Meeting of the California
Environmental Policy Council

Multimedia Evaluation of Viscon-Treated Diesel Fuel

August 15, 2011

Agenda

- Overview of Verifications & Multimedia Evaluations
- Individual Agency Staff Presentations
  - ARB
  - SWRCB
  - OEHHA
  - DTSC
  - Summary of Peer Review Comments
  - Recommendations
- Public Comments
- Council Consideration

Overview of Verifications and Multimedia Evaluations

- Control of Diesel Exhaust Emissions
- ARB Verifications Program
- Requirements for Multimedia Evaluations
- Viscon Fuel Additive

Control of Diesel Exhaust Emissions

- ARB identified diesel PM as a toxic air contaminant (TAC) with no safe threshold
- Diesel PM accounts for ~70% of toxic risk from all TACs
- ARB approved diesel risk reduction program
  - 75% PM reduction by 2010
  - 85% PM reduction by 2020
- Focus on existing fleets (in-use fleet rules)

In-Use Fleet Rules

Fleet operators can comply by:

- Purchasing new vehicles
- Repowering with new engines
- Retrofitting with verified control strategy
  - Hardware
  - **Alternative diesel fuel or fuel additive**

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Verification of Emission Reductions

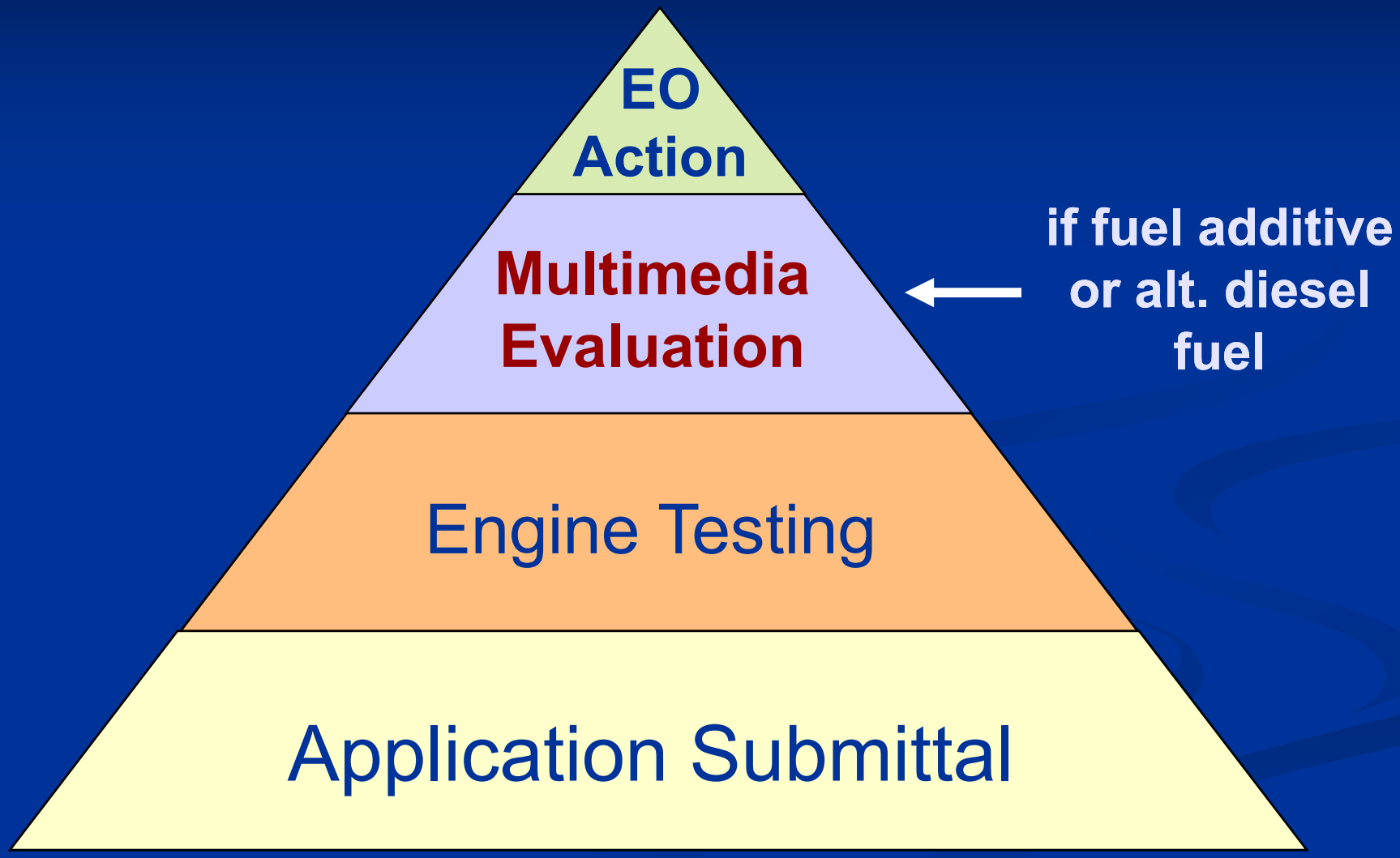
- Quantify performance and ensure emission reductions
- PM reduction classifications – Level 1 to 3
  - Level 1 ≥ 25% PM reduction
  - Level 2 ≥ 50% PM reduction
  - Level 3 ≥ 85% PM reduction
- NOx reductions classifications – Mark 1 to 5
  - Optional

