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# Overview of Key Changes and Additions in the Second Draft Risk and Exposure Assessment for the SO<sub>2</sub> Primary NAAQS Review

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Presentation to the Clean Air Scientific Advisory Committee

Office of Air Quality Planning and Standards  
Environmental Protection Agency

April 16-17, 2009

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# Overview

- REA Development
- Key changes and additions with respect to the first draft Risk and Exposure Assessment (REA)
  - Health benchmark levels
  - Air quality characterization
  - Exposure assessment
  - Quantitative lung function risk assessment
  - Policy assessment

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# REA Development

## ■ First Draft REA:

- Assessed exposures and characterized risks considering current air quality and air quality simulated to just meet the current standards
- Informed by health information and conclusions in 1<sup>st</sup> and 2<sup>nd</sup> drafts of the ISA

## ■ Second Draft REA:

- Revised and expanded air quality, exposure, and risk analyses to include potential alternative standards in St. Louis and Greene County, MO
- Includes quantitative risk assessment for lung function responses for asthmatics associated with 5-minute exposures while engaged in moderate or greater exertion
- Includes a policy assessment considering evidence based and air quality, exposure, and risk based considerations

## ■ Final REA:

- Will be informed by comments from CASAC and the public on the second draft of the document
  - Considered in conjunction with the health information evaluated in the final ISA to inform the rulemaking process
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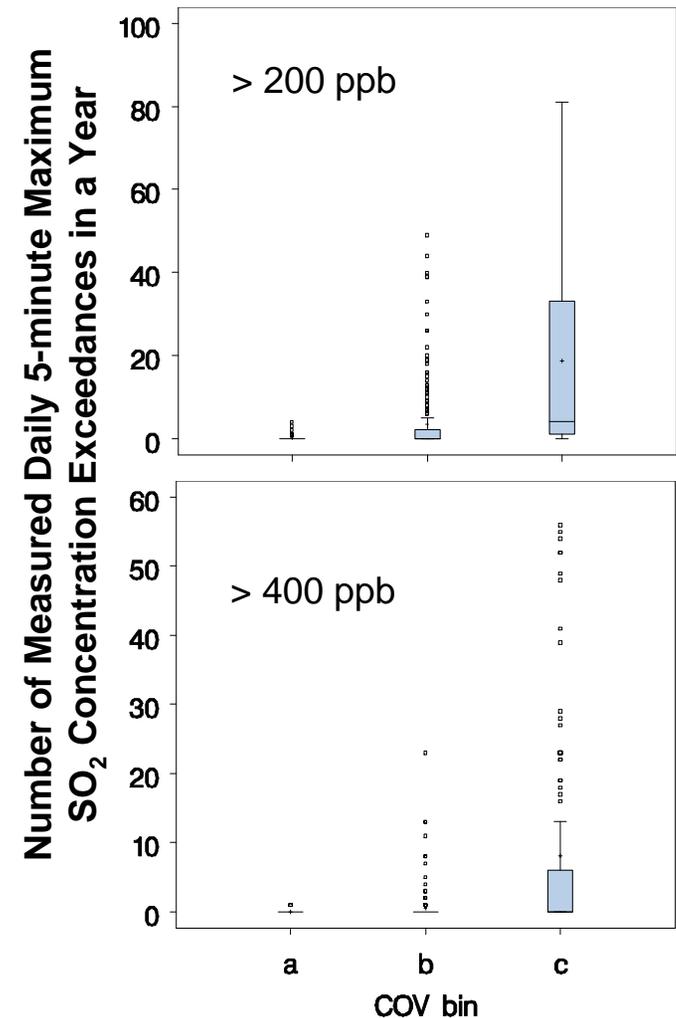
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## Key change: Lowering of potential health effect benchmark levels

