

Review of the California Ambient Air Quality Standard for Nitrogen Dioxide

February 1, 2007

Sacramento, California



Air Resources Board



**Office of Environmental
Health Hazard Assessment**

California Environmental Protection Agency

Overview

- Background
- What is the staff recommendation for revising the NO₂ standard?
- What are the regulatory steps in a standard review?
- What are the sources, emissions, and air quality trends of NO₂?
- What are the health effects of NO₂ and the health basis of the recommendations?

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)

Why Are We Concerned about NO₂?

- Based on the priority review under the Children's Environmental Health Protection Act
- Current standard may not adequately protect public health, including the health of infants and children
- NO₂ commonly found pollutant in outdoor air

Staff Recommendations for the NO₂ Standard

- NO₂ pollutant addressed by standard
- 1-hr standard – reduce current std of 0.25 ppm to 0.18 ppm, not to be exceeded
- Annual average standard- establish new annual average standard of 0.030 ppm (30 ppb), not to be exceeded.
- Retain current monitoring method

Additional Staff Recommendations

- Spatial distribution of the NO₂ - examine hot spots and regional monitoring.
- Future research areas:
 - Clinical studies on sensitive subpopulations including gene environment interaction
 - Laboratory studies on developing lung
 - Effects of co-pollutants
 - Improved exposure assessment
- Review of new scientific evidence in 5 years ⁶

Basis of One-Hour Standard Recommendation

- One Hour – Clinical Human Studies
 - Enhanced inflammatory response in asthmatics
 - Increased airway reactivity in asthmatics
 - Margin of safety added

Basis of Annual Average Standard Recommendation

- Epidemiological Studies
 - Increased asthma symptoms
 - Increased medication use, ER visits
 - Long term exposure = changes in lung function growth in children

NO₂ Standards (ppm)

	One Hour	Annual
California (current)	0.25	--
California (proposed)	0.18	0.030
US EPA	-	0.053

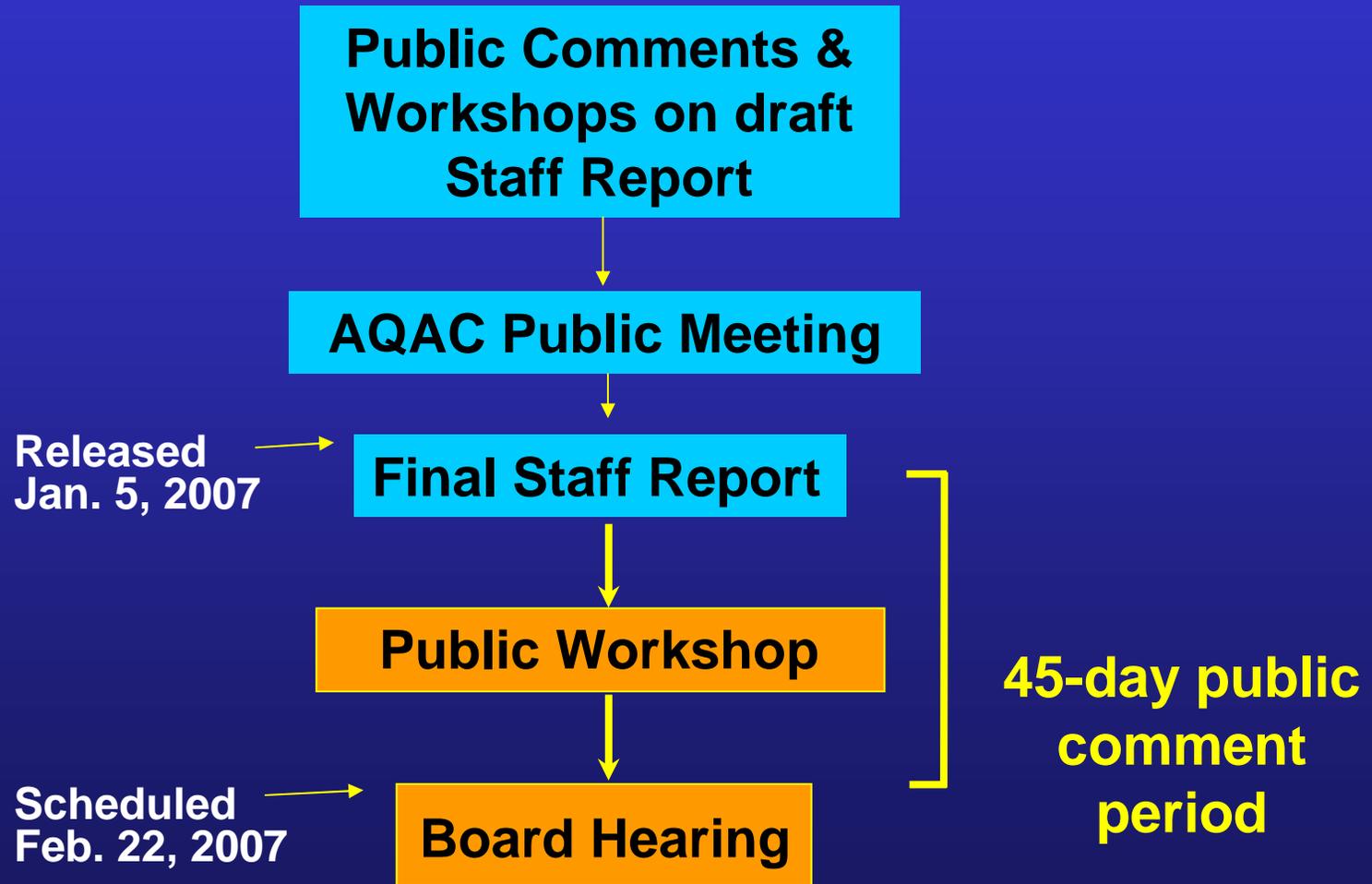
Elements of an Ambient Air Quality Standard