Verification Provides Compliance Options

Number of current verified strategies:

- Hardware technologies
  - Level 1 9
  - Level 2 6
  - Level 3 32
- Fuel technologies
  - Level 2 1 (Puri-NOx)

Verification Requires Extensive Analysis



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Health and Safety Code §43830.8

- Requires ARB to conduct multimedia evaluation prior to establishing motor vehicle fuel specification
  - New mandatory statewide vehicle fuel specification
  - Voluntary verification of a diesel emission control strategy using alternative diesel fuel or fuel additive
- Requires consultation with BDOs of Cal/EPA

Health and Safety Code §43830.8 (cont.)

- Multimedia evaluation shall include assessment of:
  - Air pollutants
  - Contamination of surface water, groundwater, and soil
  - Disposal or use of byproducts and waste material from production of fuel
- External scientific peer review
- California Environmental Policy Council (CEPC)
  - Considers multimedia evaluation

California Environmental Policy Council Shall:

Determine whether or not proposed action will cause a significant adverse impact on public health or the environment

- No significant adverse impact – No further action by Council needed
- Significant adverse impact or less harmful alternatives exist - Council recommends alternative measures to reduce impacts

Multimedia Working Group (MMWG)

- Oversees the multimedia evaluation process
- Makes recommendations to the CEPC
- Members from Cal/EPA:
  - ARB
  - SWRCB
  - OEHHA
  - DTSC
  - Other agencies consulted as needed

Multimedia Working Group Responsibilities

- ARB – Lead agency, evaluate air quality impacts
- SWRCB – Assess surface water and groundwater impacts
- OEHHA – Evaluate potential public health impacts
- DTSC – Evaluate potential soil and hazardous waste concerns

Evaluation Uses Rigorous Scientific Process

- Follows guidance document developed by University of California
- Multimedia evaluation looks at impacts associated with:
  - Emissions of air pollutants
  - Contamination of surface water, groundwater, and soil
  - Disposal or use of byproducts and waste materials
- Three tier process:
  - Tier 1 – Literature review to identify data gaps
  - Tier 2 – Test program to fill in data gaps
  - Tier 3 – Compilation and summary of data

Evaluation Uses Rigorous Scientific Process (cont.)

- MMWG conducts risk assessment and prepares staff report based on Tier 3 report
- External peer review
- CEPC considers staff report and peer review
- CEPC review within 90 days of notice by ARB of intent to adopt/approve

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What Is It?

- Viscon Additive
  - 1 part ultra-high-molecular-weight (UHMW) polymer (~ 7 million Daltons)
  - 99 parts CARB diesel
- Polymer component – Polyisobutylene (PIB)
  - Pure hydrocarbon polymer, C_4H_8
  - Food grade material – non-toxic, colorless, odorless, insoluble in water, used in chewing gum

How Is It Made?

Delivered PIB (solid)

Granulated on-site

Liquid concentrate

On-site storage

Concentrate delivered to customer

How Is It Transported, Distributed, and Stored?

- Transported to customer by tanker trucks, totes, 55-gallon drums
- Customer blends additive with CARB diesel on site
- Not currently stored in underground storage tanks

How Is It Used?

- Additive treat rate 500 ppm
- Can be used in diesel engines without modifications
- Used for off-road equipment only
  - Agricultural tractors, loaders, graders, port cranes, excavators, other industrial equipment
- Expected statewide consumption
  - Viscon additive – 10 gal/day
  - Viscon-treated diesel – 25,600 gal/day

How Does It Work?

