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# Setting of the 2008 National Ambient Air Quality Standard for Ozone

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**I**n 2008, the Environmental Protection Agency implemented a scheduled review of the National Ambient Air Quality Standards for ozone to decide whether to update or keep the standards the same. Following the assessment process, Steven Johnson, then the administrator of the EPA, controversially set the standards at a level higher than that recommended by the Clean Air Scientific Advisory Committee, reflecting a disagreement over the boundary between science and policy. A clearer definition of this boundary is important for more effective science-based policy making in this arena.

## **The Clean Air Act, National Ambient Air Quality Standards, Environmental Protection Agency, and Clean Air Scientific Advisory Committee**

The Clean Air Act (CAA) was enacted by Congress in 1970, as an acknowledgement of increased urbanization leading to higher levels of dangerous air pollution.<sup>1</sup> The CAA was meant to address these concerns and provide grounds for standard setting and for the regulation of pollutants. The CAA grants power to the

Environmental Protection Agency (EPA) to develop National Ambient Air Quality Standards (NAAQS) in order to address the aforementioned concerns regarding public health and welfare. NAAQS are maximum allowable levels that are set for six pollutants, termed criteria pollutants: carbon monoxide, lead, sulfur dioxide, ozone, particulate matter, and nitrogen dioxide. Each of these pollutants is characterized as primary or secondary (or both), where primary pollutants have direct effects on human health and secondary pollutants affect visibility, animals, infrastructure, etc. Anthropogenic emissions of ozone were first regulated by NAAQS in 1971 and the history of NAAQS decisions regarding ozone can be seen in Figure 1. Once set, these standards are reviewed and updated on a five-year cycle.

Sections 108 and 109 of the CAA describe the process for the setting and reviewing of the NAAQS. The development and implementation of the standards is an involved process consisting broadly of five steps: planning, an integrated science assessment, a risk/exposure assessment, a policy assessment, and rule making. The EPA criteria document includes the integrative assessment of scientific studies, and the EPA staff paper further discusses policy-relevant science, the risk assessment, and policy recommendations. Please note: This process is constantly evolving, but this is the general scheme followed, and these are the documents that were produced during the case in

Year	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1971	Primary and Secondary	Total photochemical oxidants	1-hour	0.08 ppm	Not to be exceeded more than one hour per year
1979	Primary and Secondary	O3	1-hour	0.12 ppm	Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1
1993	EPA decided that revisions to the standards were not warranted at the time				
1997	Primary and Secondary	O3	8-hour	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2008	Primary and Secondary	O3	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

**Figure 1:** *History of NAAQS for ozone*

question.

The planning phase starts with a science-policy review, including input from the scientific community and general public to frame questions that the subsequent steps of the process will address. The integrated science assessment is a comprehensive review of the policy-relevant science. The risk/exposure assessment builds upon this, providing quantitative effects on health and welfare of the pollutant in question. The risk/exposure assessment also includes analysis of the uncertainty in these numbers.

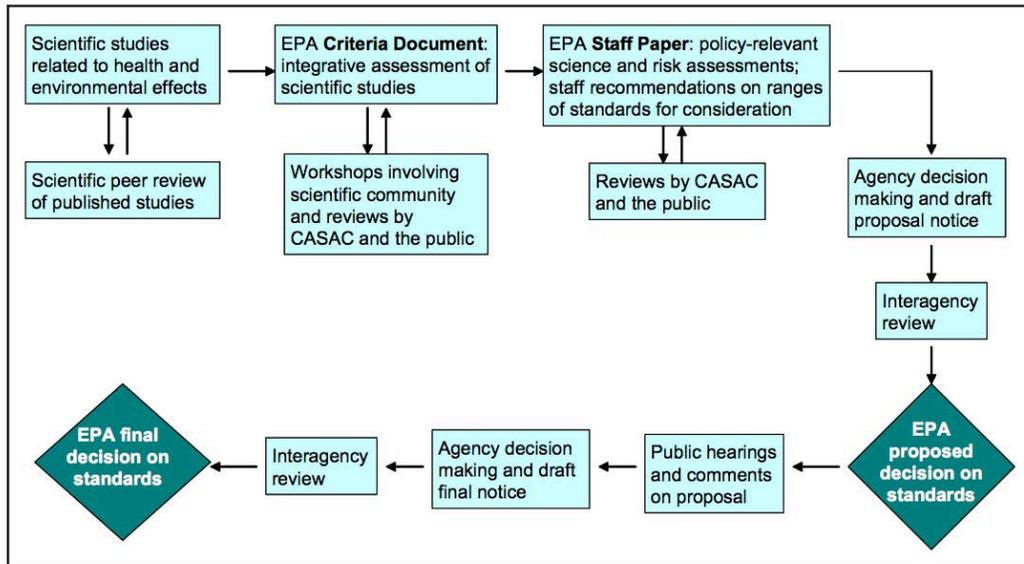
The policy assessment brings the conclusions of the previous steps into a policy context. Following a period of public review and comments, the EPA issues the final ruling. See figure 2 for an overview of this process.

