

Minutes of the Diesel Retrofit NO₂ Working Group
Kick-off Meeting
El Monte, CA
May 14, 2004

The first meeting of the Diesel Retrofit Nitrogen Dioxide (NO₂) Working Group was held at the Air Resources Board's (ARB) El Monte office on May 14, 2004, to address the issue of how to control NO₂ emissions from diesel retrofits. Ms. Annette Hebert, Chief of ARB's Heavy-Duty Diesel In-Use Strategies Branch, chaired the meeting. The agenda (Attachment A) and a list of participants and subgroup members (Attachment B) are appended.

Introduction

Ms. Hebert made some introductory remarks and provided background on the purpose of the NO₂ working group. She announced that the next meeting of the International Diesel Retrofit Advisory Committee (IDRAC) is scheduled for July 16 at present, but that she is trying to get it moved to September.

Mr. Tim Johnson, Corning, commented that increased ozone and direct exposure to NO₂ are two separate issues for which you may end up with two separate solutions. Ms. Hebert indicated that both regional and microscale effects are of concern to ARB.

Mr. Sam Altshuler, Pacific Gas and Electric Company, said that increased NO₂ emissions will likely lead to increased nitrate particulate matter (PM) formation, and that this issue needs to be investigated. Ms. Hebert said that nitrate PM was factored into ARB's previous regional air quality modeling.

Modeling and Exposure Discussion

Mr. Tony Servin, ARB, described the latest microscale modeling work undertaken by ARB. Dr. Maria Costantini, Health Effects Institute (HEI), asked how many 2007 and newer model year buses were in the idling school bus scenario. Staff will provide this information at a later date.

Mr. Vernon Hughes, ARB, briefly summarized ARB's updated regional air quality modeling for the year 2010. The new penetration scenario included alternatives to passive filter technology such as diesel oxidation catalysts and engine repowers. The results indicated a peak ozone impact of plus or minus 1 part per billion in the southern California air basin.

Mr. Chad Bailey, US EPA, indicated that there are a number of scenarios of interest that Gaussian-type models can't simulate. These include exposures very close to the

source, e.g., a child walking alongside a school bus. Mr. Bailey said that such scenarios would require models that employ computational fluid dynamics. Another scenario of potential concern pointed out by Mr. Bailey involves enclosed spaces, such as when buses come into a garage and the traps are still hot.

Mr. Altshuler asked about the status of ARB's efforts to re-evaluate the ambient one-hour NO₂ standard. No staff from the division handling the matter were available, but Mr. Joe Somers, US EPA, said that US EPA reaffirmed the federal annual standard in 1996, taking into account shorter-term exposures.

Concerning engine-out levels of NO₂, Mr. Joe McDonald, US EPA, mentioned that he's never seen more than 5-10 percent of the total NO_x as NO₂, although there may be higher levels with EGR engines. Mr. Kevin Brown, Lubrizol ECS, indicated that testing conducted at Southwest Research Institute for his company showed engine-out NO₂ approaching 20% for one engine and over 20% on another engine.

Of the microscale scenarios modeled by ARB, Mr. Servin said that the high diesel traffic freeway scenario is the worst case in terms of direct exposure to NO₂. The model considered exposure at a distance of 20 meters from the edge of the freeway. Mr. Bailey suggested looking at even closer exposures at 5 or 10 meters away.

Discussion of modeling idling scenarios had brought forth the point that platinum catalysts do not efficiently convert NO to NO₂ at typical exhaust temperatures found at idle. Mr. McDonald pointed out that stating that the temperature at idle is low assumes that the vehicle was not driven beforehand. Until a filter cools down, it can continue to generate NO₂.

Mr. Altshuler added the California Occupational Safety and Health Administration's (OSHA) 15-minute NO₂ exposure limit of 1 ppm to the discussion. He also mentioned that there are existing data from tunnel studies (UC Berkeley Professor Rob Harley's work) that could help give the working group some idea for the concentrations of pollutants that can be encountered on highways.

On the subject of identifying worst-case scenarios to model, Mr. Altshuler expressed concern with the situation in which utility technicians are working for hours above and alongside their trucks which are idling as well as powering various auxiliary equipment. Mr. Tim French, Engine Manufacturers Association (EMA), suggested the scenario of a truck stop at which there can be many idling trucks parked close together, as well as a scenario involving refuse trucks. Mr. Gene Walker, Golden Gate Transit, suggested that transit hubs would be another scenario of interest. Mr. Brown indicated that a construction site would be another candidate, adding that a recent Northeast States for Coordinated Air Use Management (NESCAUM) study would be a useful reference.

