

# **The Effect of Changes in Diesel Exhaust Composition and After-Treatment Technology On Lung Inflammation and Resistance to Viral Infection**

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# Goals

Determine the physical and/or chemical characteristics that drive health effects

- Need to see effects of different magnitude
- Need a range of exposure conditions with overlapping, yet different composition

# Health Effects

Non-cancer health effects of emerging interest

Decreased resistance to infection after exposure to air pollutants has been implicated in several studies.

Recently our lab has shown decreased clearance of Respiratory Syncytial Virus (RSV) and increased pathogenesis (more sick) after diesel exhaust exposures at our lowest exposure levels (Harrod et al.,2003)\*

Diesel exhaust, under some conditions, has also been shown to produce lung inflammation and oxidative stress in healthy rodents.

\* Am J. Resp. Cell and Mol. Biology, 28, 451-463

# Study Design

1. Partial Load
2. High Load
3. Emiss. Red.

200  $\mu\text{g}/\text{m}^3$  PM (1&2)  
or equiv. dilution (3)



6 h/d 7 d exposure  
C57Bl/6 Mice

**Group 1**

**Group 2**

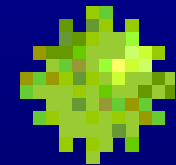


**Viral Clearance**

**Sacrifice immediately after  
Last exposure day**

**Instillation of  
RSV**

**Lung pathogenesis**



**Lung inflammation**

**Lung inflammatory/oxidative stress indicators**



**Sacrifice at 4 days**

# Engine/Fuel/Lube Oil

- Yanmar 5500 Watt Genset (YDG5500)
  - 490 cc single cylinder engine
  - Load induced by 500 watt lights (6 for partial and 11 for high)
- Lube oil: 15w/40 Rotella T (Shell) purchased “off the shelf”
  - Oil changed prior to each exposure
- Fuel: Exposures 1 and 2: #2 Certification Fuel.  
#3: BP-15 ultra low S fuel

