

Review of the California Ambient Air Quality Standard for Nitrogen Dioxide

February 22, 2007

Board Hearing

Sacramento, California



Air Resources Board

California Environmental Protection Agency

Overview

- Criteria for standard setting
- Process for standard setting
- Sources and levels of NO₂
- Health effects of NO₂
- Basis for the standard recommendations

Criteria for Standard Setting



Elements of an Ambient Air Quality Standard

- Air Quality Standard: legal definition of clean air
- Standards have:
 - Pollutant definition
 - Concentration
 - Averaging time
 - Monitoring method
 - Form of the standard
- Based solely on health & welfare

Standard Setting Does Not Include

- Attainment designation plans
- Feasibility of controls
- Cost of controls
- Implementation of controls
- Separate regulatory process to address control issues

Why Did We Review the NO₂ Standard ?

- Protect public health
- Comply with State law
- Address requirements of Children's Environmental Health Protection Act (SB25, Escutia, 1999)
- Priority for review based on Children's Environmental Health Protection Act evaluation

Why Are We Concerned about NO₂?

- Current standard not adequate to protect public health, including infants and children
- Adverse health effects related to NO₂
- Children, asthmatics most vulnerable
- NO₂ commonly found pollutant in outdoor air
- Higher concentrations reported near roadways

Staff Recommendations for the NO₂ Standard

- Reduce level of current 1-hr standard from 0.25 ppm to 0.18 ppm, not to be exceeded
- Establish a new annual average standard of 0.030 ppm, not to be exceeded
- Retain current monitoring method (gas phase chemiluminescence)

NO₂ Standards (ppm)

| | One Hour | Annual |
|-----------------------|--------------|--------------|
| California (current) | 0.25 | -- |
| US EPA | -- | 0.053 |
| California (proposed) | 0.18 | 0.030 |
| <i>WHO Guidelines</i> | <i>0.106</i> | <i>0.021</i> |

Process for Standard Setting

What Are the Regulatory Steps in a Standard Review?



Air Quality Advisory Committee (AQAC) Review

- Peer review required
- Appointed by University of California President
- Purpose of AQAC review:
 - Assess adequacy of scientific basis for proposed standards
 - Assess adequacy of proposed standards to protect public health

Findings of the AQAC Review

- Scientific conclusions and findings are consistent with the available data
- Staff recommendations are scientifically sound, and justified
- Suggested clarifications and discussion, additional references, and additional information in some sections of the report
- Staff made revisions based on AQAC review