The working group discussed the importance of conducting actual in-field measurements to gain insight into very near-source exposures that Gaussian-type models cannot accurately simulate. Two scenarios that may merit in-field

measurements involve (1) school buses and (2) utility trucks. The Los Angeles Unified School District has many trap-equipped buses and so may offer good opportunities for in-field measurements. Opportunities may also exist with Sacramento Municipal Utility District (SMUD) trucks. Mr. Brad Edgar, Cleaire, indicated that his company has retrofitted about 20 SMUD trucks with Longview systems. Mr. Tom Swenson, Cleaire, said he would be able to provide backpressure and temperature data from those trucks. Dr. Costantini suggested performing modeling in addition to the in-field measurements for comparison purposes, and mentioned that there have been some recent NO₂ exposure studies (she will forward some references to the working group).

Mr. Johnson asked as to whether the two scenarios under discussion were in fact worst-case, and whether scenarios involving high exhaust temperatures should be considered, such as right on a freeway. Mr. Altshuler mentioned a freeway scenario involving a tunnel with a grade. Mr. McDonald suggested including on-road trucks that have high off-cycle NO_x emissions. Mr. Swenson pointed out that such high-NO_x excursions are going to be a short-lived problem given California's plans to reflash those trucks.

On the subject of obtaining in-field measurements, Mr. Johnson suggested involving the mobile heavy-duty laboratory operated by UC Riverside's College of Engineering Center for Environmental Research and Technology (CE-CERT). Mr. McDonald suggested the use of portable emissions measurement systems (PEMS). He said US EPA has several PEMS but can't spare any of them at present. Mr. Tom Lanni, New York State Department of Environmental Conservation, indicated that his agency has a PEMS and may be able to make it available.

Following this discussion, the working group formed a modeling and exposure subgroup. Dr. Costantini volunteered to be the subgroup coordinator.

Technology Discussion

Mr. Scott Rowland, ARB, stated that it is important for ARB to be updated on the status of retrofit manufacturers' efforts to develop low-NO₂ technology. Recognizing the often confidential nature of the status of technology development, he said that confidential information should be given to ARB only, preferably in writing. Mr. Dale McKinnon, Manufacturers of Emission Controls Association, made a general remark that some members are in fact working on low-NO₂ technology.

Mr. French asked that if filters using base metal catalysts actually reduced NO₂, why not move to that technology. Mr. Kevin Hallstrom, Engelhard, indicated that base metal catalysts require much higher temperatures to successfully regenerate a filter. Mr. Brown concurred, pointing out that such catalysts have a niche in mining applications, but highway truck exhaust temperatures are too low. He added that a retrofit system should perform well in a variety of conditions, and that it is unfavorable to

minimize NO₂ emissions if it means reducing the breath of applications that can be retrofitted.

Mr. Hallstrom stressed the importance of developing a protocol to measure NO₂ because many factors can affect NO₂ emissions, such as the exhaust temperature history, exhaust flow rate, the amount of PM accumulated in the filter, and the engine's PM emission rate. If a clean filter is tested, a higher NO₂ emission rate will result.

Mr. Brown raised the question of lab-to-lab variability in NO₂ measurements. He asked about the influence of artifacts of different laboratories' test set-ups on NO₂.

Mr. McDonald said that it is primarily the condensation of water that affects NO₂ measurements, not the cleanliness of the dilution tunnel. Mr. Keshav Sahay, ARB, indicated that it may be possible to add NO₂ measurements to a multi-laboratory crosscheck project that is already being planned.

Mr. Cle Jackson, US EPA, said that his agency has some NO₂ data from nonroad transient tests that he would be able to share with the working group. Mr. Don Keski-Hynnila, Detroit Diesel Corporation, confirmed that another source of NO₂ data is mining engine certification testing. Mr. French said he would check with engine manufacturers to see what data EMA would be able to share.

Referring to Figure 2 of the Mine Safety and Health Administration's (MSHA) trap testing update, Mr. Paul Henderick, ARB, asked about why filters using platinum catalysts were able to reduce NO₂ for two of the eight modes tested. He added that the same behavior has been observed with some diesel oxidation catalysts. Mr. Brown commented that NO₂ reduction does sometimes take place, but only when hydrocarbons are present. Mr. Hallstrom added that platinum is a known lean-NO_x catalyst for the lower temperature regime, so the reduction of NO₂ in the presence of hydrocarbons can occur. He also said that stabilized modal testing performed by MSHA is very different from transient testing in that the hot, high load modes probably clean the filter and result in high NO₂ emissions.

Following this discussion, the working group formed a technology issues subgroup. No subgroup coordinator was identified.

Regulatory Options Discussion

Mr. Brown said that if a new emission limit for NO₂ is to become effective in January 2007, the limit should be settled on by January 2005 in order to give manufacturers the time they need to develop compliant products. Concerning the nature of the new limit, Mr. Brown indicated that the limit must exclude engine-out NO₂ emissions.