# Fuel Properties

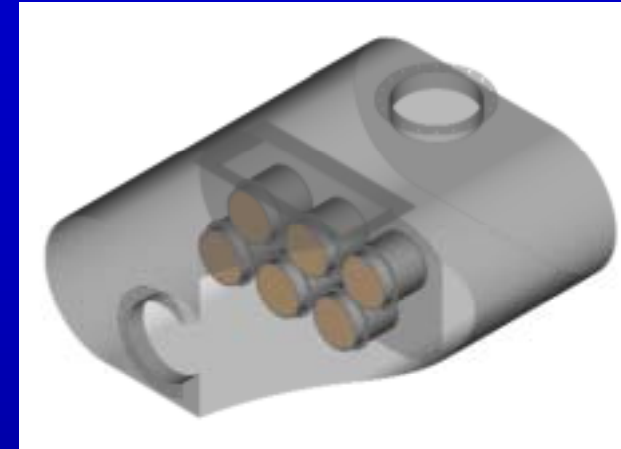
## #2 Certification Fuel

## BP-15 Fuel

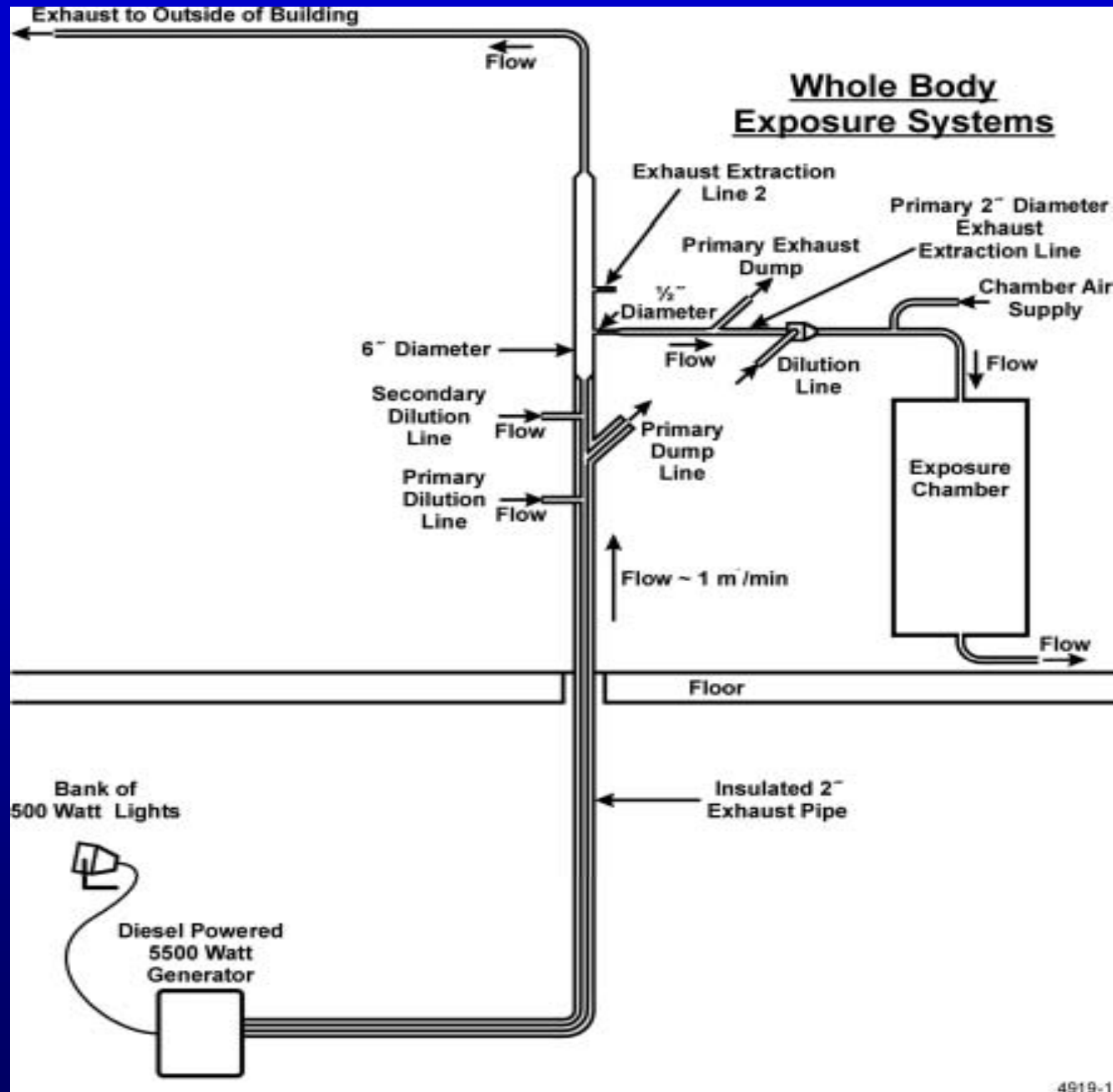
API Gravity	35.8	37.5
Spec. gravity	0.848	0.837
Viscosity	2.4	2.8
Sulfur (ppm)	371	15
Aromatics (vol %)	29	29
Cetane index	47.6	48.8
Cetane number	47.3	49.7

# Catalyzed Ceramic Filter

- PERMIT™ Filters by CleanAIR Systems
  - Technology verified by California Air Resources Board as Level 3 device (>85% PM reduction)
  - >95% CO & THC reduction