- Fuel droplet viscosity increase throughout spray formation, transport, and burn
- Droplet diameter in spray cone is reduced and superfine droplets suppressed
- Spray penetration increased in cylinder
- Improved quality of the air/fuel mixture at ignition and during burn

Benefits of Viscon

- At least a 25% reduction in PM emissions
- Economic benefits
  - Requires no engine modifications
  - Low up front cost compared to hardware retrofit devices

Benefits of Viscon (cont.)

Proposed Verification of Viscon Additive

- Qualifies as a Level 1 PM control strategy
- Off-road applications only
  - Off-road agricultural tractors, loaders, graders, excavators, port cranes, other industrial equipment
- Emission control group
  - Unregulated Model Year 1985-1995, four-stroke, off-road diesel engines, 175 to 300 horsepower

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Multimedia Evaluation of Viscon-Treated Diesel Fuel

Air Quality Evaluation (ARB)

Air Quality Evaluation

- Assessment based on relative comparison to CARB diesel fuel
- Criteria pollutants – PM, THC, CO, NO, NOx
- Air toxic emissions – diesel PM, other toxics
- Greenhouse gas emissions - CO_2

Air Quality Conclusions

- Viscon additive use reduces emissions and health risk from PM in diesel exhaust
- Air quality effects of the additive, either alone or additized, are expected to be less than or equal to CARB diesel

Air Quality Conclusions (cont.)

- Emissions of certain toxic compounds may increase with use of Viscon additive, but under conditions of the multimedia evaluation and verification, such increases would not significantly impact ambient levels of those compounds
  - NOx increase
  - 1,3-butadiene, formaldehyde, acetaldehyde, benzene increase

Air Quality Conclusions (cont.)

- Use of Viscon additive and resulting air emissions do not pose a significant adverse impact on air quality

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Water Evaluation (SWRCB)

Background

- State Water Board conclusions are limited in scope to verification application which specifies that Viscon-treated diesel is for “off-road use” and would not be stored in underground storage tanks (USTs)
- State Water Board evaluation is specific to differential environmental impacts between Viscon-treated diesel and CARB diesel
- Aquatic toxicity review is limited to published toxicity of PIB, not Viscon-treated diesel

Properties

- Viscon additive is a blend of 99% CARB diesel with 1.0% polyisobutylene (PIB)
- Viscon-treated diesel contains 5ppm PIB
- Tier I report indicates PIB is “completely insoluble in water”
- Tier I reports indicates that PIB used in Viscon has an average molecular weight of about 7 million Daltons
- Tier I report states that PIB is FDA approved for food applications in amounts more than a 1000 times greater than the proposed use of the Viscon additive

Analysis

- Material properties and lab testing suggest PIB is not likely to travel far in soil or groundwater or enhance ability of diesel to travel further in soil or groundwater
- Although material properties of PIB suggest that it may not be very biodegradable and therefore could affect the soil cleanup, it is unlikely to make any significant difference due to very low concentration of PIB to diesel

SWRCB Conclusion

- No more significant risks posed by Viscon-treated diesel than that posed by CARB diesel alone
- The potential scope of any unanticipated impacts is limited given the controlled use of Viscon-treated diesel

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Human Health Evaluation (OEHHA)

Major Activities of the Office of Environmental Health Hazard Assessment (OEHHA)

- Identification of hazards from exposure to chemicals
- Dose-response assessment for toxic chemicals
- Calculation of advisory maximum acceptable exposure levels for toxic chemicals

Primary Role of OEHHA Staff in the MMWG

- Environmental impact assessment of chemicals released into environmental media
  - Additives
  - Combustion emissions
- Human health impact assessment of reformulated fuels
  - Additives
  - Combustion emissions

Environmental Partitioning, Transport and Fate Analysis of Polyisobutylene (PIB)

- PIB release onto soil will bind tightly to soil particles
- Some resuspended particles will be deposited into surface water
- PIB will be transported to aquatic sediment
- Environmental breakdown of PIB is very slow
- PIB will accumulate in aquatic sediment

Impact of Combustion Emissions on Concentrations of Toxic Air Contaminants

- Changes in ambient air concentrations resulting in substitution of Viscon diesel for an equivalent amount of CARB diesel are evaluated
- Diesel particulates are reduced
- Acetaldehyde, formaldehyde, benzene and 1,3-butadiene concentrations are increased

Impacts of PIB Release into the Environment

- No known hazards or adverse impacts on humans
  - PIB is used as chewing gum base (FDA – CFR172.615)
  - PIB is approved for use in packaging of cosmetics
- No known hazards to organisms in the environment

