ATTACHMENT E TO RESOLUTION 13-52

Response to Comments on the Environmental Analysis Prepared for the Proposed Optional Reduced Emission Standards for Heavy-Duty Engines

To meet the requirements of the California Environmental Quality Act (CEQA) under ARB's Certified Regulatory Program, the California Air Resources Board (ARB) staff prepared an environmental analysis as part of the Initial Statement of Reasons (ISOR) for the Proposed Optional Reduced Emission Standards for Heavy-Duty Engines. The ISOR was released for public review on October 23, 2013 for a 45-day public review and comment period that concluded on December 12, 2013 at the Board Hearing.

This document presents those comments received during the 45- day comment period that raise significant environmental issues and ARB's written responses to those comments. Substantive responses are limited to comments that "raise significant environmental issues associated with the proposed action," as required by PRC section 60007(a). In accordance with ARB's Certified Regulatory Program, the Board will consider the written response to these environmental comments for approval prior to taking final action on the proposed amendments.

Staff will also prepare written responses to all public comments, not just the environmental comments, for purposes of the Administrative Procedures Act. The complete written responses to all comments will be included in the Final Statement of Reasons (FSORs) that will be made available in electronic form on the ARB rulemaking webpage at: http://www.arb.ca.gov/regact/2013/hdghg2013/hdghg2013.htm

Truck and Engine Manufacturers Association

Name: Timothy A. Blubaugh, Timothy French

Comment 1

NO_x/GHG Tradeoff

One of the most effective ways for an engine manufacturer to decrease GHG emissions is to maximize combustion efficiency, with attendant increases in engine-out NO_x, while at the same time maximizing the conversion efficiency of the selective catalytic reduction ("SCR") aftertreatment system to reduce tailpipe NO_x emissions to meet the standard. In effect, manufacturers are maximizing fuel efficiency while meeting the low NO_x emissions standards by using advanced SCR systems. However, CARB proposes new ultra-low NO_x standards that are up to 90 percent below CARB's and EPA's current low standards. Since SCR systems are near the limits of their NO_x conversion capabilities, engine manufacturers likely will need to further reduce engine-out NO_x, and/or provide additional heat to the SCR catalyst to maintain optimum temperature, to meet the new ultra-low emissions standards. The physics and thermodynamics associated with those changes will result in worse fuel efficiency and

increased GHG emissions. CARB must consider the implications of the NO_x/GHG tradeoff when adopting optional, or mandatory, lower NO_x emissions standards.

Agency Response: Staff acknowledges that in certain situations, a NOx/GHG tradeoff in emissions from heavy-duty engines may exist. For example, if an emission control strategy that utilizes supplemental heat (e.g., a burner) to warm up a SCR system to improve cold-start reduction efficiency, could significantly reduce NOx emissions, although the fuel used for the burner would likely result in an overall increase in CO2 emissions.

However, for the reasons presented below, staff does not believe that this potential NOx/GHG emissions tradeoff presents a reason to not proceed with establishing the proposed optional NOx standards, nor does staff expect the tradeoff to result in a potential for significant adverse environmental impacts.

First, no GHG emission increases are expected from the proposed optional NOx standards because any engines that manufacturers elect to certify to the optional NOx standards will also be subject to the proposed Phase 1 GHG standards. The Phase 1 GHG standards, which take effect with model year 2014, include engine emission standards for CO2 that will hold CO2 emissions in check.

Second, although some heavy-duty engine technologies/strategies do encounter a NOx/GHG tradeoff, that trade-off does not exist in all cases. For example, engine efficiency improvements and reducing engine and drivetrain friction benefit both NOx and GHG emissions (as do vehicle aerodynamic improvements). Hybridization and electrification of drivetrains and accessories can also be used to reduce emissions of both pollutants.

Third, EMA's comment presumes that all of the engines used to meet the proposed optional standards would be diesel-fueled, and that SCR will be pushed to its limits to meet the proposed optional NOx limits. However, as stated in the Staff Report, staff expects that heavy-duty natural gas engines to be the primary technology used to meet the proposed optional 0.05 g/bhp-hr and 0.02 g/bhp-hr NOx standards, at least initially. Natural gas-fueled engines can meet lower NOx standards and GHG requirements without the use of SCR systems.

Overall, although staff recognizes the existence of a NOx/GHG tradeoff for some engine technologies, EMA's comment does not acknowledge the full range of technologies that engine and vehicle manufacturers can use to meet more stringent standards, nor does it acknowledge the role the Phase 1 GHG standards will have in controlling CO2 emissions. In conclusion, the potential NOx/GHG tradeoff is not expected to result in significant adverse environmental impacts and is not a reason to delay adoption of the proposed optional standards.