- Air Quality Standard: legal definition of clean air
- Standards have:
 - Pollutant definition
 - Concentration
 - Averaging time
 - Monitoring method
 - Form of the standard

Standard Setting Does Not Include

- Attainment designation
- Feasibility of controls
- Cost of controls
- Implementation of controls

What Are the Regulatory Steps in a Standard Review?



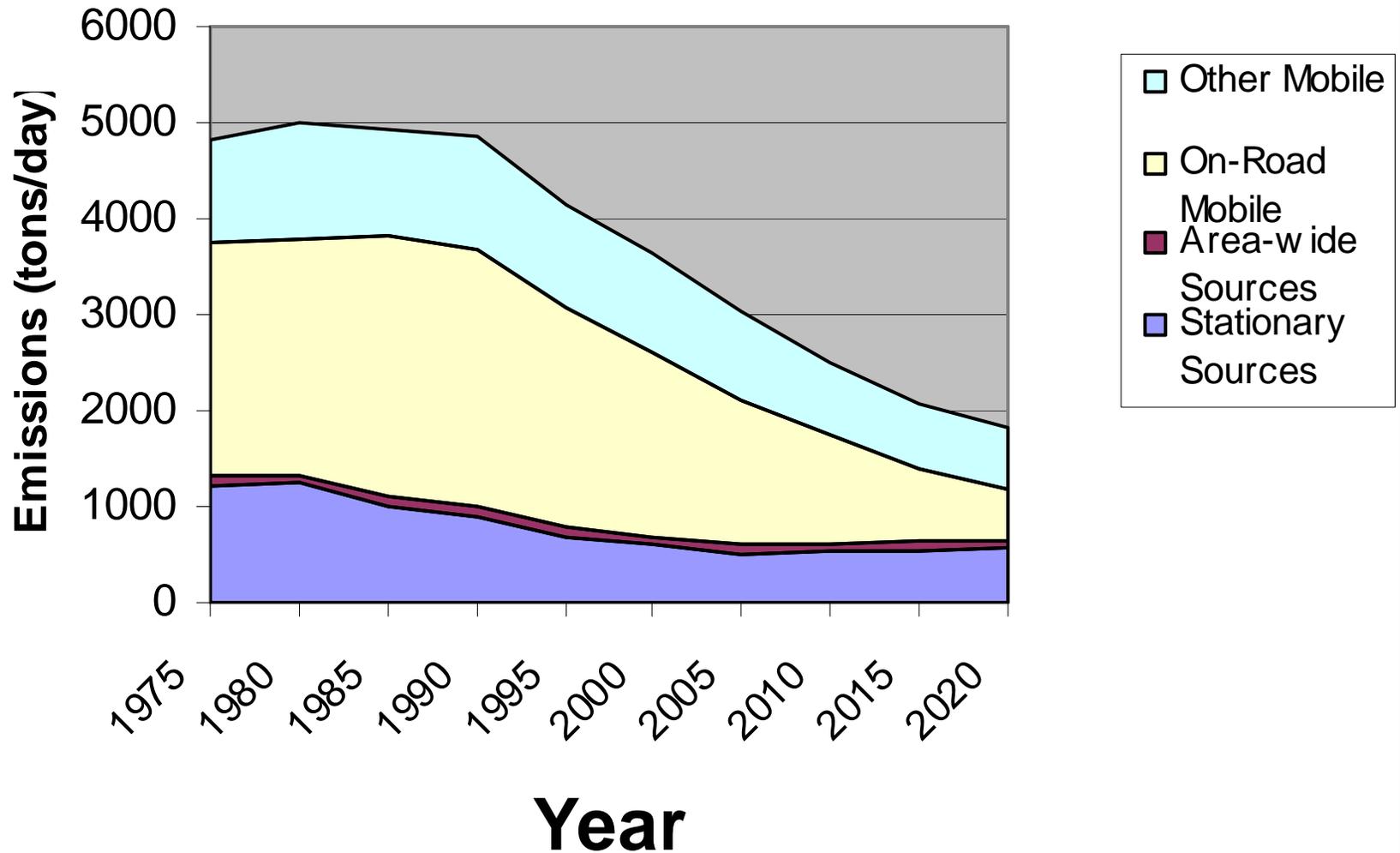
Air Quality Advisory Committee (AQAC) Review

