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ASHRAE Ventilation and EPA Air Quality Standards – *Cleaning Air of Ozone for Building Indoor Air Quality*

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February 4, 2008



Presentation Overview

- Ozone is a Pollutant by Definition
- Indoor/Outdoor Ozone Concentrations
- Indoor Ozone Chemistry
- EPA NAAQS Ozone Standards
- ASHRAE Standard 62.1 Requirements
- Standard Implementation Scenarios
- Effected State Areas
- Air Cleaners for Ozone Removal
- Research Needs

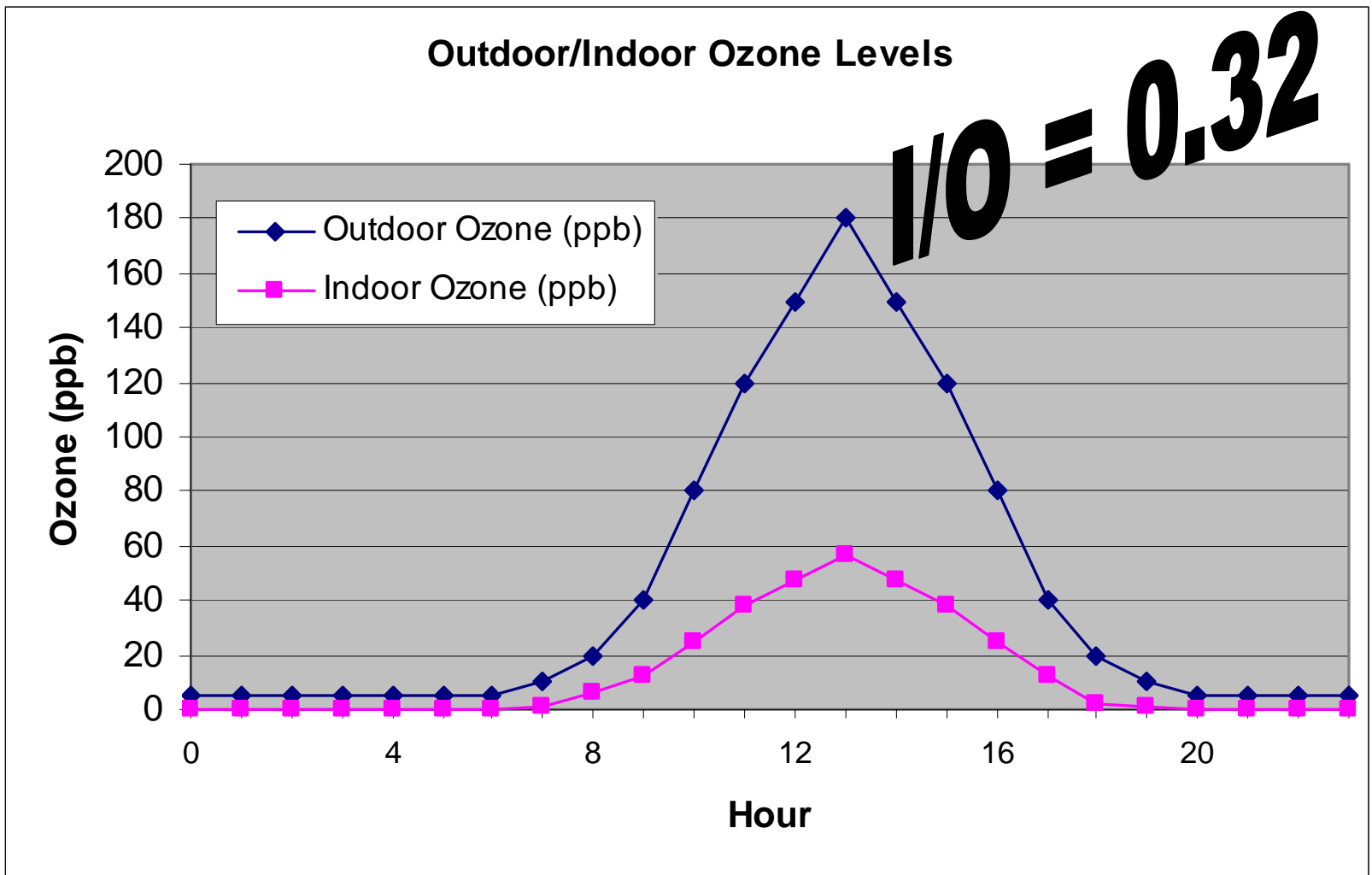
Ozone is a Pollutant, per EPA ...