Comment 2

NOx Projections and Potential Ozone Disbenefits

Although the low NOx standards are presented as an optional program to reduce NOx (and thereby ozone emissions), there is nonetheless an underlying assumption, confirmed by CARB Staff, that these voluntary standards are likely to be proposed as mandatory standards, and that such mandatory NOx reductions would yield corollary reductions in ambient ozone levels. Two key factors impact the validity of that assumption: the projection of future atmospheric NOx emissions levels; and the modeling of how those NOx emission level interact chemically with Volatile Organic Compounds ("VOC") concentrations to form ozone. The first of those factors is typically estimated and projected through ARB's EMFAC model. It has been some time since ARB has held workshops to review the inputs to EMFAC, especially with respect to those inputs that most heavily determine future emissions levels (e.g., malfunction rates and deterioration). EMA would appreciate an opportunity to review the estimates of heavy- duty vehicle population growth, average VMT/vehicle, the change in deterioration factors, rates of tampering and malfunction, rebuild practices for future model years, 'zero hour' gram per mile emission rates, as well as other factors for the future heavy-duty vehicles that most influence future emission levels. Accordingly, EMA requests that ARB provide a forum for the detailed review of those key emission inventory factors.

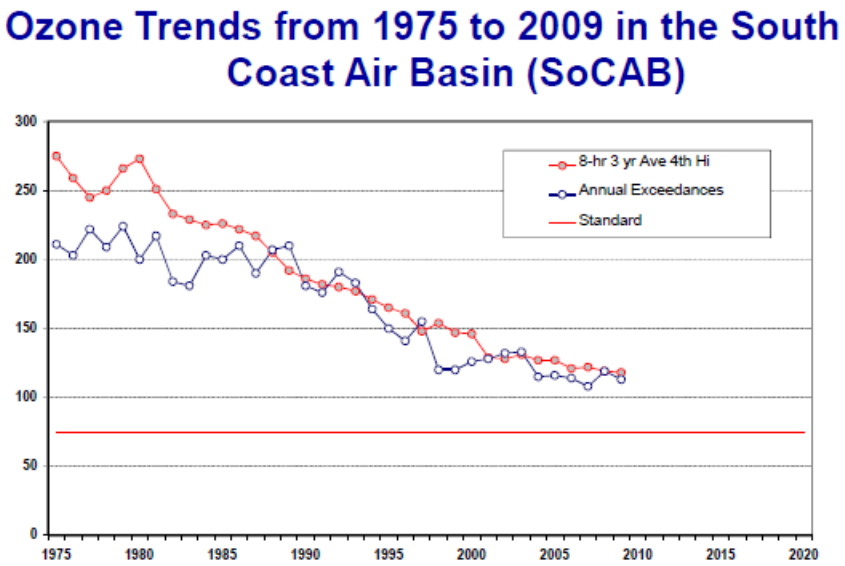
The second aspect of this modeling effort – assessing how NOx emissions interact chemically with VOC levels to form ozone – is typically estimated utilizing the Community Multiscale Air Quality ("CMAQ") Model. Critical to the results of that type of modeling is whether the regional atmosphere at issue is "NOx-limited" or "VOC-limited." In a VOC-limited environment (i.e., where lower VOC/NOx ratios prevail), marginal decreases in NOx can actually cause increases in ozone.