- Required by State law
- 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

Sources and Levels

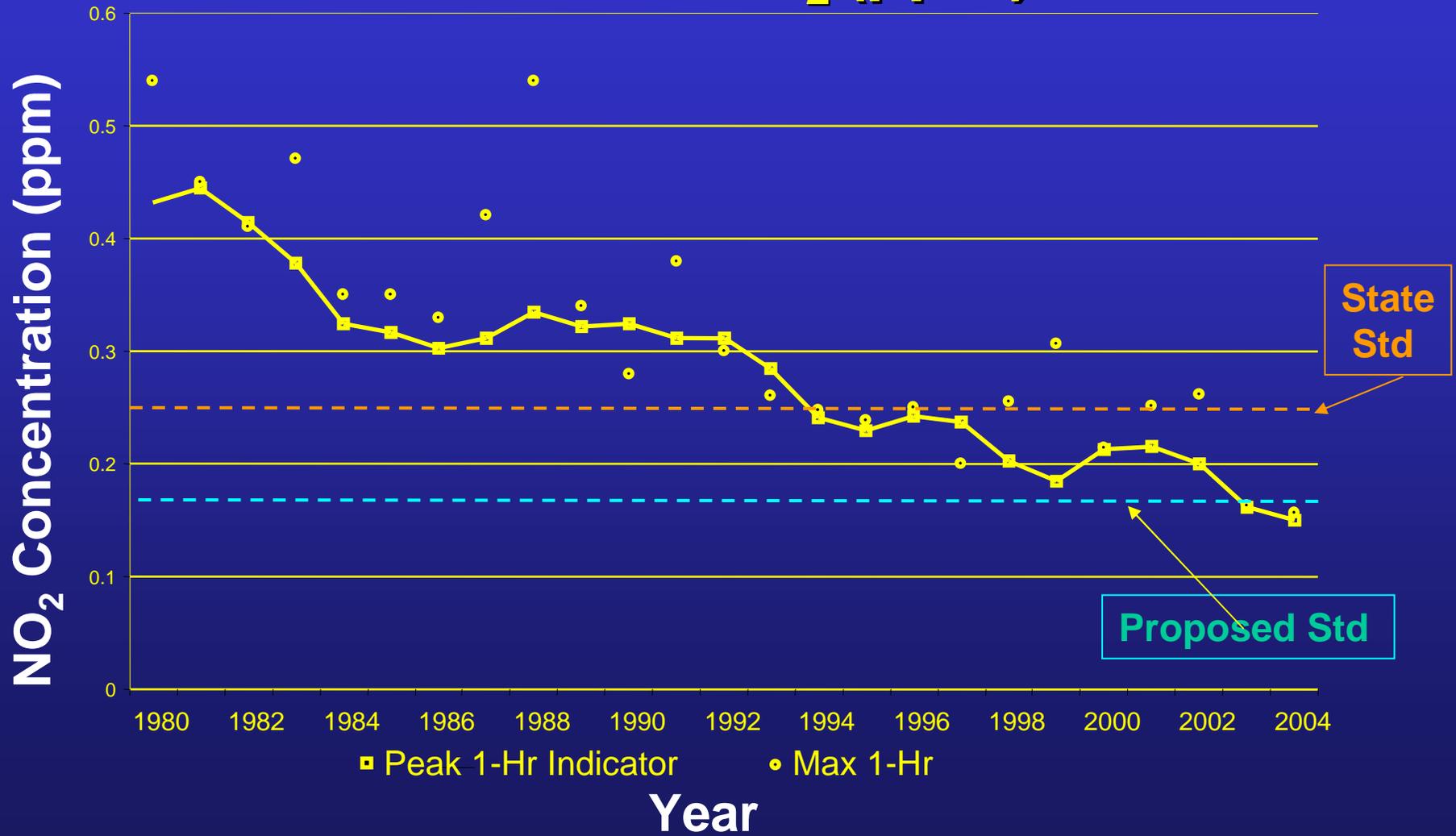
- Product of combustion sources
- An outdoor and indoor pollutant
- Also produced from nitric oxide (NO), a product of combustion, and reactive hydrocarbons

