AGENDA REQUESTED:  November 19, 2014

DATE OF REQUEST:  October 31, 2014

INDIVIDUAL TO CONTACT REGARDING CHANGES TO THIS REQUEST, IF NEEDED:  Kerry Howard (512) 239-0556

CAPTION:  Docket No. 2014-1553-MIS.  Presentation on ozone health effects by Dr. Julie Goodman.

Stephanie Bergeron Perdue  Michael Honeycutt
Deputy Executive Director  Division Director

Joyce Nelson for Kerry Howard
Agenda Coordinator

Copy to CCC Secretary?  NO  X  YES
Is a Stricter Ozone NAAQS Supported by the Science?

Julie E. Goodman, PhD, DABT, ACE, ATS

Texas Commission on Environmental Quality Agenda
Austin, Texas
November 19, 2014
## EPA's Causal Classifications

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Primary Health Effects Evidence

Controlled Exposure Studies

Experimental Studies

Epidemiology Studies
## Controlled Exposure Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Exposure</th>
<th>O$_3$ Conc. (ppb)</th>
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<tr>
<td>Adams (2006)</td>
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**Group Mean Change in FEV$_1$ (%)**

Adapted from Goodman et al. (2013)
Controlled Exposure Studies-
Change in FEV₁ with Increasing Ozone Dose
Short-term Exposure – Epidemiology Studies

• Risks are driven by mortality (not morbidity)
• New mortality studies are re-analyses
  ▪ US multi-city studies of NMMAPS data (*e.g.*, Bell et al., 2007)
  ▪ Multi-country studies (*e.g.*, Katsouyanni et al. (2009) study of US, Canadian, and European cities)
• Different methodologies and model assumptions
• Unexplained heterogeneity across cities and countries
• Limitations: exposure measurement error, confounding (co-pollutants and temperature), and model specification
Example of NMMAPS Results

Smith et al. (2009)
Air Monitors: 8-hr Ozone, 5:00 AM - 1:00 PM (CST)
Personal Exposure

At ambient air monitor: Dose is 100% of Measured Concentration

Outdoors, under a tree: Dose is ~20-80% of Measured Concentration

Indoors: Dose is ~10% of Measured Concentration
Time Spent Outdoors Impacts Interpretation of Epidemiology Studies

NHAPS - Nation, Percentage Time Spent
Total n = 9,196

- IN A RESIDENCE (68.7%)
- OUTDOORS (7.6%)
- IN A VEHICLE (5.5%)
- OFFICE-FACTORY (5.4%)
- BAR-RESTAURANT (1.8%)
- OTHER INDOOR LOCATION (11%)

Klepeis et al. (2001)
Short-term Exposures – Experimental Studies

• Animal studies reported mild effects at 100-200 ppb ozone

• Only one study reported airway hyper-responsiveness in three of nine rat species at low ozone exposures (Depuydt et al., 1999)
  ▪ Exposures of 50 ppb for 4 hours
  ▪ No airway inflammation
  ▪ EPA noted results should be confirmed in other species
Proposed Modes of Action for Ozone Respiratory Effects

Ozone + Respiratory Tract

- Dosimetric factors
- Nutritional status
- Lifestage
- Attenuation factors
- Co-exposures

Formation of secondary oxidation products

- Gene-environment interactions
- Pre-existing diseases/conditions
- COPD/smoking status
- Asthma/allergic airways disease
- Obesity/metabolic syndrome

Activation of neural reflexes
- Initiation of inflammation
- Alteration of epithelial barrier function
- Sensitization of bronchial smooth muscle
- Modification of innate and adaptive immunity
- Airways remodeling

Systemic inflammation and oxidative/nitrosative stress
- Respiratory System Effects
- Extrapulmonary Effects