# Exposure System



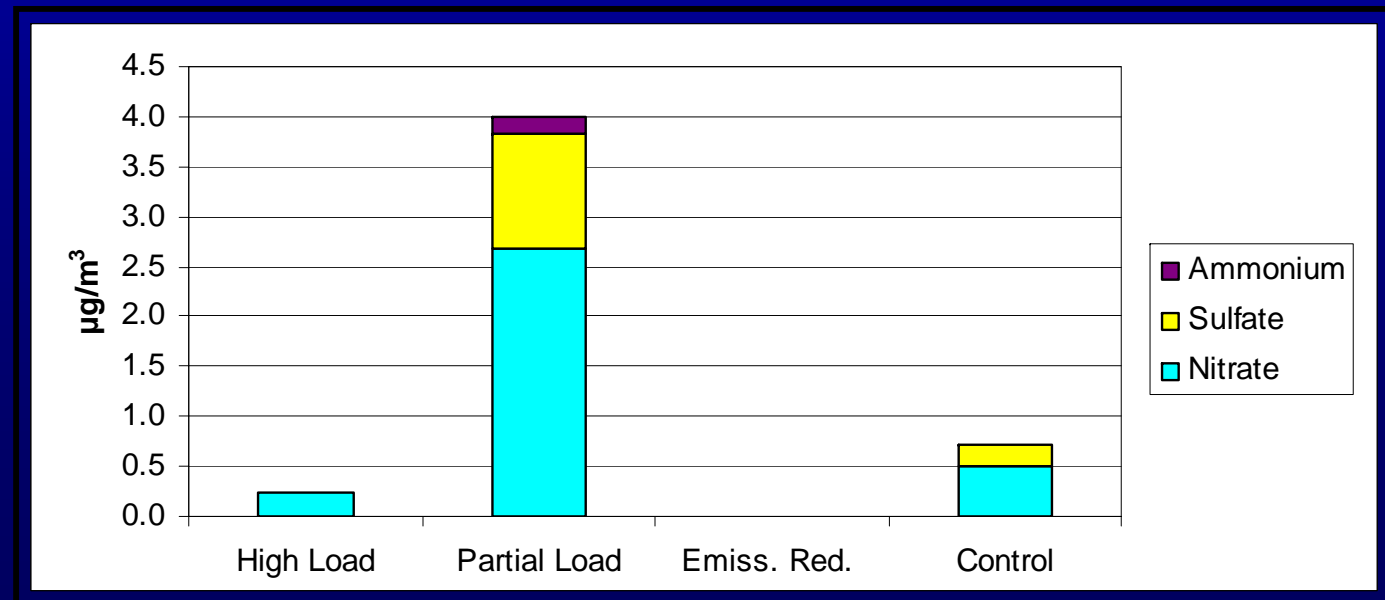
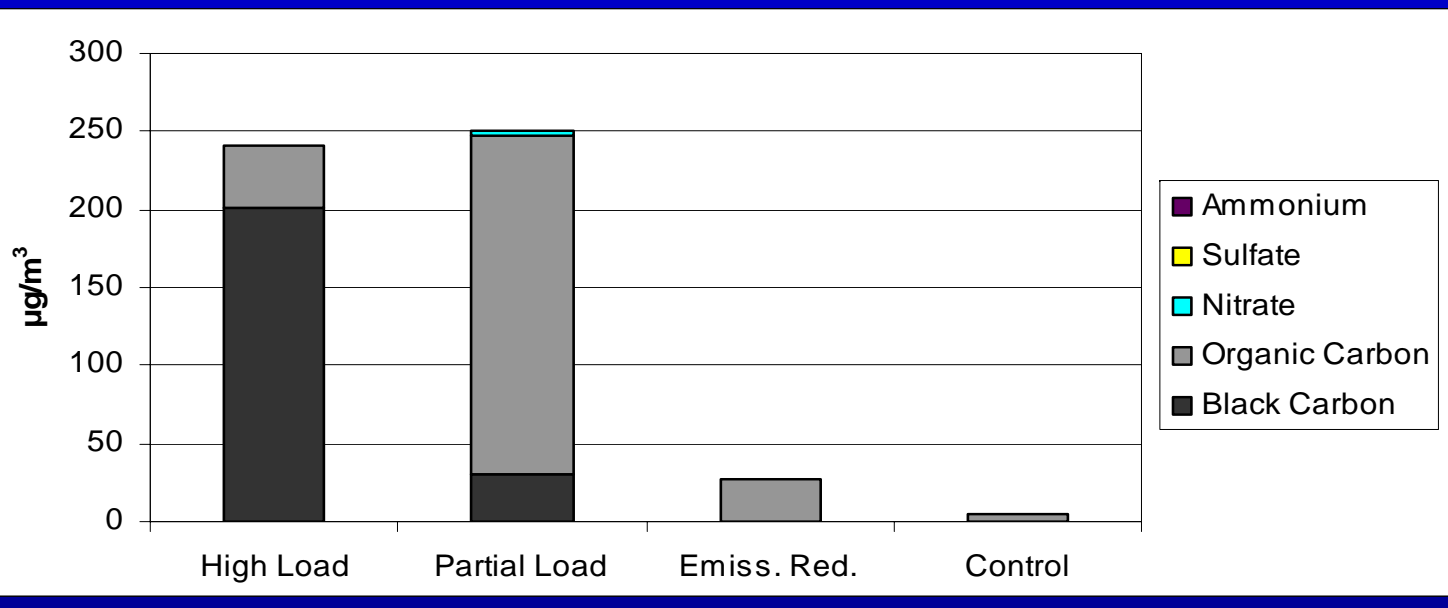