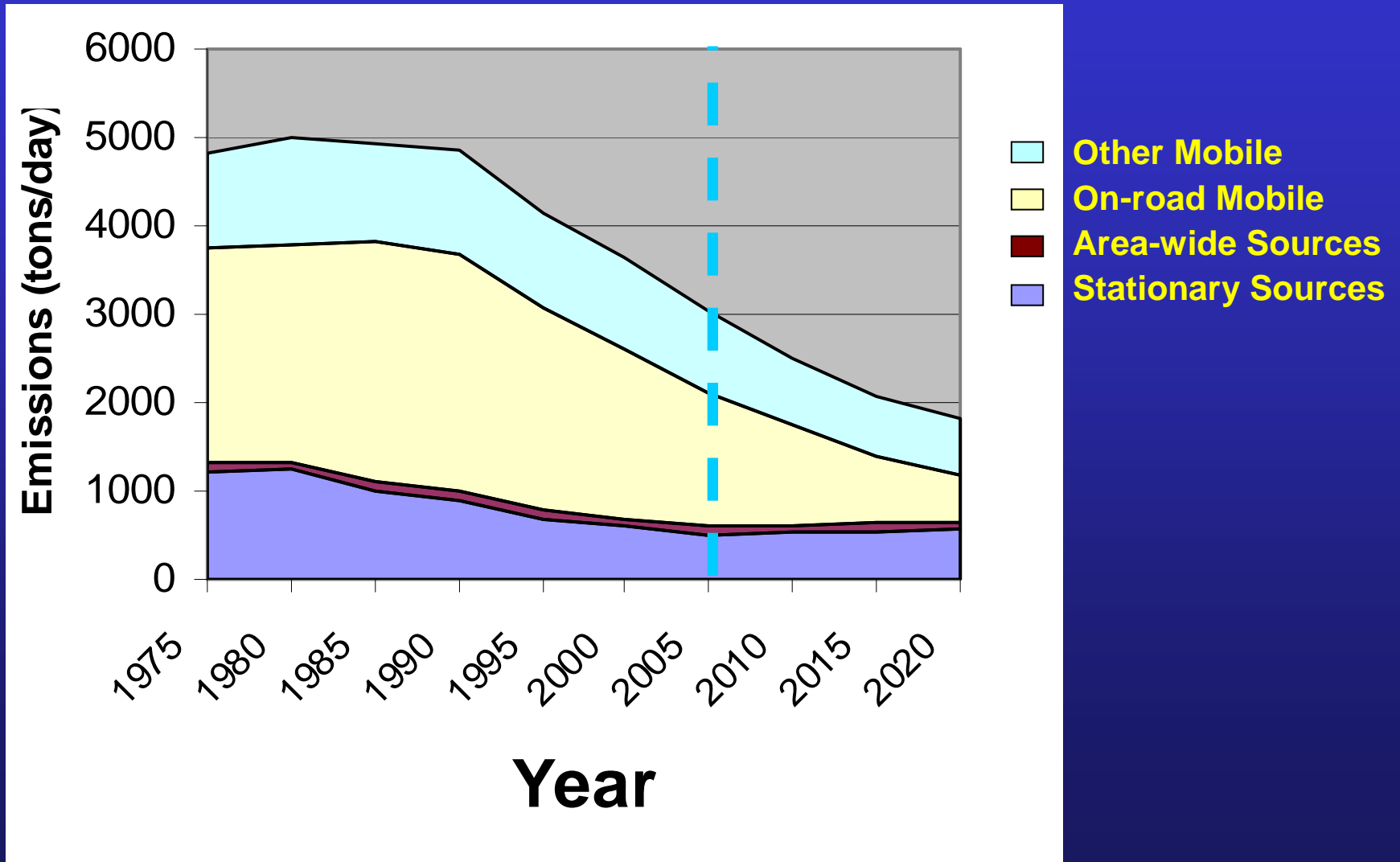
Staff Findings

- Sources and Levels of NO₂
- Health Effects
- Basis for recommendations

Sources of NO₂

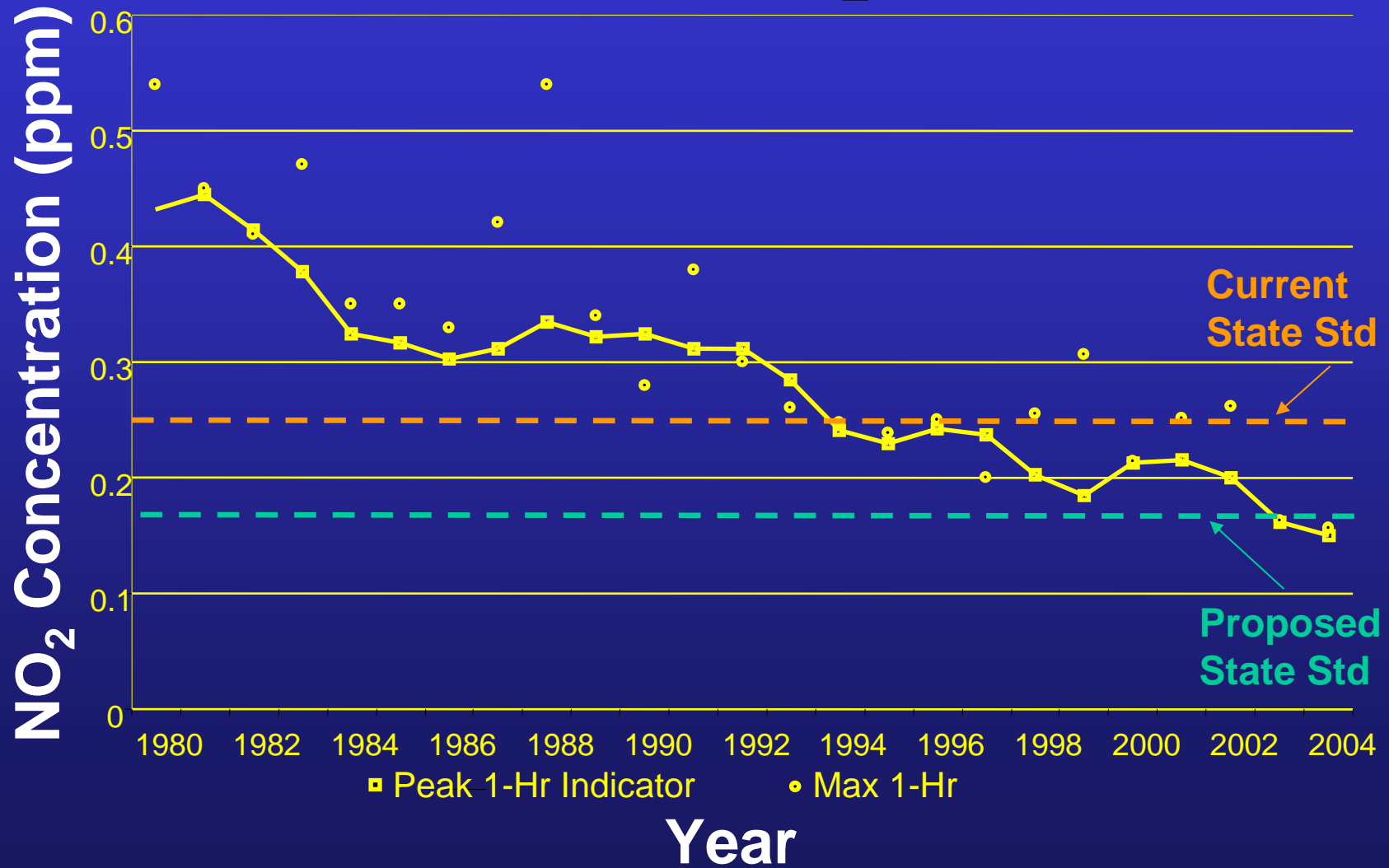
- Product of high temperature combustion
 - Power plants, motor vehicles
 - NO_x (NO + NO₂) emitted from sources
- Product of atmospheric processes
$$\text{NO} + \text{O}_3 \longrightarrow \text{NO}_2$$
- Indoor pollutant
 - Gas appliances, unvented heaters