- Potential health effect benchmark values derived from 5-10 minute exposures of exercising asthmatics lowered from 400 – 600 ppb to 100 -400 ppb
  - Considers that the lowest observed effect level in 5-10 minute free-breathing chamber studies follows a 200 ppb exposure, but that participants in those studies do not represent the most sensitive asthmatics (i.e. severe asthmatics)
  - Considers that 400 ppb is the lowest exposure level in 5-10 minute free-breathing chamber studies at which moderate or greater lung function decrements are frequently accompanied with respiratory symptoms

# Key changes: Air quality characterization

- Reorganized chapter and improved clarity
- Added ambient monitor characterization
  - Siting characteristics, proximity to emission sources, population density, concentration variability
- Evaluation of current and potential alternative standards
  - Elaborated discussion on concentration adjustment procedure
  - Expanded counties selected to 40
- PMR statistical model
  - Expanded bins from 3 x 5 to 3 x 7
  - Cross-validation of predicted/observed
    - Two bin types evaluated (COV, GSD)
- Expanded uncertainty analysis



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## Key changes: Exposure assessment

- Reorganized chapter and improved clarity
- Focused analysis on Greene County (1<sup>st</sup> draft) and St. Louis
- Expanded modeled-to-monitored air quality concentration evaluation
- Enhanced indoor SO<sub>2</sub> removal rate distributions
- Results now include microenvironmental contribution to exposures
- Added section on representativeness of St. Louis and Greene County to other U.S. areas
- Expanded uncertainty analysis including
  - Dispersion and exposure modeling uncertainties
  - Impact of multiple peaks within an hour

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## Additional representativeness evaluation of St. Louis and Greene County air quality

- St. Louis was not one of the 40 selected counties for the air quality characterization
  - Mean daily 5-minute maximum SO<sub>2</sub> concentrations were modeled in St. Louis as was done with the other 40 counties using the hourly monitoring data (2001-2006)
  - The estimated annual benchmark exceedances, average total emissions (within 20 km of monitors), and average population (within 5km) were ranked in ascending order within the 40 county data set results

# Additional representativeness evaluation of St. Louis and Greene County air quality (cont.)

Location	Air Quality Scenario	Benchmark Exceedance Rank (out of 41)			
		100 ppb	200 ppb	300 ppb	400 ppb
<b>Greene County, MO</b>  Population – 19 <sup>th</sup> Emissions – 37 <sup>th</sup>	AS IS	31	23	22	21
	Current Standard	40	33	27	23
	99-50	8	4	4	22.5
	99-100	13	6	5	4
	99-150	27	9	7	5
	99-200	32	14	8	8
	99-250	34	22	9	7
	98-200	36	21	9	8
<b>St. Louis, MO</b>  Population – 9 <sup>th</sup> Emissions – 26 <sup>th</sup>	AS IS	38	37	39	38.5
	Current Standard	2	3	8	14
	99-50	30	22.5	27	22.5
	99-100	20	30	25	24
	99-150	13	27	30	28.5
	99-200	9	21	29	30
	99-250	8	15	27	28
	98-200	8	16	24	26

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## Key change: Added quantitative lung function risk assessment

- Combined outputs from the exposure analysis for asthmatics (all) and asthmatic (children) with estimated exposure-response functions to estimate:
  - Percentage and number of asthmatics likely to experience two specified levels of response in lung function
  - Total number of occurrences per year of two specified levels of response in lung function
- Exposure–response functions were based on controlled human exposure studies
- Used sRaw  $\geq 100\%$  and  $\geq 200\%$  and decrement in FEV<sub>1</sub>  $\geq 15\%$  and  $\geq 20\%$ .
- Considered current air quality, and air quality adjusted to simulate just meeting the current, and potential alternative 99<sup>th</sup> percentile 1-hour alternative standards
- Results presented for St. Louis and Greene County

**Table 9-4. Number of Asthmatics Engaged in Moderate or Greater Exertion Estimated to Experience At Least One Lung Function Response Associated with Exposure to SO<sub>2</sub> Under Alternative Air Quality Scenarios\***