- O_3 is gas composed of 3 oxygen atoms
 - chemical reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOCs)
 - sunlight and hot weather form ground-level ozone in harmful concentrations as “smog”
- Breathing air containing ozone impairs health
 - reduce lung function, aggravating respiratory conditions and increasing infection susceptibility
 - medicine use by asthmatics and doctors visits
 - emergency department visits and hospital admissions
 - premature death in people with heart/lung disease

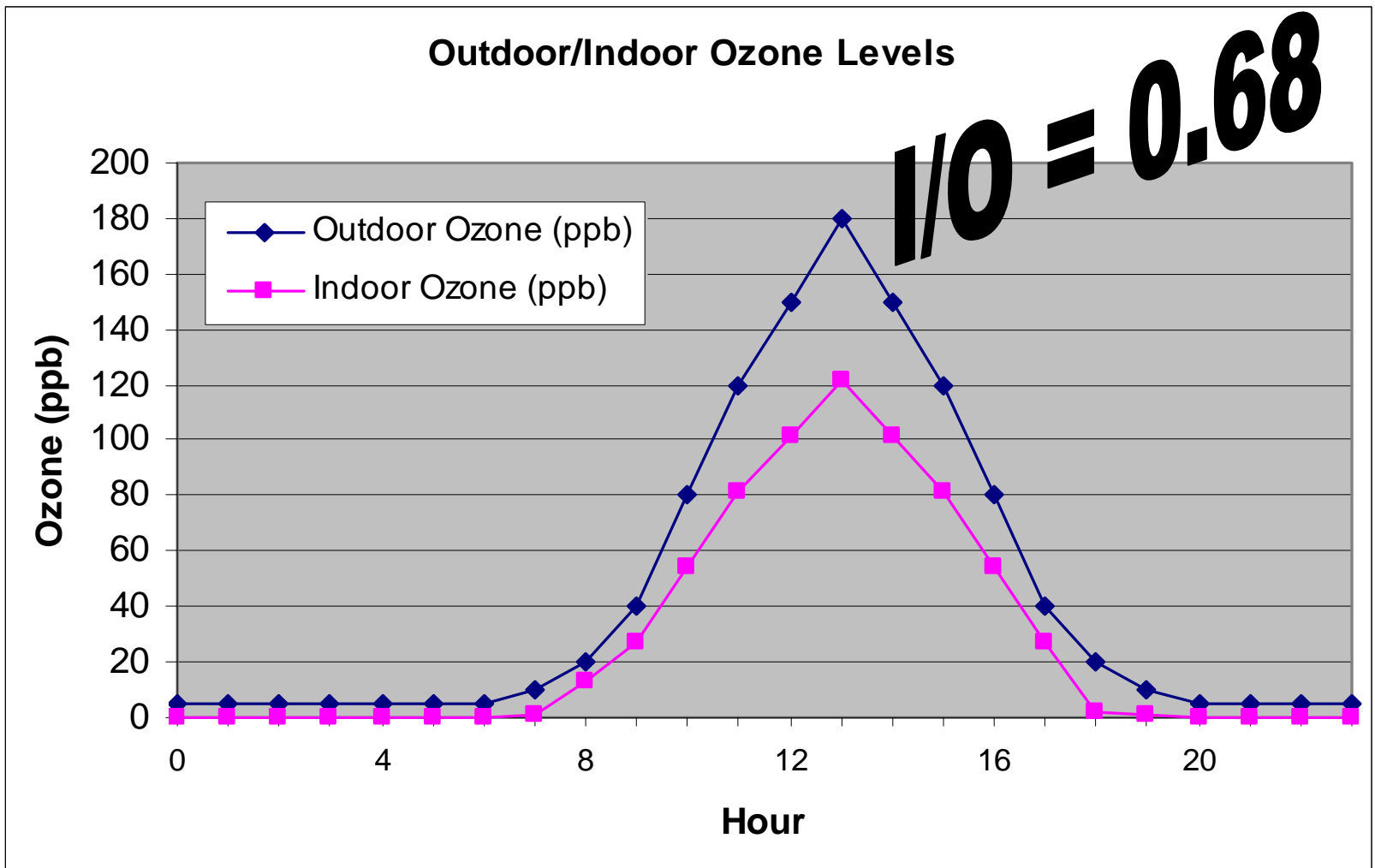
... and Buildings are Our Refuge

- Under higher outdoor ozone levels, at-risk individuals remain indoors to limit exposures
- However, “indoor exposures to ozone represent a major fraction of total ozone exposures” (Weschler 1989)
 - “I/O [indoor/outdoor ozone] ratios range from 0.05 in buildings that are tightly sealed or use charcoal filtration to 0.85 in buildings that have very high air exchange rates [via infiltration or ventilation]
 - Excluding the extremes, the I/O ratio is more often in the range of 0.2 to 0.7” (Weschler 2000)

I/O Ozone Levels in Offices



I/O Ozone Levels in Schools



Ozone Indoor Air Chemistry

- “Under normal conditions, the half-life of ozone indoors is 7 to 10 minutes and is determined primarily by surface removal and air exchange [infiltration or ventilation] ...