Each of the preceding stages incorporates the analysis of the Clean Air Scientific Advisory Committee (CASAC), which is a separate body established by the EPA solely to assess the science regarding the danger of pollutants for human health. CASAC advises the EPA and the administrator on the adequacy of current standards or potential revisions. Finally, in the

rule making stage, the EPA takes into account inputs from each of the preceding steps, determines the acceptable level for the NAAQS, and publishes a notice. It is crucial to note that none of the steps leading up to the final ruling include a cost/benefit analysis of the establishment or revision of the NAAQS. In fact, the EPA cannot, by law, include considerations of the cost or feasibility of the implementation of standards when setting those standards. This sort of analysis will take place during the implementation phase, after the standards have been determined, as well as in the development of standards for individual sectors to analyze their role in the achievement of the overall NAAQS.

## Revision of the NAAQS for Ozone

The EPA undertook a revision of the NAAQS for ozone with the hopes of setting a new ozone standard in 2008 as part of its five-year review cycle. There had been a wealth of new scientific information pointing to the harmful effects of Ozone at the existing standard. The EPAs in house-team, with support from



**Figure 2:** Overview of the NAAQS Review Process

CASAC, reviewed over 1700 policy-relevant scientific studies and eventually developed a staff paper with recommendations on new ozone standards.<sup>2</sup>

An overview of the specific review process for the assessment completed in 2008 is shown in figure 2.<sup>3</sup>

A crucial consideration in regulating ozone is that it is a secondary emission. Ozone is formed by photochemical reactions between volatile organic compounds (VOCs) and various oxides of nitrogen (NO<sub>x</sub>), and because of the nature of radical reactions, ozone formation does not proceed in a linear fashion. Therefore, controlling ozone levels has to do with the absolute amount of VOC and NO<sub>x</sub> emissions, as well as the relative composition of each type of compound in the air. This is further compounded by wind patterns, driving ozone formation to occur at locations removed from the initial sources of the primary emissions.<sup>4</sup> Figure 3 shows a schematic representation of the relationship between VOCs, NO<sub>x</sub>, and ozone formation, with each colored curve as an ozone isopleth, increasing away from the origin.

When dealing with risk assessments, modeling has proven valuable. In the early days following passage of the CAA, modeling capabilities were severely limited so most regulations were set to require the use of the best emissions-reduction technologies available, with little regard for the actual reductions and consequent impacts on the environment and human health. Today, however, models are frequently used to link

abatement activities to environmental and human health impacts.<sup>5</sup> In the course of the 2008 review process, models were used to understand the effects of ozone exposure on human health as well as in quantifying the risk associated with ozone emissions.

Because of the complicated nature of ozone formation, there is considerable uncertainty associated with regulating ozone. Risk assessments are particularly important, and modeling has proven valuable for this endeavor. In the early days following passage of the CAA, modeling capabilities were severely limited so most regulations were set to require the use of the best emissions-reduction technologies available, with little regard for the actual reductions and consequent impacts on the environment and human health. Today, however, models are frequently used to link abatement activities to environmental and human health impacts.<sup>6</sup> In the course of the 2008 review process, models were used to understand the effects of ozone exposure on human health as well as in quantifying the risk associated with ozone emissions.

The exposure models make calculations based on measurements of current emissions and predictions of reductions, while the health effects are based on the results of existing scientific studies. The exposure modeling was completed using EPA's APEX model. The APEX model is a probabilistic model which simulates the movement of people in time and space, and estimates their exposure to ozone (and other toxic

and criteria pollutants) in a number of microenvironments. Exposure is measured as daily maximum 1 hour and 8 hour average ozone exposures. These indicators are stratified by the level of exertion at the time of exposure (i.e. one's exposure will be greater if it occurs while exercising, since the rate of respiration will be elevated). This model calculates two general types of exposure quantifications: estimates of the number of people exposed to certain concentrations and estimates of the number of occurrences of such exposures.<sup>7</sup>