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



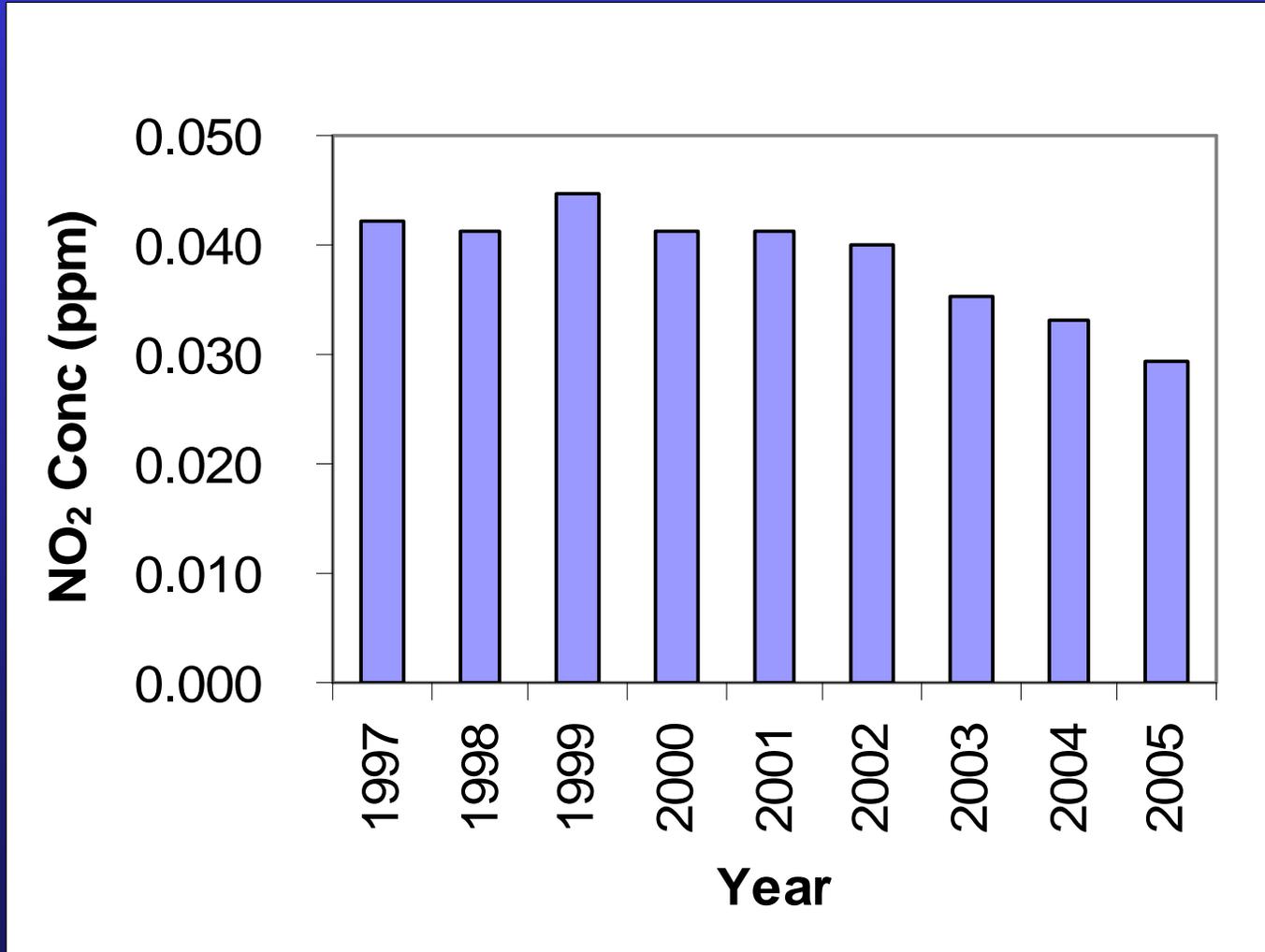
South Coast Air Quality Trends

One-hour NO₂ (ppm)



South Coast Air Quality Trends

Annual Average NO₂ Concentration (ppm)



Annual Average NO₂ Concentrations by Air Basin (ppb)

Area	2002	2003	2004	2005
Lake Tahoe	11.7	10.0	NA	NA
Mojave Desert	25.0	23.7	22.7	22.3
North Central Coast	6.9	6.2	6.8	7.6
North Coast	9.5	8.9	8.8	7.8
Sacramento Valley	19.6	17.9	16.7	16.4
Salton Sea	16.2	16.2	15.1	14.8
San Diego	22.2	20.8	23.3	24.6
San Francisco Bay Area	19.1	18.3	17.4	18.5
San Joaquin Valley	23.9	23.1	18.9	20.9
South Central Coast	16.7	15.2	13.9	15.0
South Coast	40.2	35.3	33.7	30.9

* Extracted from ADAM on May 8, 2006.
NA=not available

Spatial Variability of NO₂

- NO₂ concentrations from sources such as roadways and freeways