- ... and only a small fraction [10%] of the other indoor air pollutants react with ozone at a rate fast enough to compete with air exchange, ... [but] their reactions with ozone have the potential to be quite significant as sources of ... compounds that are often quite odorous ... [and] potentially damaging to both human health and materials” (Weschler 2000)

EPA NAAQS Ozone Standard

Non-Attainment 8 Hour Design Value Classifications

- **Extreme Area:** 187 ppb and above
- **Severe 17 Area:** 127 up to but not including 187 ppb
- **Severe 15 Area:** 120 up to but not including 127 ppb
- **Serious Area:** 107 up to but not including 120 ppb
- **Moderate Area:** 92 up to but not including 107 ppb
- **Marginal Area:** 85 up to but not including 92 ppb

Attainment 8 Hour Design Value Classification

- **Current standard** of 80 ppb is effectively expressed as 84 ppb when rounding conventions are applied

Current Non-Attainment Areas



http://www.epa.gov/air/ozonepollution/pdfs/20070621_maps.pdf

Counties With Monitors Violating the Current Primary 8-hour Ozone Standard 0.08 parts per million (Based on 2003 – 2005 Air Quality Data)



Notes:

¹ 104 of 639 monitored counties violate.

² No monitored counties outside the continental U.S. violate.

³ Monitored data can be obtained from the AQS system at <http://www.epa.gov/ttn/airs/airsqgs/>

⁴ The current standard of 0.08 ppm is effectively expressed as 0.084 ppm when rounding conventions are applied.