Impacts of Combustion Emissions

- Assessed using a screening model for the Los Angeles Air Basin
  - Assumes all Viscon combustion is in LA Air Basin
  - Assumes combustion of 25,600 gallons/day Viscon diesel
- Upper-bound lifetime cancer risk estimates
  - Acetaldehyde - 6×10^{-10}
  - Formaldehyde - 1.3×10^{-9}
  - Benzene - 8×10^{-10}
  - 1,2-butadiene - 2.5×10^{-8}
  - Sum of upper-bound risks - 2.8×10^{-8}

Calculation of Viscon Combustion Corresponding to 10^{-6} Upper-Bound Cancer Risk

900,000 gallons/day

Fixed-Location Diesel Engines as "Hot-Spots"

- Screening model assumes combustion emissions are well-mixed with ambient air
- This is not a valid assumption for a receptor near a diesel engine releasing combustion products
- Air Quality Management Districts can regulate facilities with stationary diesel engines using the Hot Spots Program

Example of Risk Management Strategy: Maximum-Use Threshold for Viscon diesel fuel of 450,000 gallons/day

- Corresponds to an upper-bound cancer risk of 0.5×10^{-6} from emissions well mixed with ambient air
- Allows for limited exposure from a nearby diesel engine while assuring that risk attributable to Viscon combustion is less than 10^{-6}

Recommendations of OEHHA

Approve use of a limited amount of Viscon-treated diesel

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Hazardous Waste Evaluation (DTSC)

DTSC Role in Multimedia Fuel Evaluation

- Identifying hazardous waste during manufacturing process
- Ensuring correct hazardous waste management is conducted
- Evaluating environmental fate and transport of new fuels and/or fuel additives in soil if spill occurs
- Evaluating effects of fuels and/or fuel additives on hazardous waste soil cleanup

Viscon Additive and Viscon Treated Diesel

- Viscon Additive
  - 1% PIB + 99% CARB Diesel
- Viscon-treated Diesel
  - 500 ppm Viscon Additive

Thus:

Viscon-treated Diesel contains 5 ppm PIB

Properties of PIB

PIB

- Low Solubility
- High Viscosity
- Low Toxicity
- Current Commercial Applications

DTSC's Conclusion on Hazardous Waste

- PIB is not likely a hazardous material
- Viscon-treated diesel could be a hazardous waste if spill occurs

Tests Completed by University of Georgia (UGA)

Comparison:
Viscon-treated diesel vs. CARB diesel

- Biodegradation Test
- Soil column fate and transport test
- Final test report submitted by UGA

DTSC's Conclusions

Based on the numbers in UGA test report and DTSC analyses

Comparing to CARB diesel:

- Biodegradation Test – No significant difference
- Fate and Transport Test – No significant difference
- Impact on Soil Cleanup – No negative impact

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Summary of External Scientific Peer Review

External Scientific Peer Review

- Review scientific portion of the evaluation based upon “sound scientific knowledge, methods, and practices”
- Institutions to conduct an external peer review:
  - University of California
  - National Academy of Sciences
  - Scientist or group of scientists of comparable stature and qualifications that is recommended by the President of the University of California

External Peer Reviewers

Peer Reviewers

- Yoram Cohen, Ph.D., Professor
  - Dept. of Chemical and Biomolecular Engineering
  - University of California, Los Angeles
- Miriam L. Diamond, Ph.D., Professor
  - Dept. of Geography, Chemical Engineer, Applied Chemistry
  - University of Toronto
- Terry Gordon, Ph.D., Professor
  - Dept. of Environmental Medicine
  - New York University Langone, Medical Center

External Peer Reviewers Cont.

- Armistead G. Russell, Ph.D., Professor
  - Civil and Environmental Engineering
  - Georgia Institute of Technology
- Frank Gobas, Ph.D., Professor
  - Biological Sciences, Resource and Environmental Management
  - Simon Fraser University

General Results

- Determined that MMWG conclusions and recommendations are based on sound scientific knowledge, methods, and practices
- Support overall finding that limited and controlled use of Viscon does not pose a significant adverse impact on public health or environment

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Recommendations

Multimedia Working Group recommends that the CEPC:

- Approve Staff Report and individual evaluations by MMWG
- Find that, based on multimedia evaluation Staff Report and Viscon verification application, there will not be a significant adverse impact on public health or the environment from limited use of Viscon additive

Recommendations (cont.)