Oxides of Nitrogen (NO_x) Emissions Trends Statewide Annual Average (tons/day)



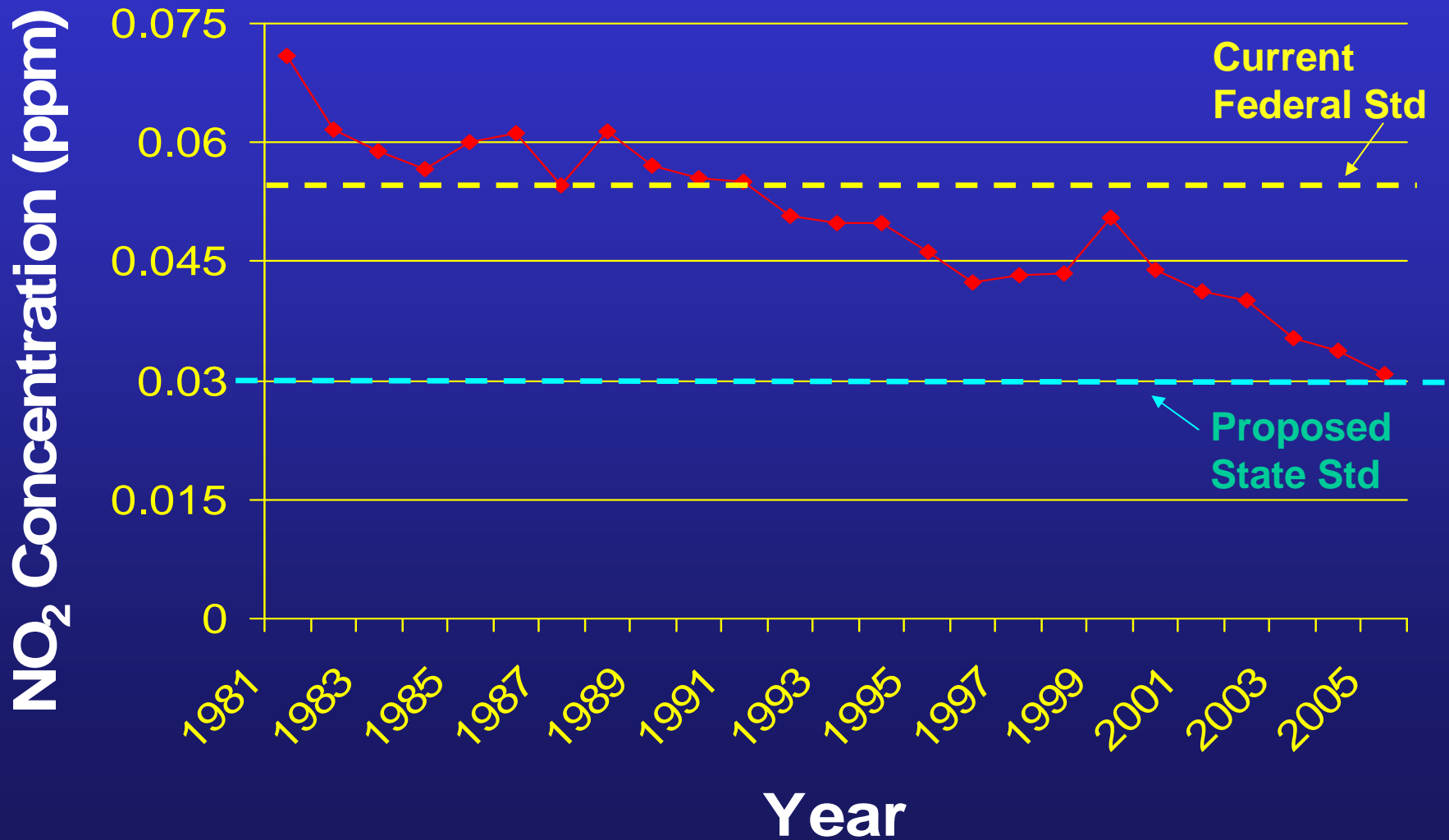
South Coast Air Quality Trends

One-hour NO₂ (ppm)



South Coast Air Quality Trends

Annual Average NO₂ (ppm)



Near Roadway Exposures

- Possible higher concentrations of NO₂ near roadways
- Some groups may be disproportionately exposed
 - Low income living near freeways
 - Children attending schools near roads
- Need to evaluate distribution of NO₂ monitoring sites
- Exposure characterization, not a health issue

Health Effects of NO₂



Evidence on the Health Effects of NO₂ Provided from Different Types of Studies

- Controlled human exposure
- Animal toxicology
- Epidemiology

Controlled Human Exposure Studies

- Exposures of human volunteers in a laboratory setting
- Responses studied: respiratory symptoms, lung function, inflammation (lung or blood), cardiovascular effects
- Typical subjects: healthy adults or mild asthmatics

Controlled Human Exposure Studies (con't)

- Advantages
 - Precise measures of exposure and response
- Limitations
 - Few studies on more vulnerable populations
 - Small sample size and studied doses
 - Few studies of pollutant mixtures
 - Cannot predict effects of chronic exposures

Controlled Human Studies of NO₂: Lowest Concentrations Showing Effects

- Healthy Subjects: no effects below 1 ppm
- Asthmatics
 - Enhanced response to inhaled allergen at 0.26 ppm (15-30 min)
 - Increased airway reactivity at 0.2 – 0.3 ppm (30 min-2 hr)
 - Potential to increase asthma symptoms and medication use

Controlled Human Studies (con't)

- Subjects with chronic obstructive lung disease
 - Decreased lung function at 0.3 ppm
- Limited data for children, elderly and those with cardiovascular disease
- Other considerations:
 - Variability in response among subjects
 - Limited data on longer exposure durations and effects of NO₂ with co-pollutants

Epidemiologic Studies of NO₂

- Examines effects of NO₂ in large human populations under real-world conditions
- Studies of acute effects
 - Time series – ↑ NO₂ from day to day and ↑ hospitalizations or death
 - Panel studies of asthmatic children
- Studies of chronic effects
 - Longer term exposures (months to years) and risk of disease

Epidemiologic Studies

- Advantages

- Evaluate exposures and responses of free-living populations over a wide range of individuals, behaviors, and subgroups, including susceptible individuals
- Examine both short and long-term exposures

- Limitations

- Difficult to determine relevant exposure averaging time
- Need to account for other factors such as co-pollutants

Findings from Epi Studies

Acute exposure to NO₂ (24-hr to several days)

- ER visits and hospital admissions, especially for asthma, most consistent for both adults and children.
- Increased symptoms and decreased lung function in panel studies of asthmatics
- Increased mortality, cardiovascular-related hospital admissions, cardiac arrhythmias

Findings from Epi Studies

Chronic exposure to NO₂ (and traffic) (months to years)