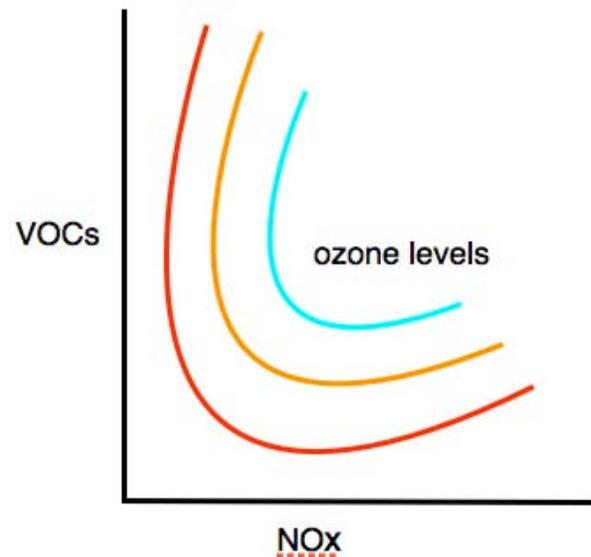
The APEX model was subjected to a rigorous uncertainty analysis. Input uncertainties were characterized using a Monte Carlo analysis, while other sources of uncertainty were examined using sensitivity analyses. Most estimates of percentages of populations exposed to ozone had 95% uncertainty intervals of only a few percentage points. The model does, however, underestimate the frequency of occurrence of individuals repeatedly exposed to 8 hour averages greater than 0.06ppm.<sup>8</sup>

The risk assessment was performed by combining these modeled exposures with data from controlled human exposure studies. Eventually, standards are set to minimize these risks.

## CASAC's 2008 Recommendations & The EPA's Decision

At the end of its review of the EPA in-staff report, CASAC issued a letter to the head of the EPA, Steve Johnson, validating the findings of the report and offering the following recommendation: "The CASAC unanimously recommends that the current primary ozone NAAQS be revised and that the level that should be considered for the revised standard be from 0.060 to 0.070 ppm."<sup>9</sup> Steve Johnson, in turn, opened up the letter for public commentary. Public opinion was somewhat split, with many commentators from environmental and public health NGOs supporting the proposed standard range, while industry players objected to any change in the ozone standard.<sup>10</sup>

Upon reviewing the evidence and the commentary, Steve Johnson issued a final ruling to the White House, proposing a new Ozone standard that would be between 0.070 - 0.075 ppm. This decision was viewed as controversial by CASAC and some members of the public, who perceived the EPA administrator as going



**Figure 3:** Schematic of the relationship between VOCs, NOx, and ozone formation. Figure not drawn to scale

beyond his bounds as decision maker. The CASAC issued a new letter, re-affirming its position, and urging Johnson to reconsider its recommendations in subsequent ozone standard reviews.<sup>11</sup>

In his testimony to the Committee on Oversight and Government Reform at a hearing on the process of the EPA in setting the new ozone NAAQS, Johnson explains his deviation from the CASAC recommendation along the following lines: "The Clean Air Act clearly established that the ultimate decisions about retaining or revising a NAAQS must be made by the EPA Administrator after weighing the scientific evidence taking into account the results of the risk and exposure assessments, CASAC's advice, and public comment....I carefully reviewed CASAC's scientific advice and their policy views on the current standards and suggested revisions to them as well as the public comments EPA received on the proposed standards. While I am in general agreement with CASAC's views regarding the interpretation of the scientific evidence, there is no bright line clearly directing the choice of level, and the choice of what is appropriate is clearly a policy judgment entrusted to the Administrator."<sup>12</sup>

CASAC responded to what it perceived to be a violation of Steve Johnson's authority to make a decision based on the best science. In their responding testimony, the head of the CASAC Ozone Panel said:

“CASAC has often been accused of wandering from scientific issues into policy. In this case, policy makers wandered into scientific issues and they did not do it well. Willful ignorance triumphed over sound science.<sup>13</sup>

## Discussion

The struggle between CASAC and the EPA on setting the 2008 ozone standard is a continuation of a long-standing debate on the boundary between policy and science.<sup>14</sup> The effectiveness of the assessment actually varies considerably depending on the perspective under consideration. It is worth discussing the effectiveness of the process from both the perspective of the policy maker (EPA) and the scientific advisory board (CASAC).