Location	"As is" SO <sub>2</sub> Concentrations*	SO <sub>2</sub> Concentrations that Just Meet the Current Standards***	SO <sub>2</sub> Concentrations that Just Meet Alternative nth Percentile 1-Hr Daily Maximum Standards, with Levels (in ppb) of m (Standard Denoted n/m):					
			99/50	99/100	99/150	99/200	99/250	98/200
<b>Response = Increase in sRaw &gt;= 100%</b>								
<b>Greene County, MO</b>	90 (20 - 390)	210 (80 - 620)	80 (20 - 380)	90 (20 - 390)	100 (20 - 420)	120 (30 - 460)	160 (50 - 520)	140 (40 - 500)
<b>St. Louis, MO</b>	1010 (340 - 3010)	13460 (9740 - 18510)	730 (220 - 2490)	1990 (860 - 4690)	3650 (1900 - 7100)	5520 (3230 - 9490)	7500 (4770 - 11850)	7050 (4410 - 11320)
<b>Response = Increase in sRaw &gt;= 200%</b>								
<b>Greene County, MO</b>	30 (0 - 210)	70 (20 - 310)	30 (0 - 210)	30 (0 - 210)	30 (0 - 220)	40 (10 - 240)	50 (10 - 270)	50 (10 - 260)
<b>St. Louis, MO</b>	330 (70 - 1520)	5520 (3400 - 8960)	230 (40 - 1290)	670 (210 - 2270)	1280 (510 - 3360)	2010 (940 - 4470)	2830 (1470 - 5590)	2640 (1340 - 5330)

\*Numbers are median (50th percentile) numbers of asthmatics. Numbers in parentheses below the median are 95% credible intervals based on statistical uncertainty surrounding the SO<sub>2</sub> coefficient in the 2-parameter logistic exposure-response function. Numbers are rounded to the nearest ten.

\*\*The "as is" exposure scenario was based on monitoring and modeling using 2002 air quality information.

\*\*\*The current primary SO<sub>2</sub> standards include a 24-hour standard set at 0.14 parts per million (ppm), not to be exceeded more than once per year, and an annual standard set at 0.03 ppm, calculated as the arithmetic mean of hourly averages.

**Table 9-6. Number of Occurrences (In Hundreds) of a Lung Function Response Among Asthmatics Engaged in Moderate or Greater Exertion Associated with Exposure to SO<sub>2</sub> Concentrations Under Alternative Air Quality Scenarios\***

Location	"As is" SO <sub>2</sub> Concentration s**	SO <sub>2</sub> Concentration s that Just Meet the Current Standards***	SO <sub>2</sub> Concentrations that Just Meet Alternative nth Percentile 1-Hr Daily Maximum Standards, with Levels (in ppb) of m (Standard Denoted n/m):					
			99/50	99/100	99/150	99/200	99/250	98/200
<b>Response = Increase in sRaw &gt;= 100%</b>								
<b>Greene County, MO</b>	125 (24 - 572)	127 (25 - 577)	125 (24 - 572)	125 (24 - 572)	125 (24 - 573)	126 (24 - 573)	126 (24 - 575)	126 (24 - 574)
<b>St. Louis, MO</b>	657 (128 - 2985)	1672 (663 - 4740)	652 (125 - 2975)	686 (141 - 3041)	762 (176 - 3184)	880 (234 - 3398)	1036 (315 - 3673)	997 (295 - 3604)
<b>Response = Increase in sRaw &gt;= 200%</b>								
<b>Greene County, MO</b>	38 (4 - 310)	39 (4 - 312)	38 (4 - 310)	38 (4 - 310)	38 (4 - 310)	38 (4 - 310)	39 (4 - 311)	39 (4 - 311)
<b>St. Louis, MO</b>	201 (21 - 1614)	560 (165 - 2407)	199 (20 - 1609)	211 (24 - 1639)	237 (32 - 1703)	278 (47 - 1799)	332 (68 - 1923)	319 (63 - 1892)

\*Numbers are median (50th percentile) numbers of occurrences. Numbers in parentheses below the median are 95% credible intervals based on statistical uncertainty surrounding the SO<sub>2</sub> coefficient in the 2-parameter logistic exposure-response function. Numbers are rounded to the nearest whole number.