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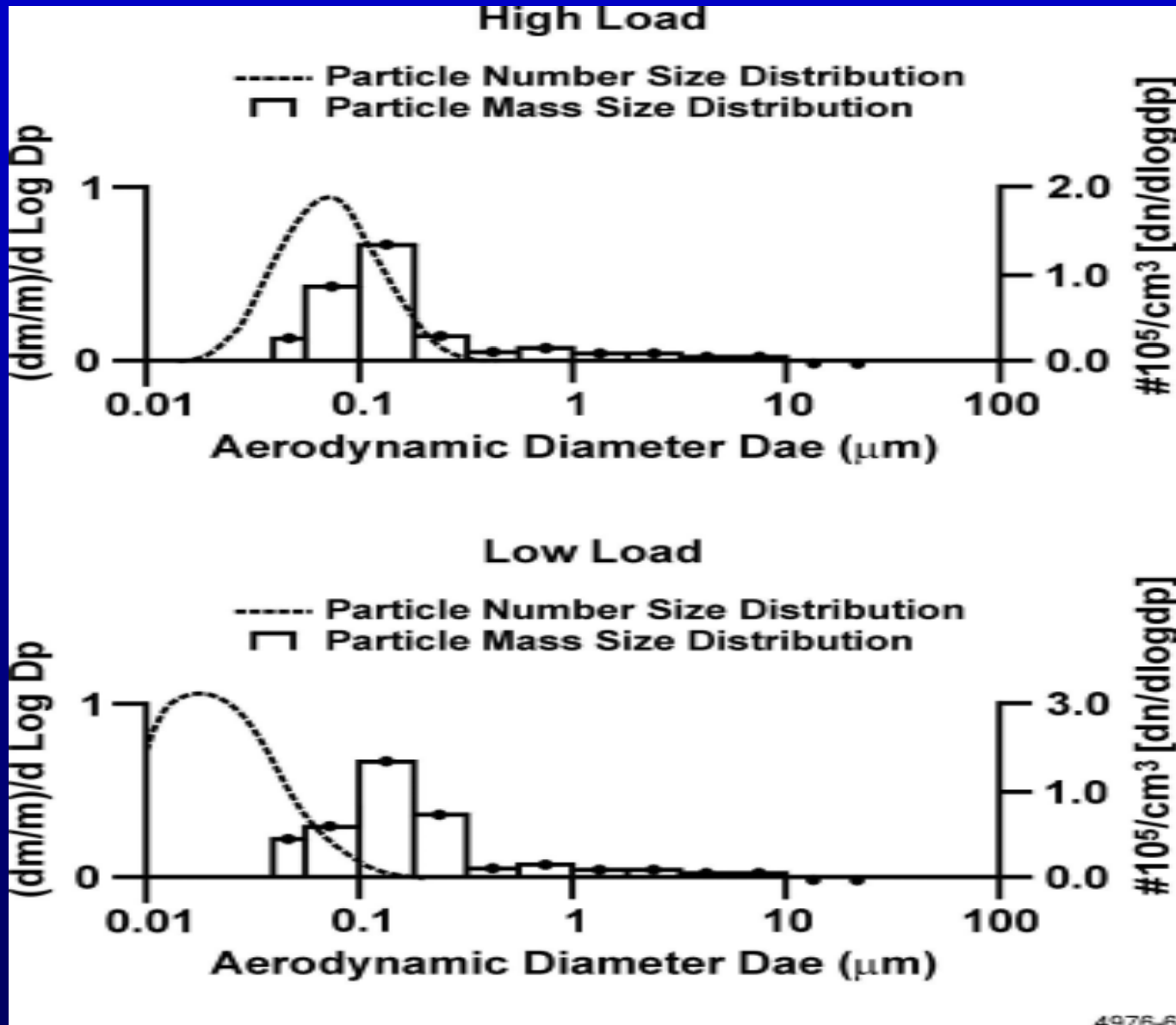
# Exposure Atmosphere Characterization