ERC

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EPA Proposed Ozone Rulemaking

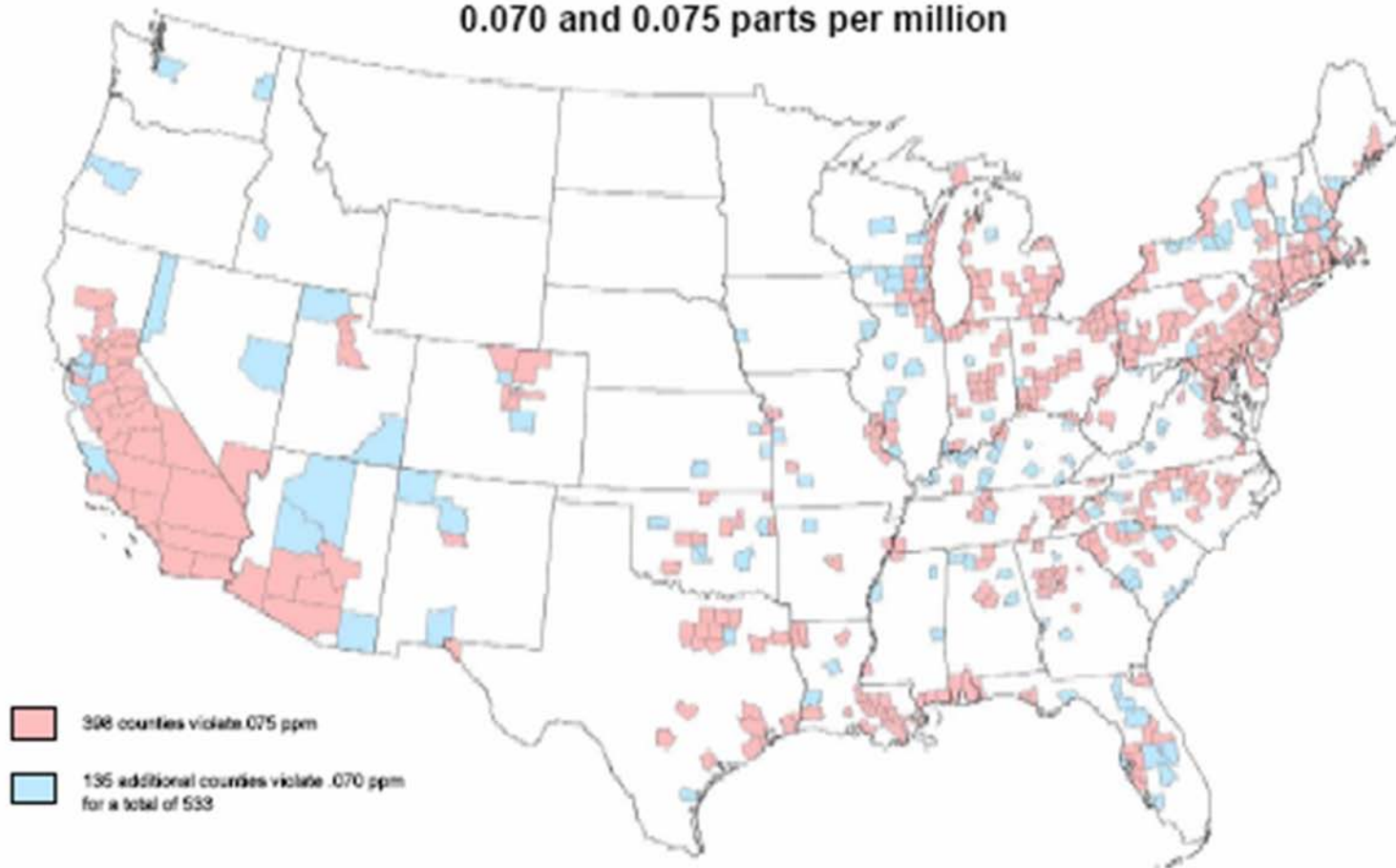
- Mounting scientific evidence indicates that adverse public health effects occur following exposure to ozone at levels below the current standard, particularly in those with respiratory illnesses
- **In 2007, EPA proposed to set the primary (health) standard to a level within the range of 70 -75 ppb (a reduction up to 15 ppb from 85 ppb)**

Future Non-Attainment Areas ?



Estimates are based on the most recent data (2003 - 2005). EPA will not designate areas as nonattainment on these data, but likely on 2006 - 2008 data which we expect to show improved air quality.