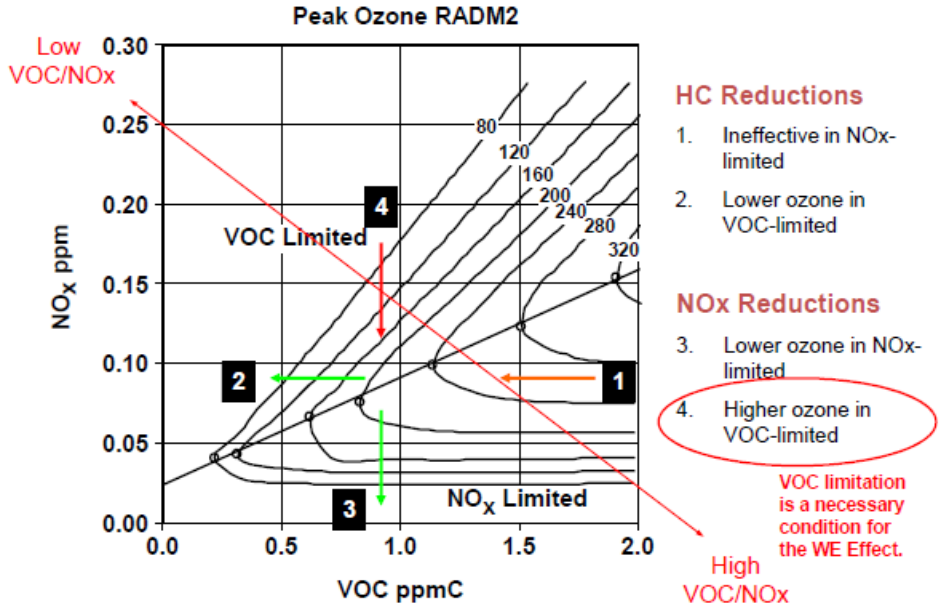
Given the foregoing, there is a fundamental public policy issue that is embedded in CARB's pursuit of an ultra-low NOx standard for heavy-duty on-highway ("HDOH") engines and vehicles, regardless of whether that standard is styled as "optional" or not. CARB's motivating public policy assumption is that reducing NOx emissions from HDOH vehicles in California by up to an additional 90% will yield corresponding reductions in ambient ozone concentrations. Unfortunately, given the "VOC-limited" nature of the prevailing atmospheric chemistry in California, most especially in the South Coast Air Basin ("SoCAB"), CARB's assumption is very likely incorrect. The net result, as summarized below, is that CARB's quest for a new ultra-low NOx standard for HDOH vehicles and engines is likely to cause significant increases in ambient ozone levels for a significant period of time.

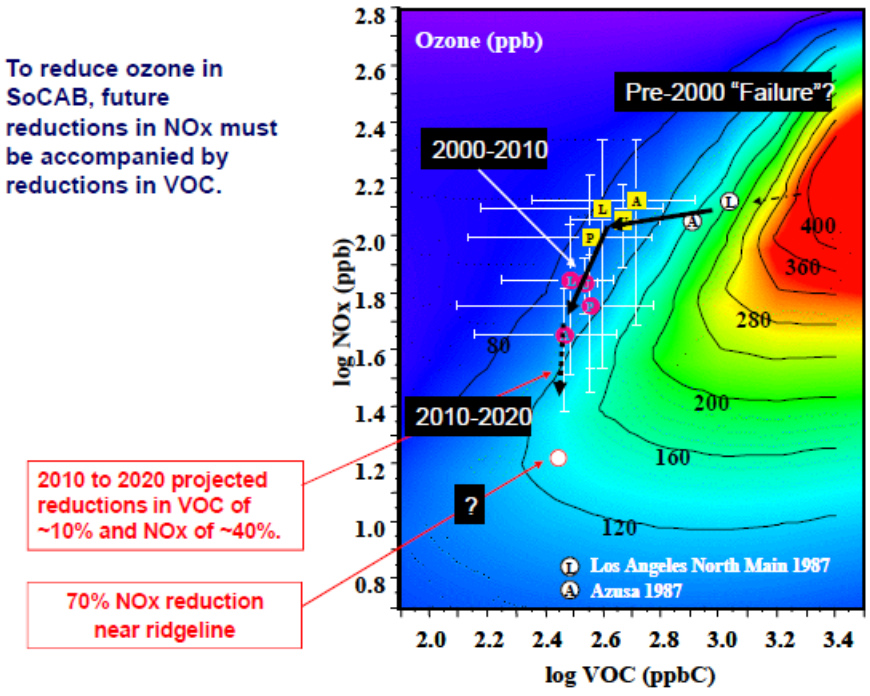
Extensive research has been conducted on the chemistry of ozone formation in California over the past twenty years. That work has been performed by Drs. Eric Fujita, Doug Lawson, Bill Stockwell, and others. See, e.g., Fujita, et al. (2013), "Past and future ozone trends in California's South Coast Air Basin," Journal of Air & Waste Manag. Ass'n., 63:1, 54-59. Taken together, that work (including the well-established

weekday/weekend ozone phenomenon, and the prevailing ozone trends in the SoCAB) demonstrates that at low VOC/NOx ratios (i.e., in "VOC-limited" environments) unilateral reductions in NOx cause an increase, not a decrease, in ambient ozone levels. The ozone contour plots depicted on the following pages show how a reduction in NOx levels (on the vertical axis) is likely to cause significant ozone increases as higher ozone concentration contour lines are crossed (e.g. levels could rise from approximately 110 ppb to approximately 200 ppb, or even higher under certain scenarios). Similarly, the ozone formation graph (the fourth of the four charts) depicts how ozone levels are likely to increase in the SoCAB (moving from right to left on the graph's horizontal axis) as ambient NOx levels are reduced.