- Some groups (e.g. economically disadvantaged) may be disproportionately exposed near these hot spot sources
- Relationship of hot spot sources to regional monitoring values

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

Responses to AQAC Review and Public Comments

- Responses provided in Technical Support Document
- Clarification, additions, and justifications provided
- Information incorporated into Staff Report and Technical Document

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 (cont)

- 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 (cont.):

- Subjects with chronic 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

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

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

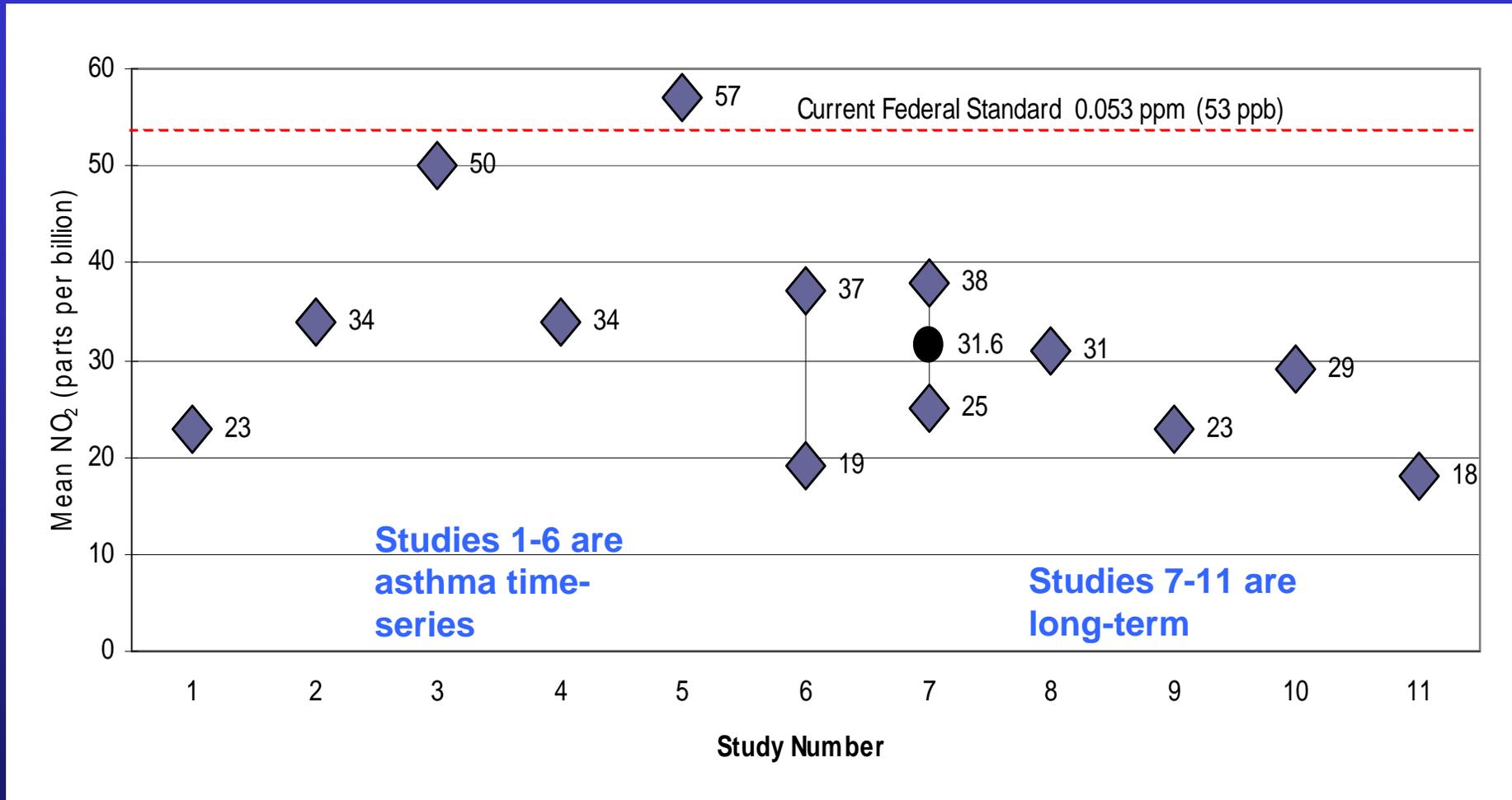
Chronic exposure to NO₂ (and traffic) (months to years)