Counties With Monitors Violating Alternate 8-hour Ozone Standards 0.070 and 0.075 parts per million



Notes:

¹ 398 of 630 monitored counties violate 0.075,
533 of 630 monitored counties violate 0.070.

² Monitored data can be obtained from the AQS system at
<http://www.epa.gov/oars/aqs/aqs/>

³ No monitored counties outside the continental U.S. violate.

ASHRAE Standard 62.1 History

Ventilation for Acceptable IAQ

- 2001 - required an assessment, but only recommendations for outdoor air cleaning
- 2004 - introduced requirements for air cleaning of ozone for building ventilation
- 2007 - outdated EPA 1-hour ozone design values need to be replaced
- Addendum our for public review #
 - #1 & 2) 8-hour Serious classification threshold
 - # 3) lowering to non-attainment threshold?

ASHRAE Standard 62.1 Addendum *Public Reviews #1 and #2*

- “**Air-cleaning devices for ozone shall be provided** when the building is located in an area with a ‘**design value**’ of **107ppb or more** ... an area designated as ‘Extreme’, ‘Severe’, or ‘Serious’ by the U.S. EPA has a ‘design value’ of 0.107 ppm or more
- A list of areas designated as described is available at <http://www.epa.gov>
- Such **air-cleaning devices** shall have a minimum **ozone removal efficiency of 40%** ... [and] be **operated whenever** the 8-hour average outdoor **ozone levels are expected to exceed 80 [85] ppb**
- This forecast is available in local media or at the AIRNow Web site, <http://www.airnow.gov>”

ASHRAE Standard 62.1 Addendum *Public Review #3 PENDING*

- Incomplete voting by SPC 62.1 during ASHRAE Meeting last month in NYC
 - Motion on table to lower both the installation and operation threshold level to a ‘design value’ of 80 [85] ppb or more – **essentially requiring all non-attainment areas to install (and operate) air-cleaning devices**
 - Absent member votes being secured on very close vote for 2/3 approval to send revised addendum out for public review

Ozone Standards Scenarios

1. “Serious” Scenario

- A. ASHRAE Public Review #1/2 Addendum**
- B. Above with EPA Proposed Rulemaking**

2. “Non-Attainment” Scenario

- A. ASHRAE Pending Public Review #3**
- B. Above with EPA Proposed Rulemaking**

“Serious” Scenario 1A – *California ONLY Requirement*

- Based on latest EPA design values, limited to
 - Los Angeles area counties with large population
 - Interior valley counties with limited population

Ozone Design Value for Areas ≥ 107 ppb

Nonattainment Area	State	2004-2006 Design Value (ppb)	2000 Population	Affected # of Counties
Los Angeles South Coast Air Basin, CA	CA	121	14,593,587	4
San Joaquin Valley, CA	CA	110	3,191,367	8
TOTAL			17,784,954	12

“Serious” Scenario 1B – *Cascading EPA Rule on ASHRAE*

- EPA rule cascading effect could bring areas in 8 states previously designated Moderate to Serious classification, i.e., $107 - 15 = 92$ ppb