- Particle Mass
- Particle Size Distribution (number and mass)
- NO<sub>x</sub> (NO + NO<sub>2</sub>)
- NMVOC/speciated NMVOC
- SVOC/PM Organics
- Metals and associated elements
- Organic/Black carbon and inorganic ions

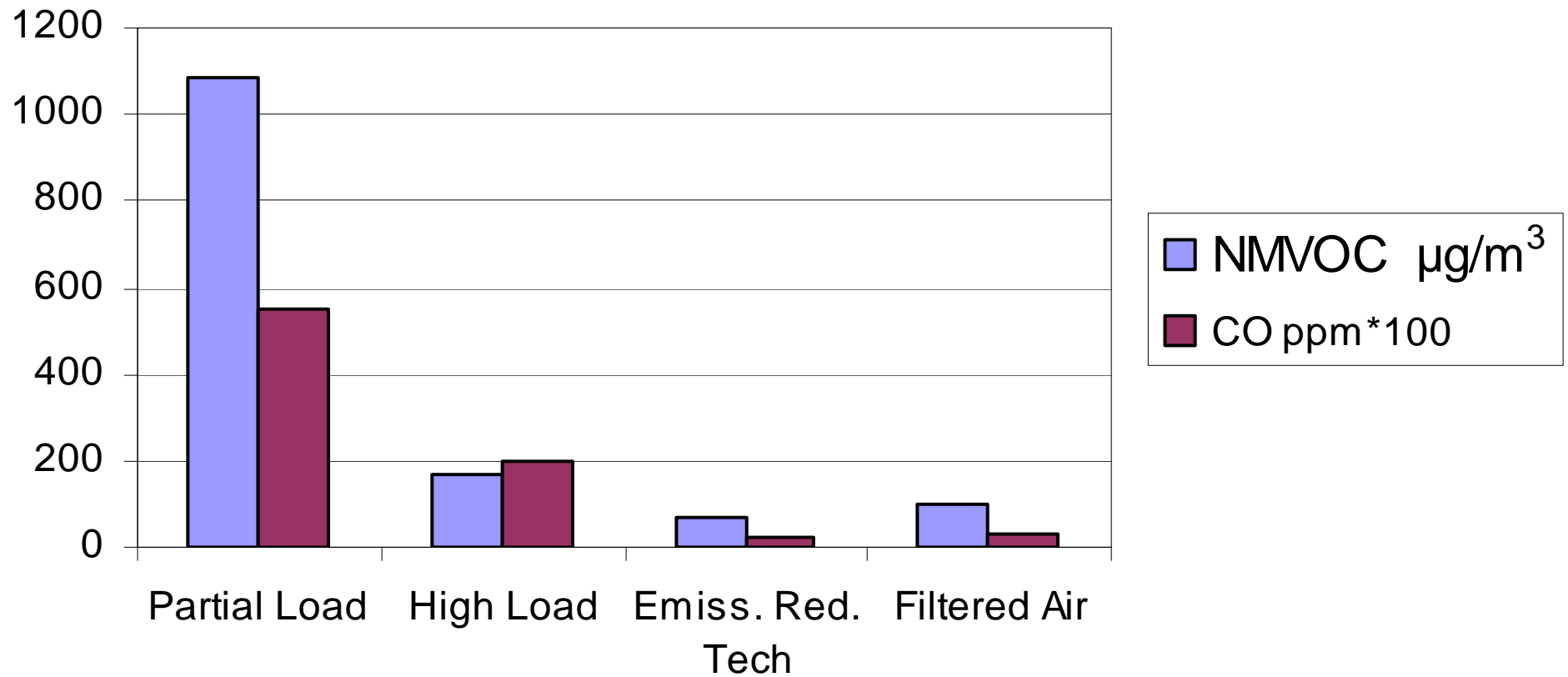
# Particle Composition



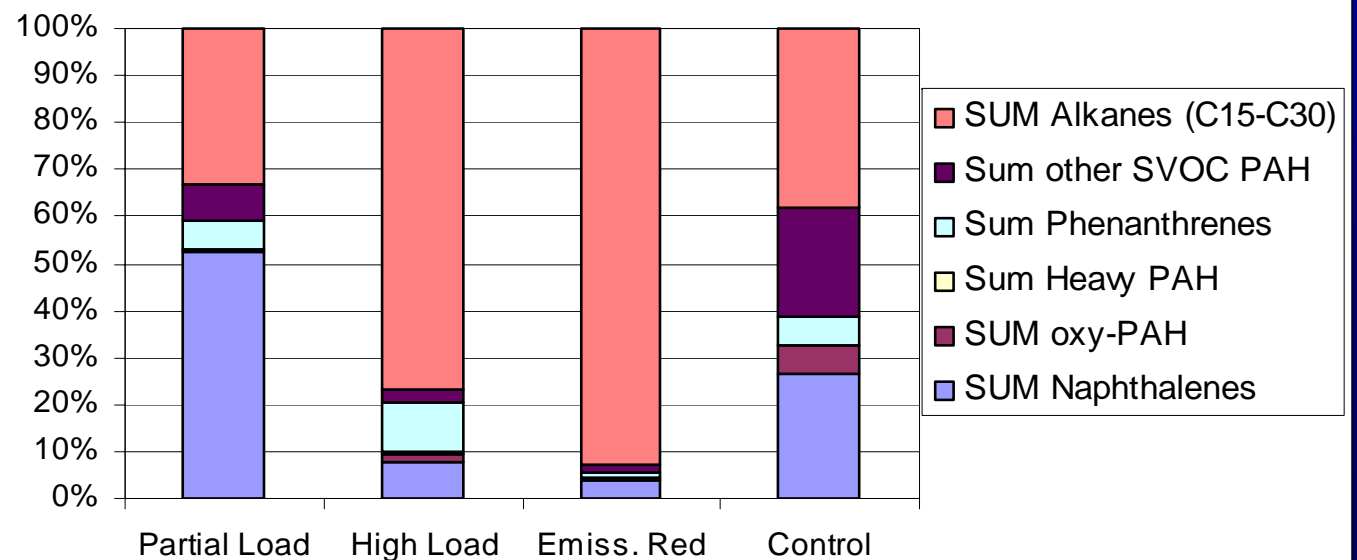
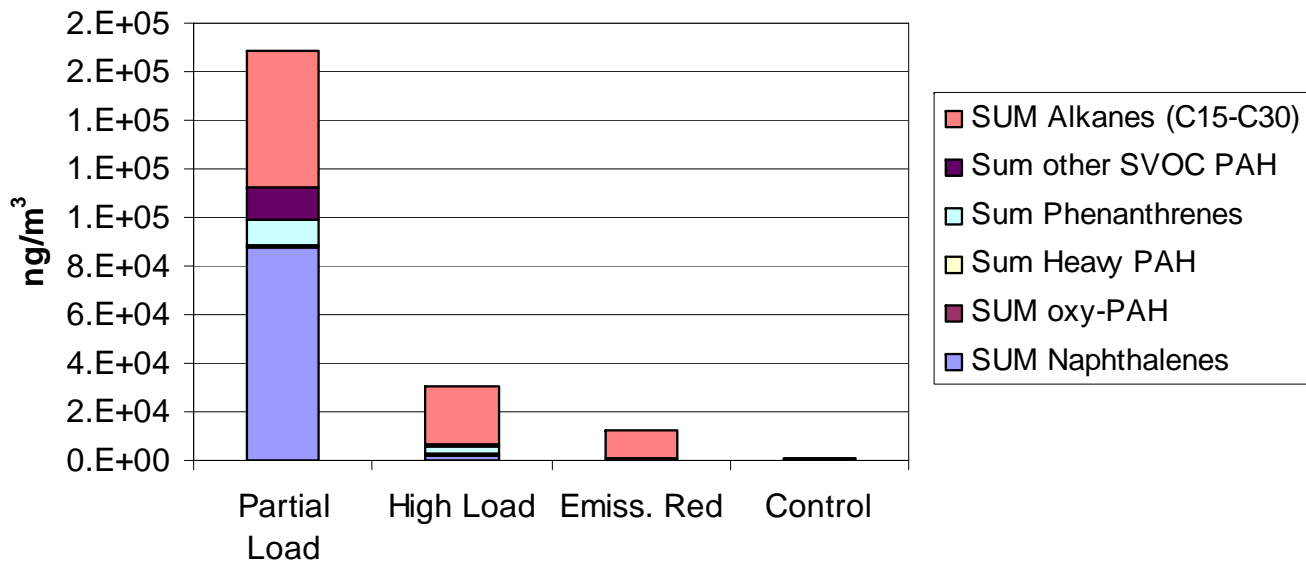
# Particle Size