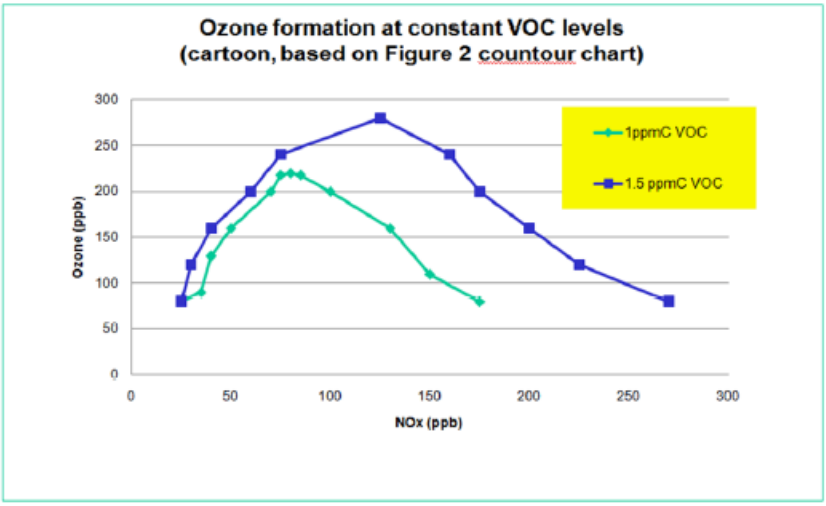
Thus, in light of the prevailing science, it is incumbent on CARB to thoroughly investigate and publicly discuss the ozone "disbenefits" that are likely to result from any proposed reductions in NOx emissions. Simply stated, since ozone reductions are a function of both NOx and VOCs, unilateral reductions in NOx, as CARB is pursuing, are much more likely to increase ozone levels, especially in the SoCAB. This fundamental issue of public policy and atmospheric chemistry needs to be addressed in a comprehensive manner *before* CARB takes any final action on any new standards for HDOH vehicles and engines that either incentivize lower NOx standards, or that mandate them. Otherwise, the unintended consequences of CARB's rulemakings may be significantly detrimental. In that regard, and as CARB Staff is aware, the Coordinating Research Council (CRC) is sponsoring an update to the work of Dr. Fujita and his colleagues to assess the potential impacts of unilateral NOx reductions in the SoCAB based on current assessments of the prevailing NOx/VOC ratios. (See CRC Project A-91, Exploration of Potential Ozone Disbenefits.) Any further action by CARB pertaining to this regulatory matter should, at a minimum, be informed by the results of that CRC project.




Peak Ozone RADM2
Low VOC/NOx
High VOC/NOx
NOx ppm
VOC ppmC
VOC Limited
NOx Limited
80
120
160
200
240
280
320
1
2
3
4
HC Reductions
1. Ineffective in NOx-limited
2. Lower ozone in VOC-limited
NOx Reductions
3. Lower ozone in NOx-limited
4. Higher ozone in VOC-limited
VOC limitation is a necessary condition for the WE Effect.


To reduce ozone in SoCAB, future reductions in NOx must be accompanied by reductions in VOC.
Ozone (ppb)
Pre-2000 "Failure"?
2000-2010
2010-2020
2010 to 2020 projected reductions in VOC of ~10% and NOx of ~40%.
70% NOx reduction near ridgeline
?
Los Angeles North Main 1987
Azusa 1987
log NOx (ppb)
log VOC (ppbC)

Ozone is a function of NOx and VOCs (not NOx alone)
Figure 3



Agency Response: The South Coast and San Joaquin Valley are the only two extreme ozone nonattainment areas in the nation. Both areas will require significant emission reductions in order to attain the 0.08 ppm 8-hour ozone standard by 2023, and the more stringent 0.075 ppm standard by 2032. The overall control approach for meeting these standards is developed through air quality modeling of a comprehensive strategy that reflects all precursors and all emission sources. This approach reflects the science of ozone chemistry in each region, and informs the magnitude of emission reductions needed and the appropriate precursors to control that provide the most effective pathway towards attainment.