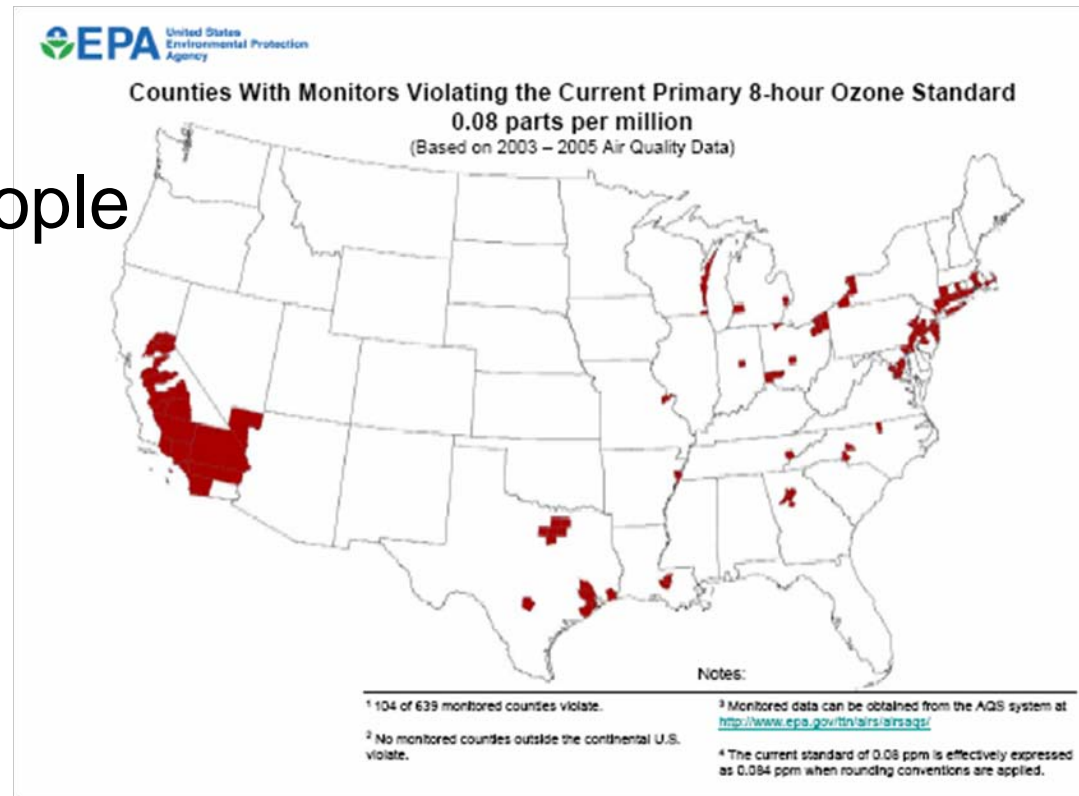
Ozone Design Value for Areas >92 ppb and <107 ppb

Nonattainment Area	State	2004-2006 Design Value (ppb)	2000 Population	Affected # of Counties
Amador and Calaveras Cos (Central Mtn), CA	CA	93	75,654	2
Baltimore, MD	MD	93	2,512,431	6
Dallas-Fort Worth, TX	TX	96	5,030,828	9
Houston-Galveston-Brazoria, TX	TX	103	4,669,571	8
Los Angeles-San Bernardino Cos(W Mojave), CA	CA	103	656,408	2
Nevada Co. (Western Part), CA	CA	96	77,735	1
New York-N. New Jersey-Long Island, NY-NJ-CT	NY-NJ-CT	92	19,634,122	24
Philadelphia-Wilmin-Atlantic Ci, PA-NJ-MD-DE	PA-NJ-MD-DE	93	7,333,475	18
Riverside Co, (Coachella Valley), CA	CA	102	324,750	1
Sacramento Metro, CA	CA	97	1,978,348	6
TOTAL			42,293,322	77

“Non-Attainment” Scenario 2A – *Equating EPA & ASHRAE Levels*

- ASHRAE matches air cleaning threshold to the current EPA non-attainment 85 ppb level

