICOTINE  
N-NITROSONORNICOTINE  
FORMALDEHYDE  
BENZENE  
NICKEL  
TOLUENE



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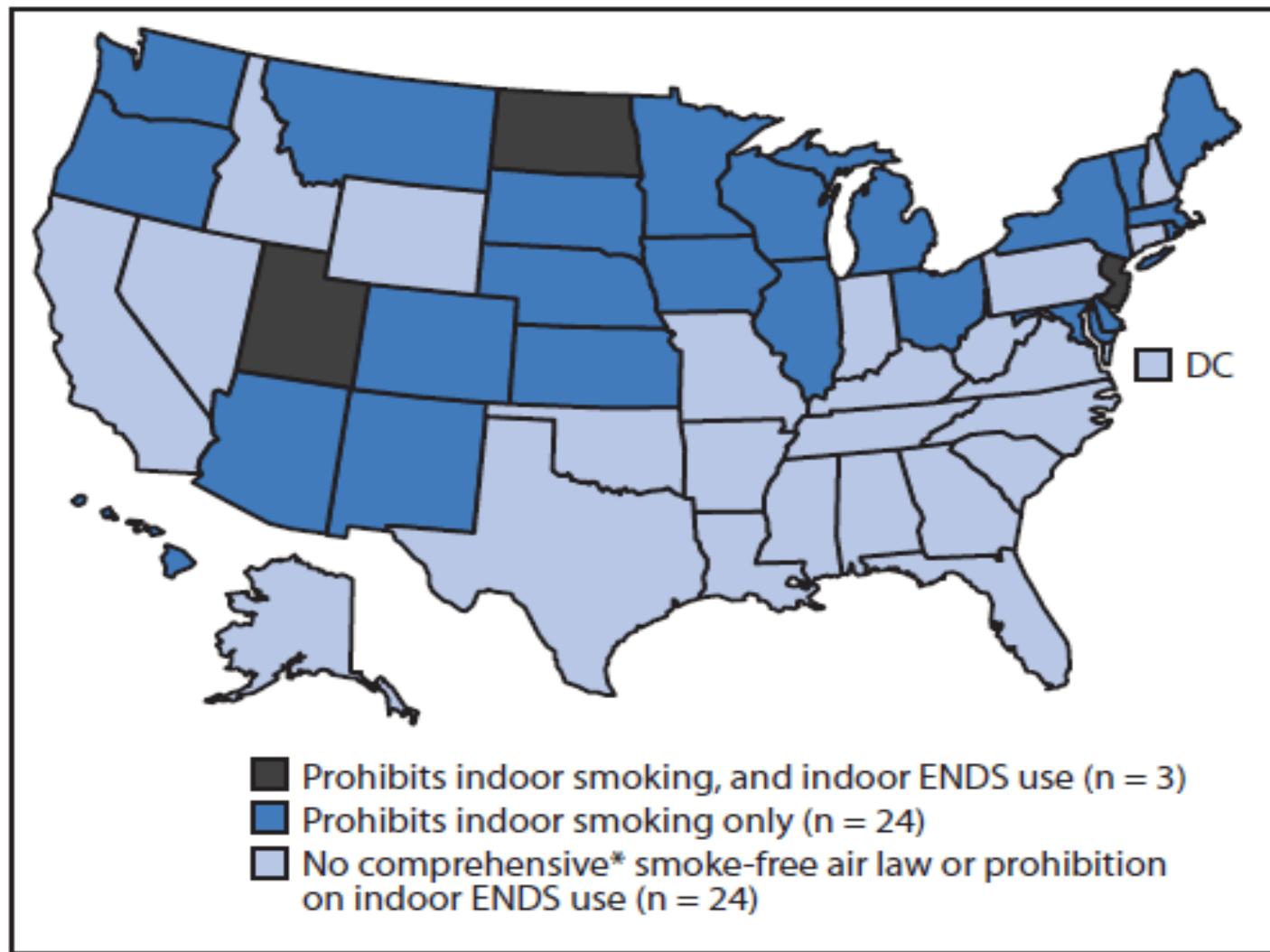
# Effects on the Immune System