# CO and Volatile Organics

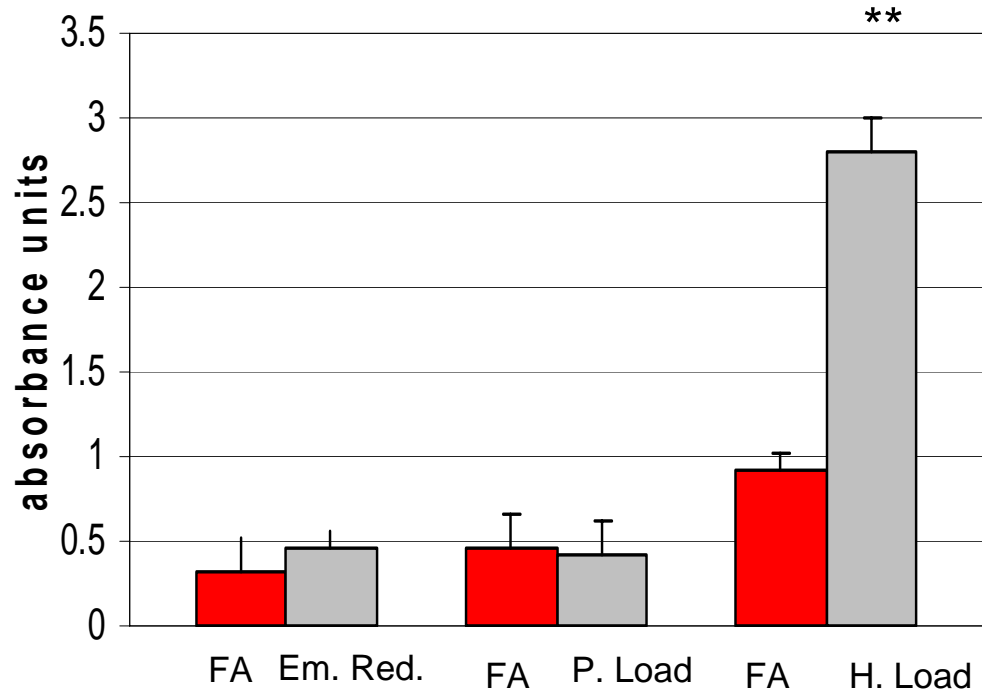


# Select Semi-Volatile and Heavy Organics

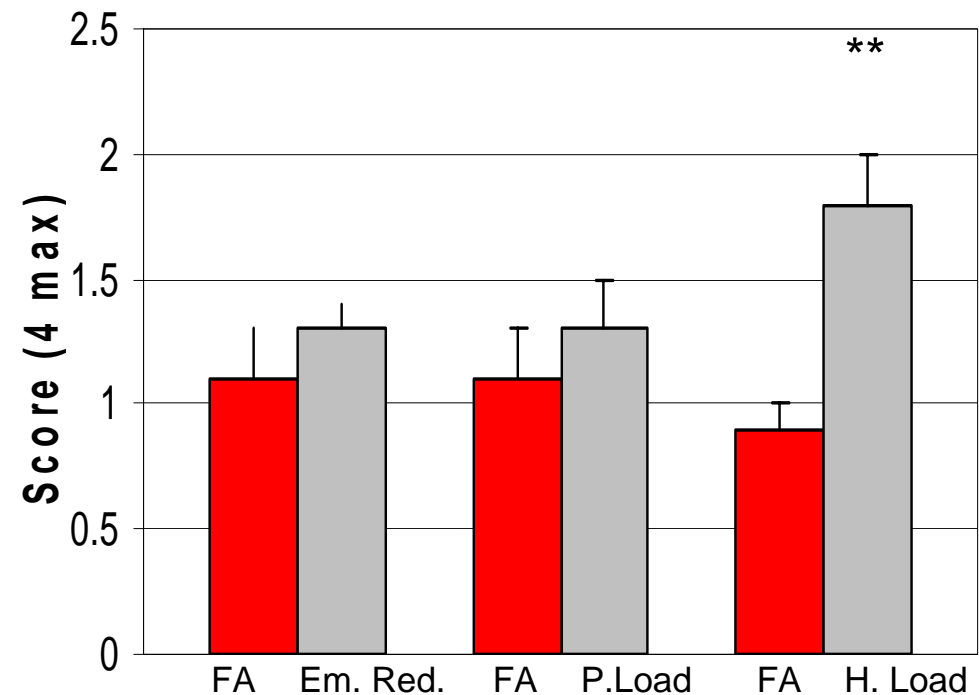


# Viral Persistence and Lung Inflammation by Histopathology

## Viral Persistence

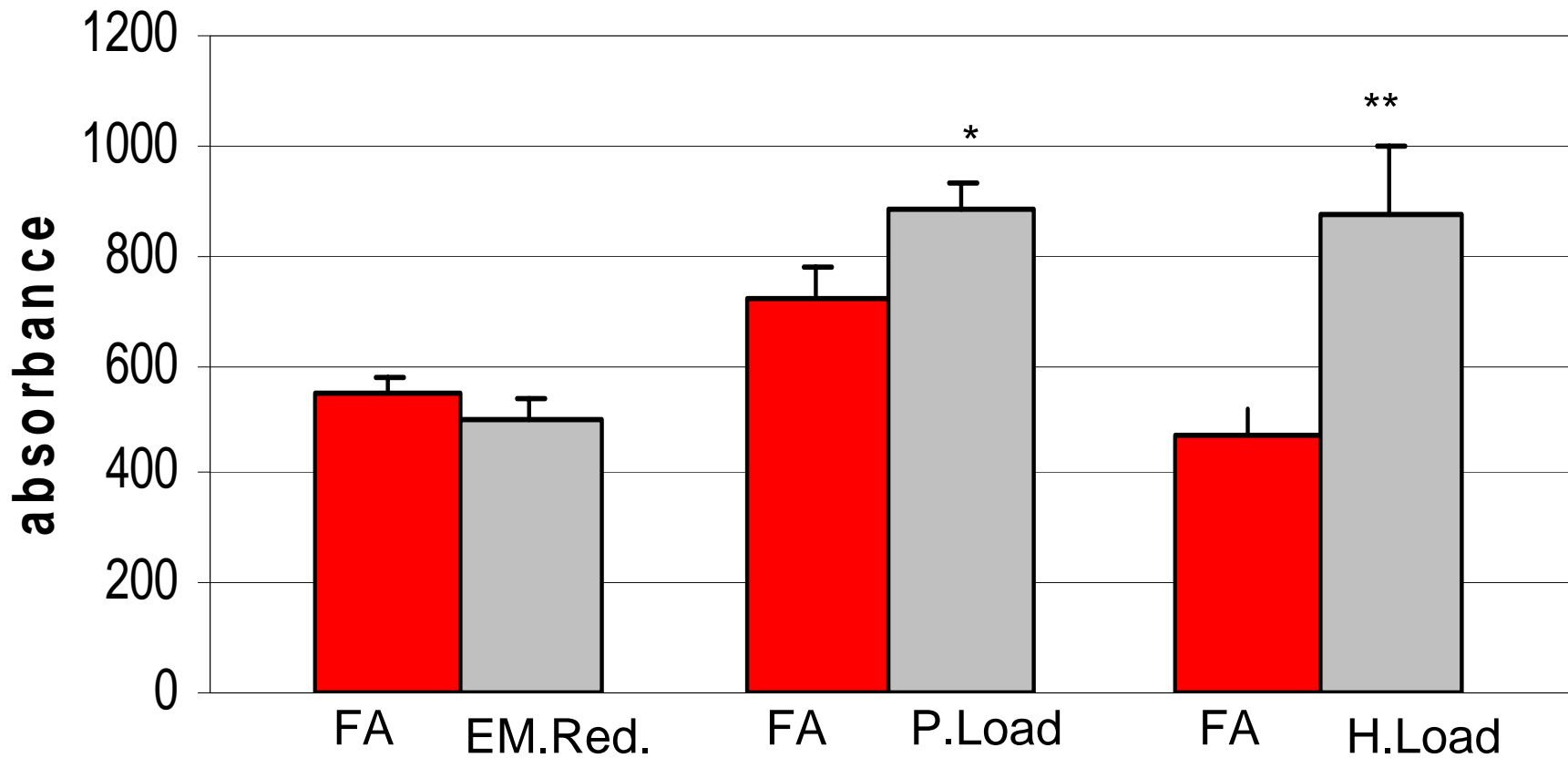


## Histopathology (Inflammation/Injury)

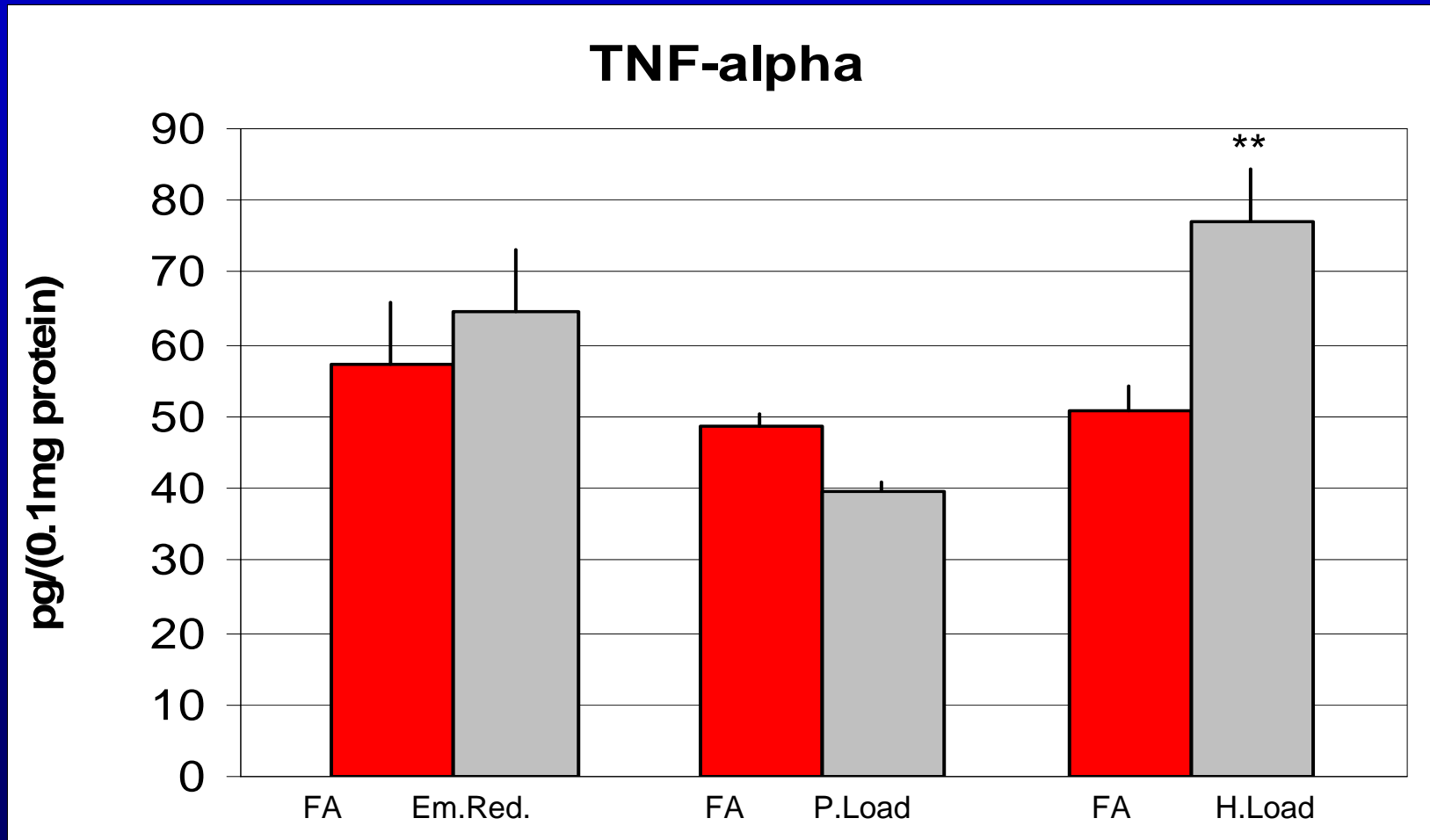


# Oxidative Lung Damage

Heme-Oxygenase (Oxidative Stress Marker)



# Lung Inflammatory Indicators





# Summary

- Engine load variation and catalyzed trap/low S fuel were used to produce exposure atmospheres of different composition
  - Observed
    - Differences in organic content/composition and particle size
    - Differences in health response

# What's Next?

- Complete chemical and biological analyses
- Investigate additional exposure atmosphere compositions
  - High load plus organic/inorganic denuders (strippers)
  - Ceramic trap with no catalyst
  - Transients to increase oil content
  - Spark Ignition
- Relate compositional differences to health effects quantitatively to improve understanding of “health drivers”

# Further Acknowledgments

Desert Research Institute

Organic Analytical Lab-VOC

Environmental Analysis Facility-  
Carbon/Ions

BP: Global Fuels Technology Group

Donation of BP-15 fuel