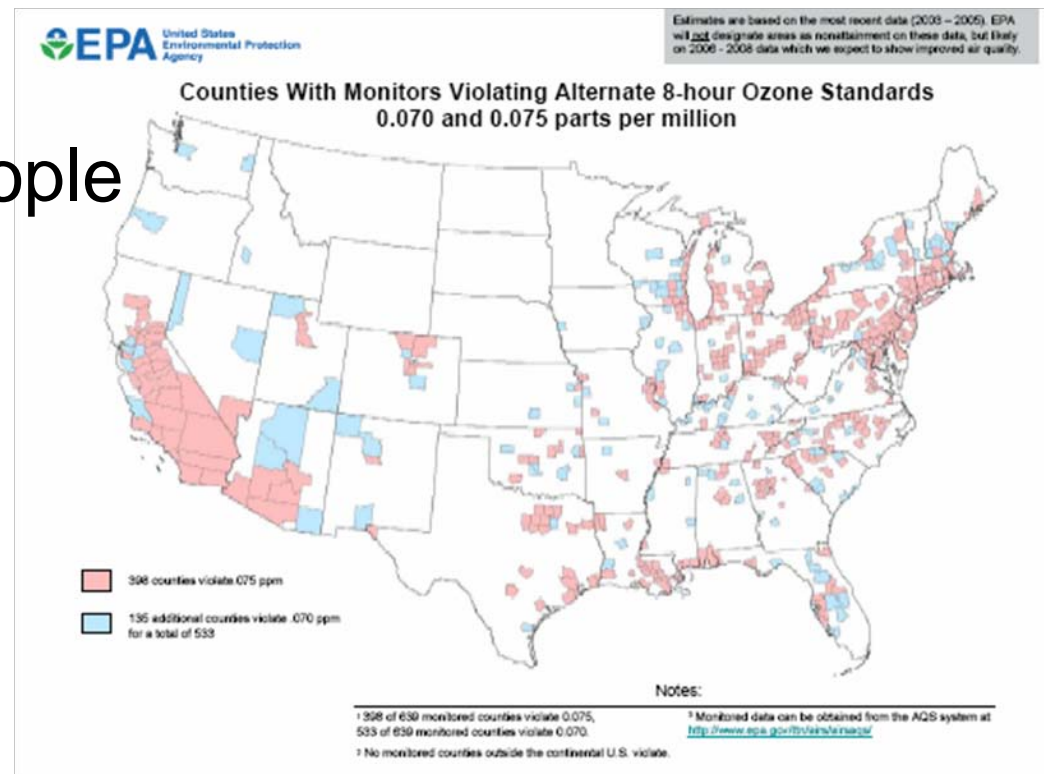
- 130 million people
- 104 counties
- 23 states



“Non-Attainment” Scenario 2B – *Cascading EPA Rule on ASHRAE*

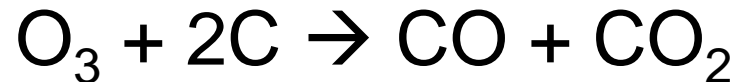
- EPA rule cascading effect could lower non-attainment classification, i.e., $85 - 15 = 70$ ppb

- TBD million people
- 533 counties
- 42 states



Air Cleaners for Ozone Removal

- Typically active carbon (sorbent) filters
 - Granular beds or impregnated media
 - Likely reaction NOT sorption process
 - Carbon gasification occurs at ppb level per



- Alter chemistry with fast reactant pollutants
- Past air cleaner research completed
 - Insightful small scale sorbent sample tests
 - But dated and limited full scale filter tests

Research Needs

- Defined by ASHRAE Environmental Health Committee at 1/08 NYC Meeting
- 3 areas identified but unfunded
 1. Situation and Cost/Benefit Analysis
 2. Air Cleaner Technical Evaluation
 1. Sorbent sample testing (ASHRAE Std. 145.1)
 2. Air cleaner testing (ASHRAE Std. 145.2)
 3. Field Intervention with Air Cleaners
 1. Leaky buildings
 2. Tight Buildings

Summary

- **SITUATION IS DYNAMIC!**
 - EPA 3 year rolling average ozone design data
 - EPA proposed ozone standard rulemaking
 - ASHRAE 62.1 standard public review process
- **BUT DIRECTION IS CLEAR!**
 - EPA ozone standard to be reset downward
 - ASHRAE threshold for air cleaning is trending downward as well, possibly dramatically so
 - Not just a California requirement in the future
- **AND RESEARCH IS NEEDED!**
- Upcoming white paper (and Indoor Air 2008 Conference paper) due out soon!