- Johns Hopkins study exposed mice to e-cigarette vapor for two weeks in amounts that approximated human e-cig exposure, then exposed them to *Streptococcus pneumoniae* and influenza A virus.
  - E-cigarette vapor alone produced mild effects on the lungs, including inflammation and protein damage
  - E-cigarette exposure inhibited the ability of mice to clear bacteria from their lungs and the viral infection led to increased weight loss and death indicative of an impaired immune response

# Miscellaneous Concerns

- Lithium ion batteries
  - Many have no overcurrent or overcharge protection (overheating)
  - Incorrect chargers also lead to overheating
- Smoke alarm concerns
  - Has been demonstrated that e-cigs have the potential to set off a smoke alarm, but appears to be dependent on the situation and type of alarm
- Indoor use
  - Allowing e-cigs may confuse occupants as to whether smoking is allowed
  - For smokers, the observation of others smoking can increase cravings

# State Regulations



Centers for Disease Control and Prevention. State Laws Prohibiting Sales to Minors and Indoor Use of Electronic Nicotine Delivery Systems - United States, November 2014.

# Food and Drug Administration (FDA)

- The FDA currently regulates only e-cigarettes that are marketed for therapeutic purposes.
- However, the FDA has proposed a rule extending its tobacco product authorities to cover additional products that meet the legal definition of a tobacco product, such as e-cigarettes
  - Final proposed rule sent to OMB October 19, 2015
  - OMB has 90 calendar days, but delays expected

# WHO

- The World Health Organization (WHO) has recommended that consumers be strongly advised not to use electronic nicotine delivery systems, including e-cigarettes, until they are deemed safe and effective and of acceptable quality by a competent national regulatory body.



# NIOSH

- NIOSH Current Intelligence Bulletin 67 published April 2, 2015 recommends that employers “establish and maintain smoke-free workplaces that protect those in workplaces from involuntary, secondhand exposures to tobacco smoke **and airborne emissions from e-cigarettes and other electronic nicotine delivery systems.**”  
(emphasis added)

# ANSI/ASHRAE 62.1

- ASHRAE Standard 62.1 contains requirements for ventilation of spaces that are free of environmental tobacco smoke (ETS).
- Also contains requirements for separation of an ETS-free area from any spaces containing ETS.
- Addendum c to ANSI/ASHRAE Standard 62.1-2013 clarifies that the definition of ETS “includes smoke produced from the combustion of cannabis and controlled substances **and the emissions produced by electronic smoking devices.**”
- “The existing requirements for separation of ETS-free spaces from ETS spaces remains unchanged.”

