Residual Benefit Summary
staff working paper

Background:

The Environmental Protection Agency (EPA) looked at several sets of data on the effect of sulfur on advanced technology engines. A discussion of this data along with the limitations and caveats can be found in the Regulatory Impact analysis of EPA's low sulfur and Tier II vehicle emission standards. These were published as EPA publication number 420-R-99-023, December 22, 1999 titled, "Appendix B: Evidence Supporting the Irreversibility of Sulfur's Emission Impact". An electronic copy can be found at:
http://www.epa.gov/otaq/tr2home.htm .

In addition, discussions of how EPA ultimately chose to handle the data as a part of their Mobile 6 model can be found in EPA publication number 420-R-01-039, July 2001 titled, "Fuel Sulfur Effects on Exhaust Emissions." This document is also available electronically at:
http://www.epa.gov/otaq/models/mobile6/m6tech.htm

Brief Summary of the Issue:

It has been argued that by producing a lower sulfur gasoline in an earlier year, say 2003, NOx benefits can be calculated in a later year, say 2006. The thought being that if a car experienced lower sulfur levels than was assumed in earlier years there would be a carry over or "residual" positive NOx benefit in a later year. Although this argument may have some validity, there are several technical issues and one large practical issue that make the calculation and crediting of a residual sulfur effect very difficult.

Technical Issues: The above mentioned EPA report on gasoline sulfur effects and the corresponding report on how EPA chose to handle effects are fairly thorough. They looked at several studies conducted by the Auto/Oil research group, various auto manufacturers, EPA themselves and other entities.

EPA was attempting to quantify the impact of exposure of advanced technology vehicles to elevated sulfur levels. They were attempting to answer the question of what happens to a vehicle's emissions in the future if a vehicle experiences high sulfur levels in the past. Will the vehicle's emission performance be degraded just during the time they are using the high sulfur fuel, or is the emission control equipment (mainly the catalyst) permanently negatively effected by elevated sulfur levels.

Briefly, what EPA discovered is that under some circumstances, the emission control equipment can in fact become permanently negatively impacted by experiencing high sulfur levels. This is what EPA terms as "residual" effect. The effect EPA has found is a negative one. Therefore, EPA when setting up the Mobile model used these data to allow Mobile 6 to calculate the negative effects of past high sulfur. The effect EPA was attempting to characterize was a negative residual effect, not the converse or positive residual effect.

It is possible to run EPA's mobile model with a very low sulfur level, for example 50% of what EPA expected sulfur to be in 2003 and ask it to evaluate the NOx level in 2006, for example. The Mobile model does show a small NOx benefit on the order of about 1%. This may or may not be significant depending on how much fuel in 2003 was produced at this level and that was trying to be carried forward into the future.

Practical Issues: The practical issues surrounding a potential residual effect are very difficult if not impossible to surmount. Take the example of a vehicle operated in Anywhere Town, Texas. If Anywhere Town happened to get their fuel supply from one refiner, and that refiner reduced its sulfur level by 50% in 2003, by 2006 some NOx benefit could be calculated per the Mobile model. However, almost no city in Texas receives all their gasoline from one supplier. It is also unknown if a town that had multiple suppliers, if all those suppliers reduced their sulfur levels substantially. In addition, the vehicle may have left Anywhere Town at some point between 2003 and 2006 in which case it may have re-fueled with a higher sulfur fuel, and therefore potentially experience the negative residual effect found by EPA. In addition, because sulfur levels in gasoline were not mandated to be low in the early years, there was no prohibition on producing a "batch" of higher sulfur fuel due to crude supplies or other refining issues. If either of these events happened, EPA's negative residual effect again comes into play.

The positive residual effect argument could possibly be made with additional technical data on the reversibility effect and specific data on a potential of a positive residual effect. In addition, some type of justification would have to be made that a fleet of vehicles had only experienced the lower sulfur fuel over a period of several years. This practical issue may be more difficult to surmount than the actual technical issue of using the Mobile model to calculate a benefit.