The air quality modeling included in the approved State Implementations Plans (SIPs) for the 0.08 ppm 8-hour ozone standard for both the South Coast and the San Joaquin Valley demonstrates that large NOx reductions are needed in order to meet the standard. These NOx reductions are also coupled with strategies for further VOC reductions in the South Coast. (See ARB's Staff Report on Proposed Revisions to the PM2.5 and Ozone State Implementation Plans for the South Coast Air Basin, released January 13, 2013, approved January 25, 2013, http://www.arb.ca.gov/planning/sip/planarea/2012scaqmp_final_staff_report.pdf , which discusses the dual pollutant NOx/VOC strategy. See also US EPA's final approval of the South Coast's 2007 plan, http://www.gpo.gov/fdsys/pkg/FR-2012-03-01/pdf/2012-4673.pdf) This dual pollutant approach in the South Coast recognizes the need for a mix of reductions in order to address the differing nature of the ozone problem throughout the air basin. The approved control strategies in these SIPs underwent a comprehensive public process at the local, State, and federal level. Analysis conducted by ARB staff indicates that even greater reductions in NOx will be required to meet the 0.075 ppm standard. As with the 2023 attainment strategy, additional VOC reductions will also continue to be essential in the South Coast.

Given the magnitude of these emission reductions, the strategy to bring both regions into attainment will need to include the cleanest technologies for NOx across all source sectors. The optional low-NOx standard cannot be considered in isolation, but rather as one important element of the broader comprehensive NOx and VOC attainment strategy and the overall benefits this strategy will provide. This strategy must also consider emission reductions needed to meet fine particulate matter (PM2.5) standards. As with ozone, the air quality modeling included in the approved SIPs for the annual PM2.5 standard of 15 ug/m3 demonstrates the effectiveness of NOx reductions in reducing the ammonium nitrate fraction of PM2.5 in both the South Coast and San Joaquin Valley. Further NOx reductions will continue to be critical for meeting the more stringent annual standard of 12 ug/m3 that must be attained between 2021 and 2025.

The long-term effectiveness of California's dual pollutant strategy for ozone is demonstrated by the dramatic decline in ozone statewide, including in the South Coast Air Basin and San Joaquin Valley. Although there have been differential degrees of improvement between regions, within regions, and on weekdays compared to weekends, the ozone air quality trend overall is positive. Some locations improve more quickly than others due to a complex combination of factors including emissions, meteorology, and atmospheric chemistry. The commenters general statement that research[1] shows that the atmospheric chemistry of California is "VOC limited" does not recognize the fact that the relative effectiveness of VOC and NOx reductions changes with time. As a result, California's long-term ozone strategy must include both pollutants.

The benefits of the dual pollutant strategy are documented by the long-term ozone monitoring data, and a differential rate of improvement by location or day of week does not indicate an adverse impact of continuing NOx reductions from new and existing regulations. While the commenter suggests that the "weekend effect" is an indicator that further NOx control is not effective, that assertion is not true overall. The weekend effect is a phenomenon that occurs in some areas of the State where ozone concentrations are typically higher on weekends compared to weekdays. The fact that NOx emissions tend to be lower on weekends, while VOC emissions are generally similar, is suggested as evidence that NOx control is counter-productive. However, there are many factors in addition to the change in VOC and NOx levels between weekdays and weekends that may also help explain the weekend effect, and thus the presence of a weekend effect alone does not indicate that a long-term NOx control program is ineffective (see ARB's staff report on the weekend effect, http://www.arb.ca.gov/research/weekendeffect/arb-final/web-executive-summary.pdf). The weekend effect has been observed in the South Coast, but not in the San Joaquin Valley, and the magnitude of the weekend effect has been diminishing in the South Coast over time.

[1] Drs. Eric Fujita, Doug Lawson, Bill Stockwell, and others (citing Fujita, et al. (2013), "Past and future ozone trends in California's South Coast Air Basin," Journal of Air & Waste Manag. Ass'n., 63:1, 54-59

The commenters also stated that, “It has been some time since ARB has held workshops to review the inputs to EMFAC…” This is not correct. ARB held two public workshops on EMFAC in 2013. On June 5, 2013, ARB held a public workshop on improving mobile source planning tools, including EMFAC. (http://www.arb.ca.gov/msei/public-workshop-june-5-2013-sacto.pdf) On October 8, 2013, ARB held a public workshop on update to the EMFAC model. (http://www.arb.ca.gov/msei/emfac2013_oct_workshop_meeting_notice_final-agenda.doc) In addition to these publicly noticed workshop, ARB held several meetings in 2013 with EMA to discuss ARB’s mobile source emission inventory and the EMFAC model, the most recent meeting on Friday, December 6, 2013 specifically to discuss truck emission factors.

California’s long-term dual pollutant strategy of reducing both NOx and VOC has brought multiple air districts into compliance with federal ozone standards since 1990, and greatly reduced ozone in the nation’s only two extreme ozone nonattainment areas. Therefore, continuing NOx reductions needed to meet long-term federal ozone attainment deadlines, and also mid-term PM2.5 deadlines, does not result in an overall adverse impact.