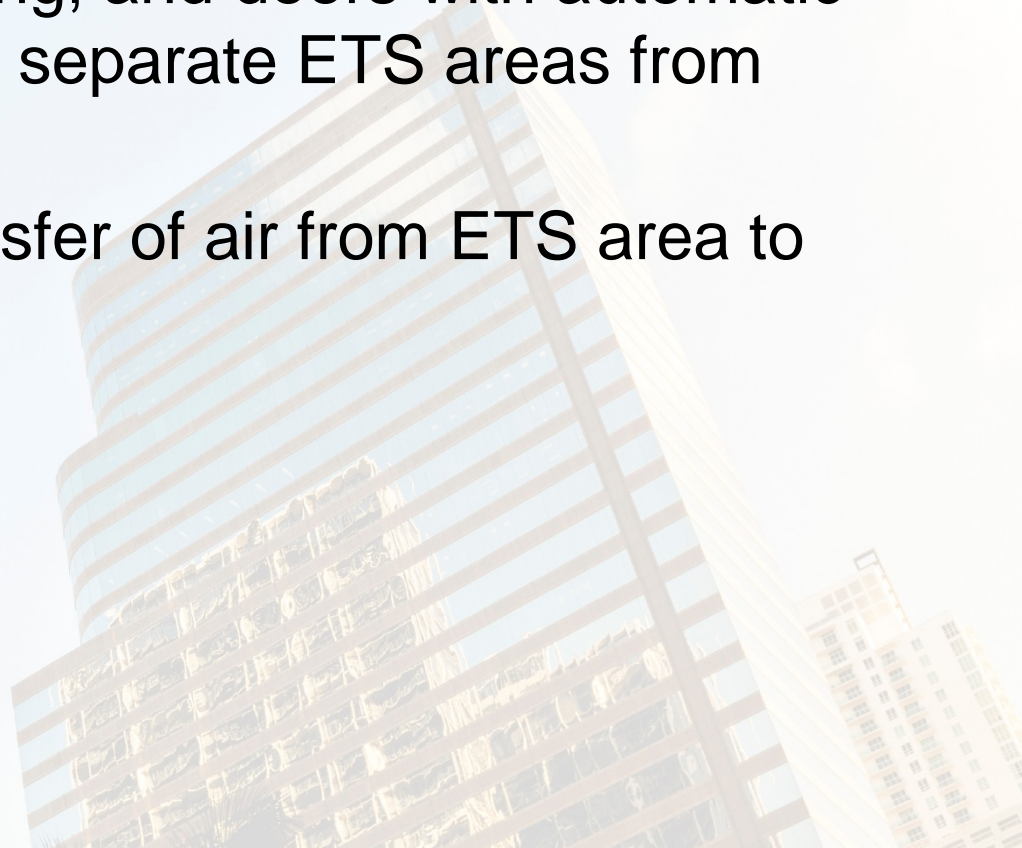
# ANSI/ASHRAE 62.1

- “This addendum clarifies the intent of the standard that provisions of acceptable indoor air quality is incompatible with the presence of ETS, including cannabis smoke and e-cigarette emissions.”
- “The ventilation rates determined in accordance with the provisions of the standard apply only to spaces where these emissions are not present that are adequately separated from spaces where they are present.”



# ANSI/ASHRAE 62.1

- ETS-free areas at positive pressure to ETS areas
- Solid walls, floors, ceiling, and doors with automatic closing mechanisms to separate ETS areas from ETS-free areas
- No recirculation or transfer of air from ETS area to ETS-free area
- Signage for ETS areas



# AIHA White Paper: Electronic Cigarettes in the Indoor Environment

## **Recommendation:**

“E-cigarettes should be considered a source of volatile organic compounds (VOCs) and particulates in the indoor environment that have not been thoroughly characterized or evaluated for safety.”\*

\*Quoted by NIOSH in the 2015 Current Intelligence Bulletin 67 “Promoting Disease and Injury Through Workplace Tobacco Policies”

# AIHA White Paper: Electronic Cigarettes in the Indoor Environment

Research on e-cigarettes should be conducted in at least the following areas:

1. Health effects from inhaling e-cigarette ingredients that are reported to be generally recognized as safe (GRAS) via ingestion, but which have not yet been evaluated for inhalation toxicity, as well as their thermal degradation products;
2. Effects of second-hand emissions, third-hand exposures, and nicotine addiction from e-cigarettes;
3. Understanding the dynamics of pre- and post-respiration aerosols and their fate in the environment; and
4. Lifecycle and end-of-use issues.\*