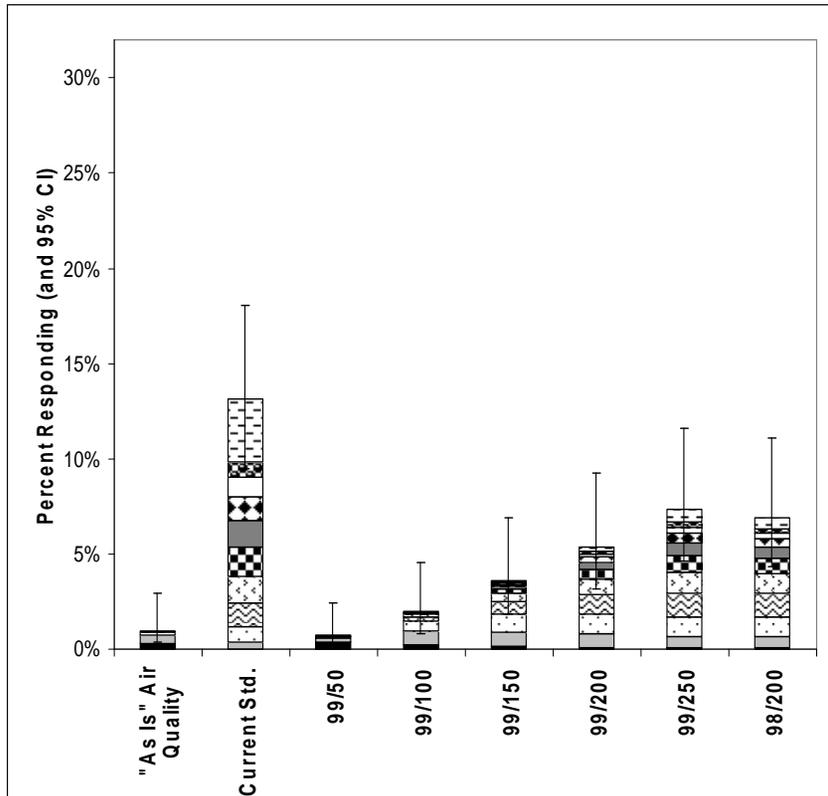
\*\*The "as is" exposure scenario was based on monitoring and modeling using 2002 air quality information.

\*\*\*The current primary SO<sub>2</sub> standards include a 24-hour standard set at 0.14 parts per million (ppm), not to be exceeded more than once per year, and an annual standard set at 0.03 ppm, calculated as the arithmetic mean of hourly averages.