- Asthma exacerbations
- Reduced lung function and lung growth
- Low birth weight
- Respiratory symptoms

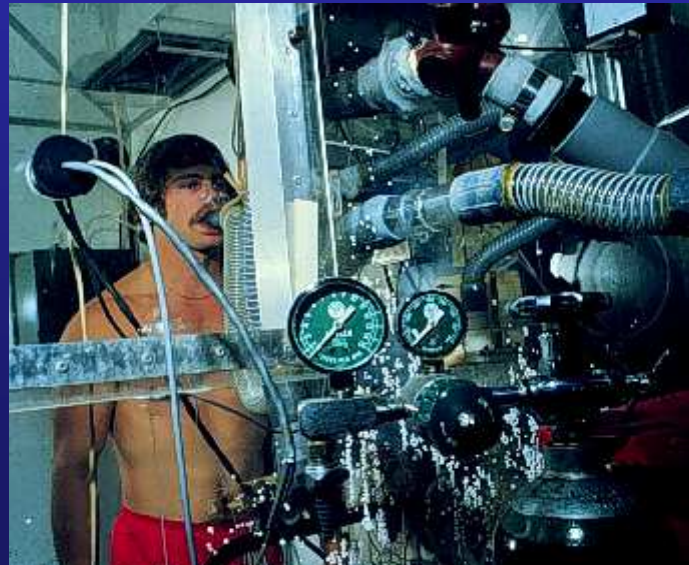
Likely Effect Levels for NO₂ and Respiratory Disease

- Time series studies linking NO₂ with emergency room visits and hospital admissions for asthma had long-term average of 0.03 - 0.05 ppm (24-hr avg)
- Several of these studies suggest an independent effect of NO₂
- At these concentrations, studies also link chronic exposures (months to years) to NO₂ with loss of lung function and asthma symptoms

Findings from Animal Studies

- Prolonged repeated exposure of young animals during lung development show changes in lung structure (≥ 0.25 ppm)
- In animal models of allergic asthma, exposure to high concentrations of NO_2 (≥ 5 ppm) produce consistent increased markers of allergic inflammation
- Animal studies suggest oxidant damage – consistent with human studies
- In terms of the amount of inhaled NO_2 reaching the deep lungs, rodents inhaling 1 ppm NO_2 is about equivalent to humans inhaling 0.25 ppm NO_2

Basis for Recommendations



Basis for NO₂ 1-hour Standard of 0.18 ppm

1. Enhanced response to allergen in asthmatics at 0.26 ppm for 15-30 min
2. Increased airway reactivity in asthmatics at 0.25 - 0.3 ppm for 30 min- 1 hr

Basis for NO₂ 1-hour Standard (con't)

3. Add margin of safety for:
 - Children and other susceptible populations (e.g. more severe asthmatics)
 - Possible effects at lower concentrations
 - Proposing 1-hr avg standard but effects observed after 15-30 minutes
4. Effects observed in epidemiologic time-series and panel studies may be due to short-term exposures

Basis for Annual Average Standard of 0.030 ppm

1. Hospital admissions and ER visits for asthma, and effects on lung development and asthma exacerbation in areas with annual averages of 0.025 to 0.040 ppm
2. Potential effects of NO₂ on serious outcomes including mortality, ER, hospitalization for cardiac and respiratory disease and arrhythmias
3. NO₂ likely to be best marker of traffic among criteria pollutants

Basis for Annual Average (con't)

4. Studies show airway reactivity and enhancement of allergic response and alterations in lung structure in young animals due to long term exposures
5. Important to lower full distribution of exposures not just peak 1-hr

SB 25 Requires Special Considerations for Infants and Children

- Exposure patterns: higher exposures per body weight and more time spent outdoors
- Susceptibility: exposure may impact lung development and function
- Pollutant interactions: little evidence at this point

Summary of Staff Recommendations



Summary Staff Recommendations for Nitrogen Dioxide

- Retain Nitrogen Dioxide as the pollutant definition
- Reduce the current 1-hr standard to 0.18 ppm, not to be exceeded
- Establish a new annual average of 0.030 ppm, not to be exceeded
- Retain the chemiluminescence monitoring method

Review of the California Ambient Air Quality Standard for Nitrogen Dioxide

February 22, 2007

Board Hearing

Sacramento, California



Air Resources Board

California Environmental Protection Agency