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

Key Studies of NO₂ and Respiratory Disease

Study	Author	Outcome	Location
1	Peel (05)	Asthma ERV	Atlanta
2	Galan (03)	Asthma HA	Madrid
3	Atkinson (99)	Asthma ER	London
4	Hajat (99)	MD asthma	London
5	Anderson (98)	Asthma HA	London
6	Sunyer (97)	Asthma HA	3 Euro cities
7	Gauderman (04)	Lung function	So. Calif.
8	Gauderman (05)	Asthma, wheeze	So. Calif.
9	Kim (04)	Asthma, bronchitis	S.F. Bay Area
10	Kramer (00)	Allergic symptoms	Dusseldorf
11	Janssen (03)	Allergic sensitization	Netherlands

Key Epidemiologic Studies Showing Associations between NO₂ and Respiratory Disease



◆ = Average NO₂ in single city study

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◆ = Range of averages in multi-city study

● = Overall average NO₂ in multi-city study

Basis for Recommendations

Basis for NO₂ 1-hr Standard of 0.18 ppm

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

Basis for NO₂ 1-hr standard (cont.)

- 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
- 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

- 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
- Potential effects of NO₂ on serious outcomes including mortality, ER, hospitalization for cardiac and respiratory disease and arrhythmias
- NO₂ likely to be best marker of traffic among criteria pollutants

Basis for Annual Average (cont.)

- Studies show airway reactivity and enhancement of allergic response and alterations in lung structure in young animals due to long term exposures
- 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 Staff Recommendation for Nitrogen Dioxide

- Retain Nitrogen Dioxide as the pollutant definition
- Decrease 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

Additional Staff Recommendations

- Spatial distribution of the NO₂ - examine hot spots and regional monitoring..
- Future research areas:
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Comment Period

- Board Meeting Scheduled Feb. 22, 2007
- Direct comments Electronically:
- <http://www.arb.ca.gov/lispub/comm/bclist.php>
- Or by Postal Address:
- Clerk of the Board
Air Resources Board
1001 I street, 23rd Floor
Sacramento, CA. 95814
- Written submissions not physically submitted at the hearing must be received no later than 12:00 noon, Feb. 21, 2007

Timeline for NO₂ Review

April 14th	Release of Draft Report
May 8, 11 th	Public Workshops
June 12-13	AQAC Meeting
Jan. 5, 2007	Release of Final Report
Feb. 1, 2007	Public Workshop
Feb. 22, 2007	Board Hearing on Staff Recommendations

Contact Information

- Nitrogen Dioxide standard review website:
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