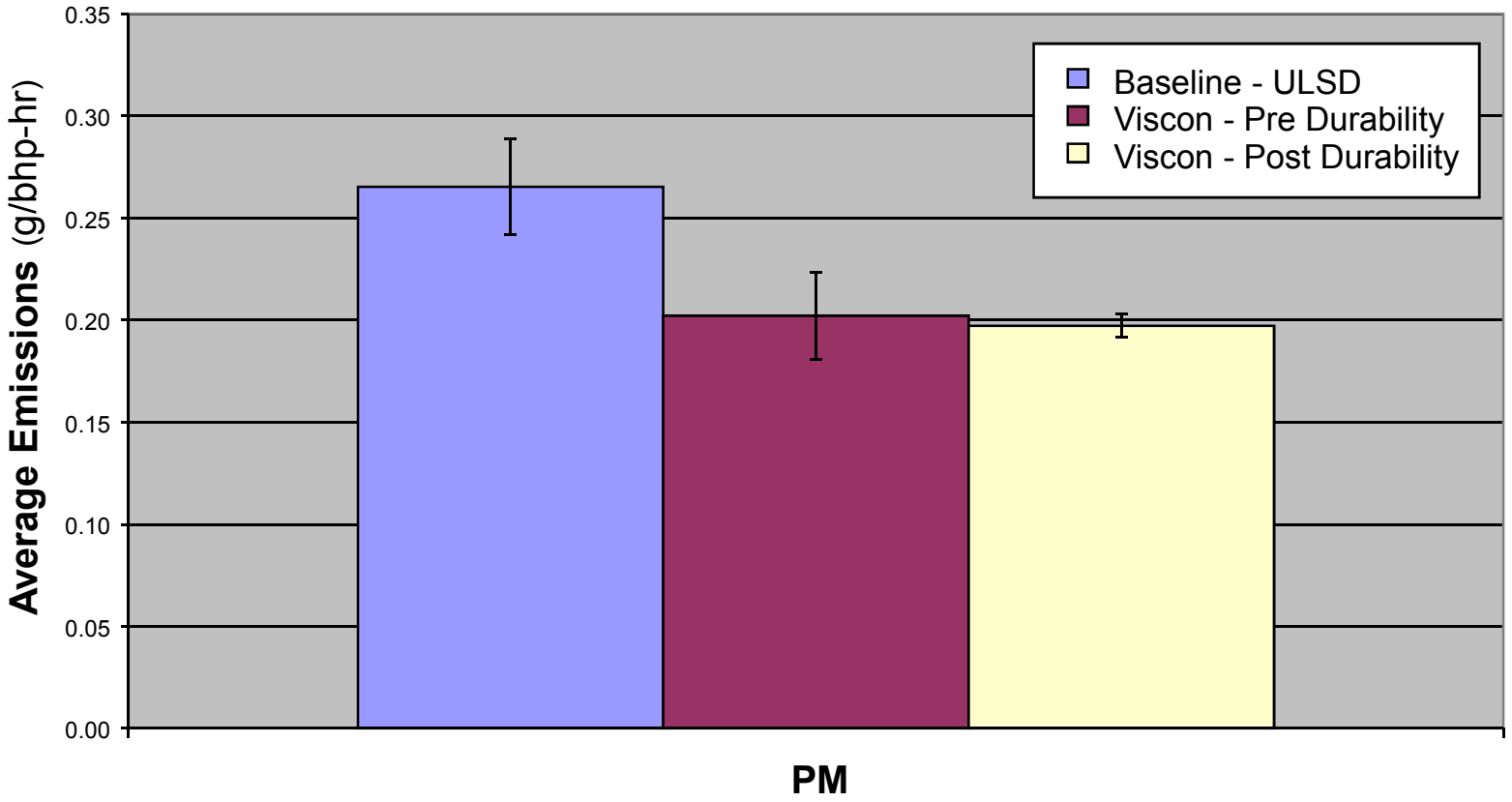
- Appropriate to require:
  - Viscon California, LLC to submit quarterly reports to MMWG for first year and annual reports thereafter:
    - CA and national sales of Viscon additive
    - CA and national sales of total Viscon-treated diesel fuel
    - Identification of end users in CA

Recommendations (cont.)