Mr. Hallstrom repeated the need for a well-defined protocol to measure NO₂. Mr. Brown suggested following the 2007 federal certification procedure which ensures

the testing begins with a clean filter. Mr. Hallstrom pointed out that doing so would result in the highest NO₂ emissions.

Mr. McKinnon asked if a 30% NO₂ limit would be acceptable if it was based on starting the testing with a clean filter (worst case). Mr. Rowland replied that as with any other option, a case would need to be made in support of that limit.

Mr. Brown commented that the term “degreened” is ill-defined for NO₂, and recommended that the NO₂ value used to determine compliance with the regulation should be obtained after the 1000-hour durability period. Mr. Marty Lassen, Johnson Matthey, said that aged systems have shown a clear decline in NO₂ emissions.

Following this discussion, the working group formed a regulatory options subgroup. Mr. McKinnon volunteered to be the subgroup coordinator.

Closing Comments

Mr. Rowland requested that if data submissions from the working group include information that the submitter does not wish to be shared openly, the data should be submitted in two formats: one which is a full disclosure for ARB only, and a second which is okay to share and post on the NO₂ working group website.

The working group then selected Wednesday, June 30, 2004 at 10 am for the next full working group meeting. In the interim, subgroups will meet independently to further define action items and begin taking steps towards achieving their goals. Subgroups will report on their progress to the entire working group at the June 30 meeting.

Attachment A: AGENDA

Diesel Retrofit NO2 Working Group

Kick-off Meeting

El Monte, CA

May 14, 2004

- 1) Introductory ARB Presentation
- 2) Update on ARB Air Quality Modeling
- 3) Air Quality Modeling Studies
 - a) Identify Action Items
 - b) Form Subgroup
- 4) Technology Update and Issues
 - a) Identify Action Items
 - b) Form Subgroup
- 5) Regulatory Options
 - a) Identify Action Items
 - b) Form Subgroup
- 6) Schedule Next Meeting In June

Attachment B: List of Participants and Subgroup Members

Diesel Retrofit NO2 Working Group

Kick-off Meeting

El Monte, CA

May 14, 2004

Name		Organization
Paul	Allen	ARB
Sam	Altshuler	Pacific Gas & Electric
Chad	Bailey	U.S. EPA
Gary	Bailey	Sacramento Metro AQMD
Dipak	Bishnu	ARB
Kevin	Brown	Lubrizol ECS
David	Chou	ARB
Maria	Costantini	HEI
Shawn	Daley	ARB
Brad	Edgar	Cleaire
Tim	French	EMA
Gina	Grey	Western States Petroleum
Kevin	Hallstrom	Engelhard
Staci	Heaton	CTA
Annette	Hebert	ARB
Paul	Henderick	ARB
Vernon	Hughes	ARB
Julian	Imes	Donaldson Company
Cle	Jackson	U.S. EPA
Timothy	Johnson	Corning
Dennis	Johnson	U.S. EPA
Gary	Kendall	Bay Area AQMD
Don	Keski-Hynnilla	Detroit Diesel Corporation
Thomas	Lanni	NYSDEC
Cameron	Larson	Kubota
Marty	Lassen	Johnson Matthey
Joe	McDonald	U.S. EPA
Dale	McKinnon	MECA
Susan	Reed	ARB
Scott	Rowland	ARB
Keshav	Sahay	ARB
Kathryn	Sargeant	U.S. EPA
Tony	Servin	ARB
Joe	Somers	U.S. EPA
Michael	Starr	Southwest Research Institute
Jeb	Stuart	CIAQC

Tom	Swenson	Cleaire
Gene	Walker	Golden Gate Transit
Mike	Waugh	ARB
Gary	Yee	ARB

Modeling and Exposure Subgroup		
*subgroup coordinator		
Paul	Allen	ARB
Sam	Altshuler	Pacific Gas & Electric
Maria	Costantini*	HEI
Brad	Edgar	Cleaire
Tim	French	EMA
Gary	Kendall	Bay Area AQMD
Dale	McKinnon	MECA
Tom	Swenson	Cleaire
TBD		U.S. EPA

Technology Subgroup		
*subgroup coordinator		
Kevin	Brown	Lubrizol ECS
Brad	Edgar	Cleaire
Tim	French	EMA
Kevin	Hallstrom	Engelhard
Paul	Henderick*	ARB
Marty	Lassen	Johnson Matthey
Keshav	Sahay	ARB
TBD		U.S. EPA

Regulatory Options Subgroup		
*subgroup coordinator		
Gary	Bailey	Sacramento Metro AQMD
Brad	Edgar	Cleaire
Tim	French	EMA
Staci	Heaton	CTA
Thomas	Lanni	NYSDEC
Dale	McKinnon*	MECA
TBD		U.S. EPA