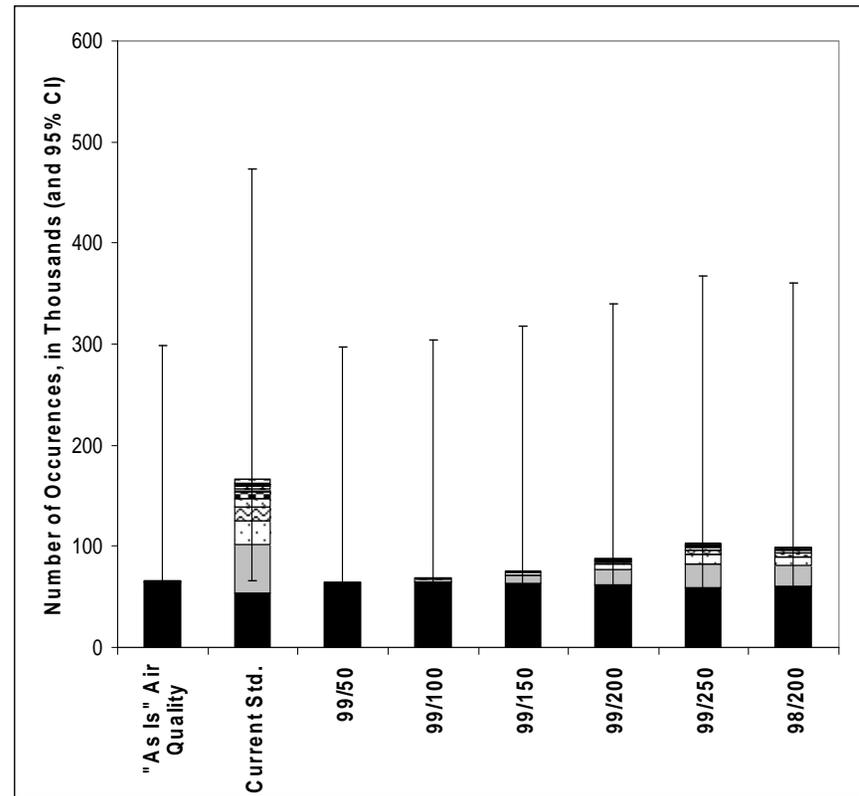
# Key for contribution of risk figures

- Attributable to  $500 \text{ ppb} \leq \text{SO}_2$
- Attributable to  $450 \text{ ppb} \leq \text{SO}_2 < 500 \text{ ppb}$
- Attributable to  $400 \text{ ppb} \leq \text{SO}_2 < 450 \text{ ppb}$
- Attributable to  $350 \text{ ppb} \leq \text{SO}_2 < 400 \text{ ppb}$
- Attributable to  $300 \text{ ppb} \leq \text{SO}_2 < 350 \text{ ppb}$
- Attributable to  $250 \text{ ppb} \leq \text{SO}_2 < 300 \text{ ppb}$
- Attributable to  $200 \text{ ppb} \leq \text{SO}_2 < 250 \text{ ppb}$
- Attributable to  $150 \text{ ppb} \leq \text{SO}_2 < 200 \text{ ppb}$
- Attributable to  $100 \text{ ppb} \leq \text{SO}_2 < 150 \text{ ppb}$
- Attributable to  $50 \text{ ppb} \leq \text{SO}_2 < 100 \text{ ppb}$
- Attributable to  $\text{SO}_2 < 50 \text{ ppb}$

## Lung Function Responses (defined as $\geq 100\%$ increase in sRaw) for Asthmatics- Total and Contribution of 5-Minute SO<sub>2</sub> Exposure Ranges



**Estimated Percent of Asthmatics Experiencing One or More Lung Function Responses**



**Estimated Annual Number of Occurrences**

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## Key addition: Policy assessment

- Considers the scientific evidence from the ISA and the exposure and risk information in the REA as it relates to the:
    - Adequacy of the current standards
      - 24-hour average of 0.14 ppm, not to be exceeded more than once per year
      - Annual average of 0.03 ppm
    - Consideration of potential alternative standards
      - 99th percentile 1-hour daily maximum levels of 50, 100, 150, 200, and 250 ppb
      - 98th percentile 1-hour daily maximum level at 200 ppb
  - Key conclusions
    - The scientific evidence and exposure and risk information call into question the adequacy of the current standards to protect public health with an adequate margin of safety from the respiratory effects associated with SO<sub>2</sub> exposure.
    - Staff provisionally concludes that the scientific evidence and exposure and risk information reasonably support a 99<sup>th</sup> percentile 1-hour daily maximum standard at levels ranging from 50 -150 ppb
    - Staff recognizes that the particular standard level selected will have implications for retaining or revoking the current 24-hour and/or annual standard
-