# Life Cycle Issues

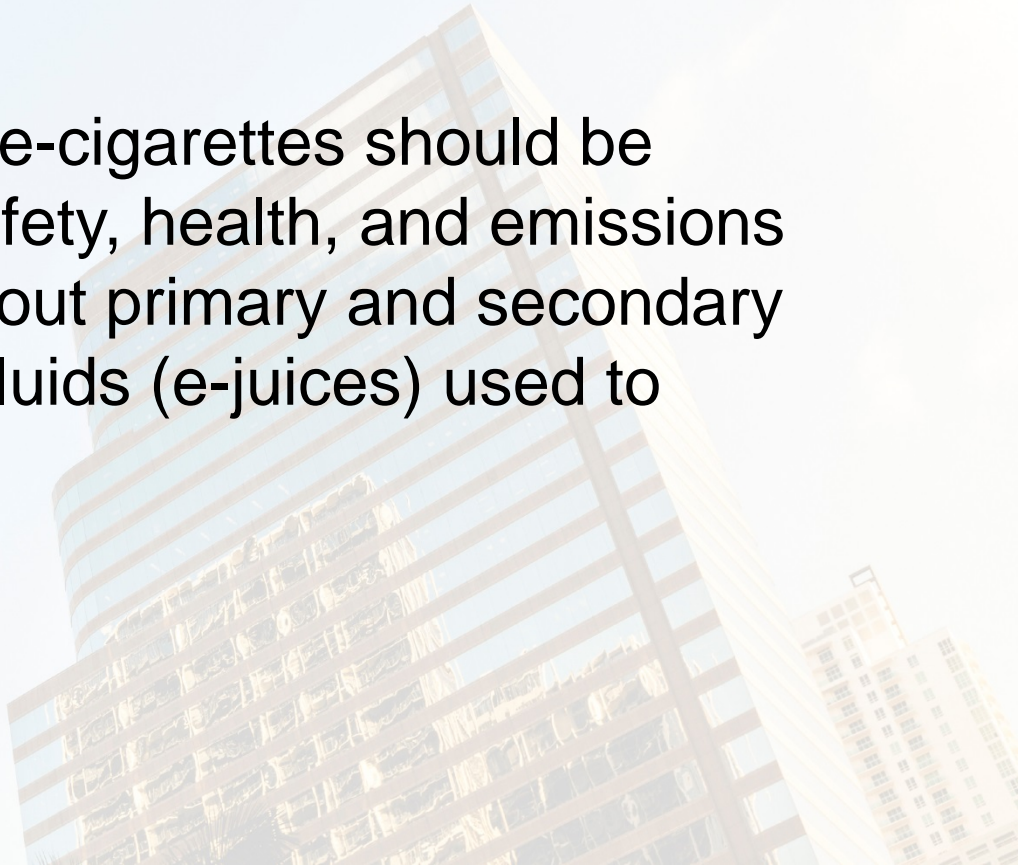
- Some are single use or disposable
- Lithium ion batteries
- Nicotine (acute hazardous waste)
  - EPA: “unused (unsold, expired, or returned) nicotine-containing products, including patches, gums, lozenges, inhalers, nasal sprays, and e-cigarettes, are classified as P075 listed acute hazardous wastes when discarded.”
- Some manufacturers offer recycling programs
- There is at least one disposal company that is disassembling the components, recycling the batteries, metal, and plastic components that can be recycled, then disposing of the nicotine by incineration.



# AIHA White Paper: Electronic Cigarettes in the Indoor Environment

## **Recommendation:**

Risk-based regulation of e-cigarettes should be adopted using reliable safety, health, and emissions data, due to concerns about primary and secondary exposure to vapors and fluids (e-juices) used to charge e-cigarettes.



# AIHA White Paper: Electronic Cigarettes in the Indoor Environment

Four areas of regulation relating to the safety of primary users and people exposed to second-hand vapors or e-juice products should be considered:

1. All e-cigarette devices, whether they are used for therapeutic or recreational purposes, should be evaluated for potential physical and/or electrical hazards by a regulatory agency;
2. The health risks and economic consequences of accidental exposure to e-juices by children, adults and pets should be addressed, including proper labeling and child-resistant packaging requirements;

# AIHA White Paper: Electronic Cigarettes in the Indoor Environment

Risk-based regulation recommendations (cont.):

3. All future e-juice components that may be used by consumers should be fully evaluated for any potential hazards (e.g., toxicity, flammability, safety hazards, secondary exposures, etc.) prior to introduction into the marketplace; and
4. As e-cigarettes are a source of pollutants, their use in indoor environments should be restricted, consistent with current smoking bans, until, and unless, research documents that they will not significantly increase the risk of adverse health effects to occupants.

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# Questions?

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