Obesity/Metabolic Stress Lifestage

Attenuation factors

US EPA (2013) ISA Figure 5-9
Long-term Exposure – Epidemiology Studies

- Few new studies; most show no association with cause-specific mortality
- EPA relies primarily on ACS cohort (Jerrett et al., 2009)
  - Decreases in mortality from any cause, CV effects, and ischemic heart disease in models with PM$_{2.5}$
  - Demonstrates threshold

![Figure 2. Exposure–Response Curve for the Relation between Exposure to Ozone and the Risk of Death from Respiratory Causes.](gradient.png)
Little evidence for Respiratory Effects from Ozone Exposure less than 75 ppb

- **Controlled Exposure**: Effects at ≤72 ppb not adverse, effects ≤60 ppb not stat sig
- **Animal Bioassay**: High exposure levels not relevant to exposures ≤75 ppb
- **Epidemiology**: Conflicting findings; confounding, and other biases not ruled out
- **Biomarker**: Inflammatory responses not consistent ≤75 ppb

No evidence of adverse effects less than 75 ppb
Ozone and Asthma

- EPA claims short-term increases in ambient ozone exposure increases respiratory symptoms and asthma medication use in children with asthma
- Epidemiology study results are inconsistent
- Controlled exposure studies reported inconsistent results in asthmatics at 160 to 400 ppb
- There is no good asthma model for studying effects of ozone in animals and studies use high ozone concentrations (> 300 ppb) that do not reflect relevant human exposures
Short-term Ozone and Asthma

Causal Question
Does short-term ozone exposure <75 ppb exacerbate asthma?

Literature Search Strategy
Asthma and ozone
(epidemiology, controlled human, and experimental studies)

Study Selection Criteria
(e.g., short-term, asthmatics only)

Identify Studies
Short-term Ozone and Asthma

Controlled Human Exposure (n=55)
Animal Studies (n=32)
Epidemiology Studies (n=65)

Study Quality Evaluation

Tier 1
Tier 2
Short-term Ozone and Asthma Exacerbation

- Specificity
- Experimental evidence
- Temporality of effects
- Exposure-response
- Adversity
- Biological plausibility
- Consistency and coherence
- Strength of association
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Short-term Ozone and CV Effects

- Controlled exposure
  Largely null; few positive results not likely clinically significant

- Animal Bioassay
  Cannot be extrapolated to humans; high exposure and hypothermic response

- Epidemiology
  Largely null; some conflicting findings; confounding, bias, and chance likely

- Biomarker
  Inconsistent; do not support a mode of action for CV effects

No evidence for a causal relationship <75 ppb
Impact of Ozone on Mortality – Houston, 2009

Ambient Ozone Concentration Adjusted to Meet Standard (ppb)

- 75: 47 additional deaths
- 70: 48 additional deaths
- 65: 44 additional deaths
- 60: 35 additional deaths

91 ppb Measured Ozone Conc
## Main Issues

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<td>Current ozone standard is health protective</td>
<td>Current standard should be presented as an option to Administrator</td>
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<tr>
<td>Layers of conservatism in analysis of proposed alternative standards</td>
<td>Health benefits overestimated</td>
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<tr>
<td>Presentation of results is sometimes misleading</td>
<td>Masks uncertainty</td>
</tr>
<tr>
<td>No statistical tests to compare benefits of alternative vs. current standard</td>
<td>Arbitrary interpretation of findings</td>
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<tr>
<td>Wide confidence intervals and many qualitative uncertainties</td>
<td>Benefits from alternative standards do not differ from those from current standard</td>
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Ozone Workshop 2015

• Provide policy makers with perspectives, insights, and information relevant to the upcoming ozone NAAQS decision that have not been the focus of other public deliberations

• Convene panels of experts to discuss scientific issues related to the ozone NAAQS within a multidisciplinary and policy-oriented context that is broader than CASAC takes on

• Revisit important aspects of the health and welfare effects evidence

• Discuss potential offsetting societal risks of a revised ozone NAAQS
Questions?

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