CASAC behaved as though it was responsible for setting the final range within which the NAAQS could be established. From this point of view, EPA Administrator Johnson’s final standard was considered arbitrary, as it was set outside the recommended range, and therefore not reasonable. However, the issue looks different when viewing it through the lens of Johnson, the policy maker in question. CASAC’s recommendations are certainly legitimate to Johnson, as CASAC is an external committee established exclusively to analyze scientific data to make a policy recommendation. There is nothing in Johnson’s behavior or statements that allude to his being concerned about CASAC’s motives. Johnson does not dispute the data presented by CASAC, only the conclusions that the committee draws for drawing a policy line; he appears to respect the validity of the EPA’s assessment process and of the CASAC’s review. Therefore, he finds them credible.

While the review process itself is salient in that it fulfills the CAA’s mandate for periodic review and reestablishment of NAAQS for ozone. But because Johnson did not think that CASAC’s policy recommendations were binding for his decision, their review was only seen as a recommendation.

The dividing issue for Johnson was CASAC’s insistence that their recommendation of ozone limits be adopted as policy. From Johnson’s perspective it was his job to review *that* science amongst other sources of input and then make an appropriate policy judgment. For him CASAC’s review was effective in

assessing the science behind ozone standards, but its role ended there, and it was Johnson’s responsibility to make the final decision.

From CASAC’s perspective, the process was not effective, as their recommendations were not the ultimate conclusion of the NAAQS setting for ozone in 2008. Because Johnson was tasked with the role of policy maker, not scientific advisor, they felt he did not have the authority to set the limits beyond its recommendation.

## Conclusion

Setting the Ozone standard was and continues to be a controversial issue: Following the 2008 debate, the EPA scientific assessment of ozone was formally reconsidered, and the result was the same policy recommendation as seen in 2008. All the while environmental groups have lobbied for the implementation of more stringent ozone standards. At the heart of this controversy and delayed decision-making is the question of the boundary between science and policy, whether or not CASAC’s recommendations for acceptable ozone limits should be made binding for policy decisions. While the existence of this question does not necessarily indicate a failure of the assessment process, the dispute over the science/policy boundary needs to be resolved in order to improve the effectiveness of the standard setting.<sup>15</sup>

## References

- <sup>1</sup>Summary of The Clean Air Act: <http://www.epa.gov/lawsregs/laws/caa.html>
- <sup>2</sup>“US EPA, Fact Sheet: Final Revisions to the National Ambient Air Quality Standards for Ozone,” 2008
- <sup>3</sup>Review of the Process for Setting National Ambient Air Quality Standards, US EPA, 2006, 7.
- <sup>4</sup>Geophysical Research Letters, Vol. 28, No. 15, Pages 2903-2906, August 1, 2001.
- <sup>5</sup>“Models in Environmental Regulatory Decision Making” NRC, 2007.
- <sup>6</sup>“Models in Environmental Regulatory Decision Making” NRC, 2007.
- <sup>7</sup>US EPA, “Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information, OAQPS Staff Paper”, EPA-452/R-07-007, July 2007.
- <sup>8</sup>Langstaff, John, “Memorandum: Uncertainty Analysis in Ozone Population Exposure Modeling,” January 2007.
- <sup>9</sup>Letter from CASAC to Steven Johnson October 2006: EPACASAC07001

<sup>10</sup>EPA. 40 CFR Parts 50 and 58: National Ambient Air Quality Standards for Ozone; Final Rule. Federal Register. Vol 73 No 60. 2008

<sup>11</sup>Letter from CASAC to Steve Johnson April 2008: EPA-CASAC-08-009

<sup>12</sup>Testimony of Stephen Johnson before Committee on Oversight and Government Reform. May 2008.

<sup>13</sup> Testimony of Rogene Henderson (Chair of CASAC) to Committee on Oversight and Government Reform. May 2008

<sup>14</sup>Jasanoff, S. (1994). The fifth branch: Science advisers as policymakers. Harvard University Press.

<sup>15</sup>Ibid.

## Discussion Questions

1. What should CASAC's role be? Should they even include a policy recommendation in their final report?
2. Does the EPA's setting of a different limit than the one suggested by CASAC constitute a failure of the assessment process?
3. Can realistic standards be set without consideration of economic or technological feasibility? Is it plausible that this is how standards are set at all?

## Readings

1. Fact Sheet: Final Revisions to the NAAQS for Ozone
2. Critical Evaluations in Evaluation Scientific Evidence of Health Effects of Ambient Ozone: A Conference Report (read abstract and skim)
3. Smog versus Jobs video
4. *Not required but interesting to look at:* Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information: OAQPS Staff Paper
5. Time: EPA's New Ozone Limit: Not Enough?

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