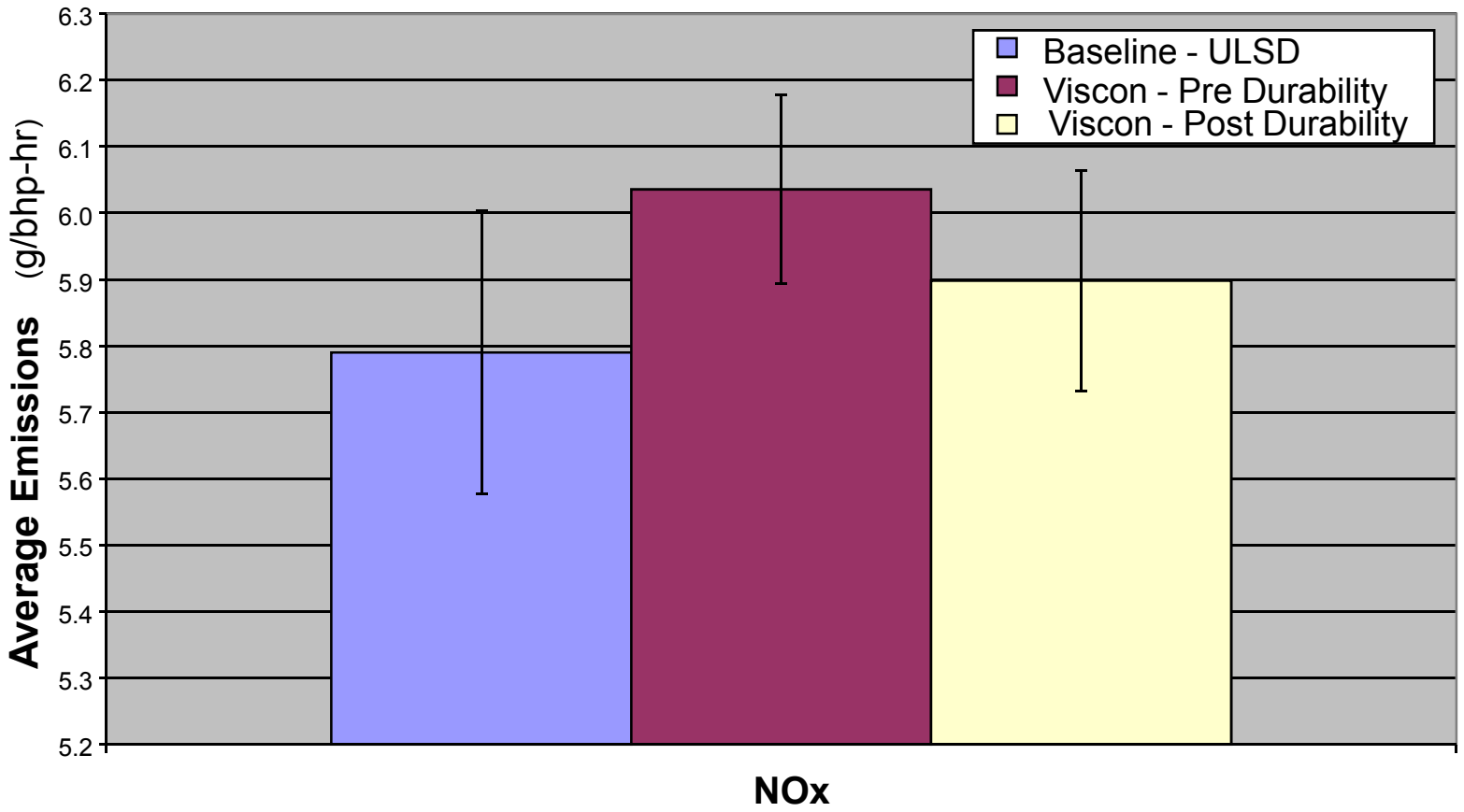
- Appropriate for the MMWG to consider reassessing the multimedia evaluation if:
  - CA sales of treated diesel approaches or exceeds 450,000 gallons/day
  - Treated diesel will be stored in USTs
  - Requested data, studies, or other relevant information indicate potential for significant risks
- Reassessment of Viscon additive use will be submitted for review by CEPC for consideration

End of Presentation

PM Emissions



NOx Emissions



Verification Limits on NOx

Control strategy must not increase NOx by more than 10% of baseline emissions levels

1,3-Butadiene

- Average pre-durability and post-durability results
  - ~ 4.14 mg/bhp-hr increase
  - ~ 770% increase
- OEHHA conducted additional risk assessment
  - Lifetime cancer risk
  - Fixed location analysis
- Recommendation of maximum-use threshold for Viscon-treated diesel fuel in CA – 450,000 gal/day