

US EPA ARCHIVE DOCUMENT

Measuring the Emission Benefits of Cleaner Burning Fuels

US EPA & Mexico Workshop

Vera Cruz, Mexico
April 16, 2010

<http://www.cert.ucr.edu>

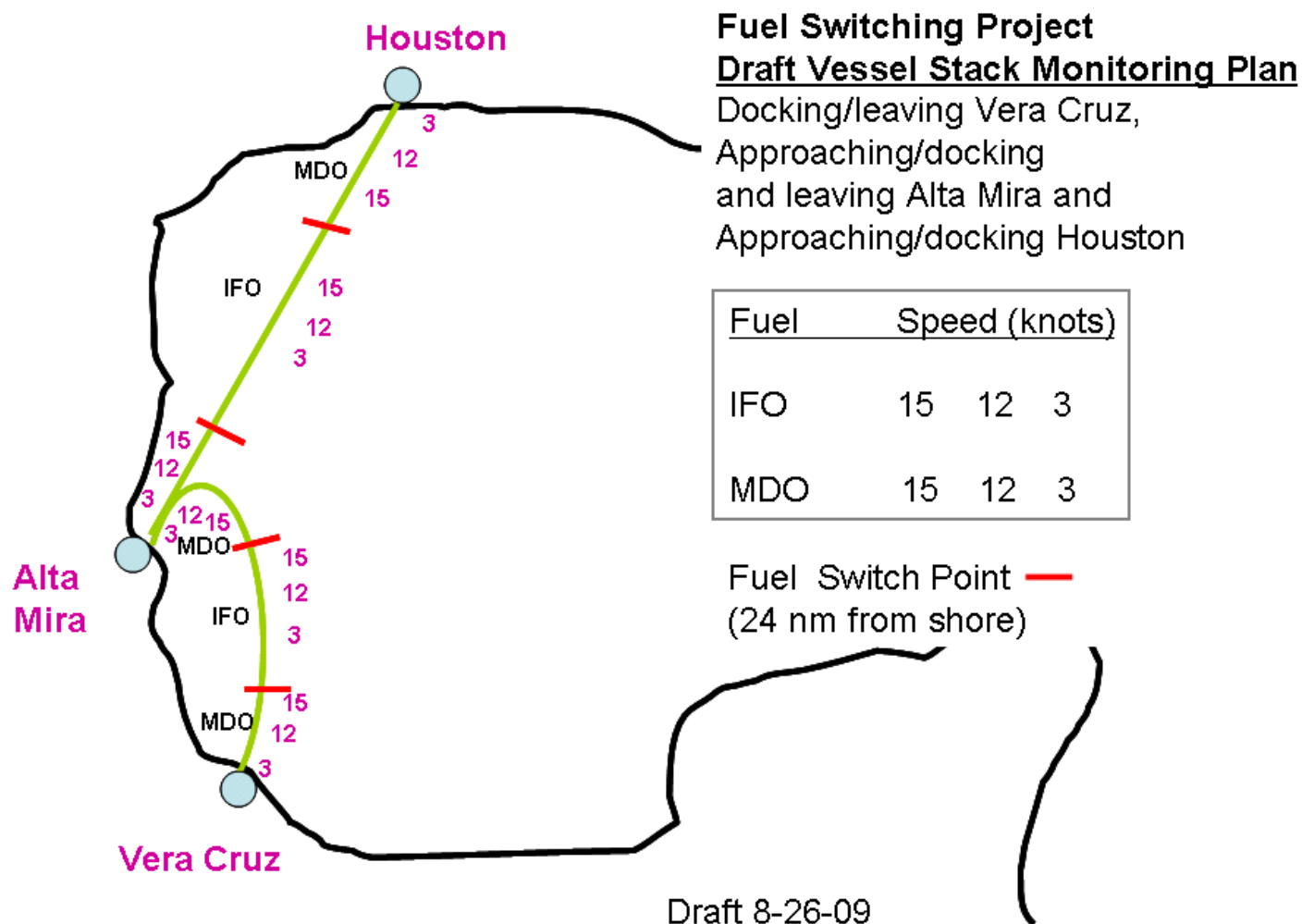
Acknowledgement of Partners

- Government of Mexico
- United States Environmental Protection Agency
- Port of Houston
- Hamburg Süd
- ICF Consulting

Discussion Topics

- Goal: measure emissions from:
 - Auxiliary engines (AE)
 - Main propulsion engine (ME)
- Planned Approach
 - Test with distillate (light) and bunker (heavy) oil
 - Use European test cycles
 - Use European measurement methods
- Questions?

Planned Ship Route and Speeds



Test Fuels

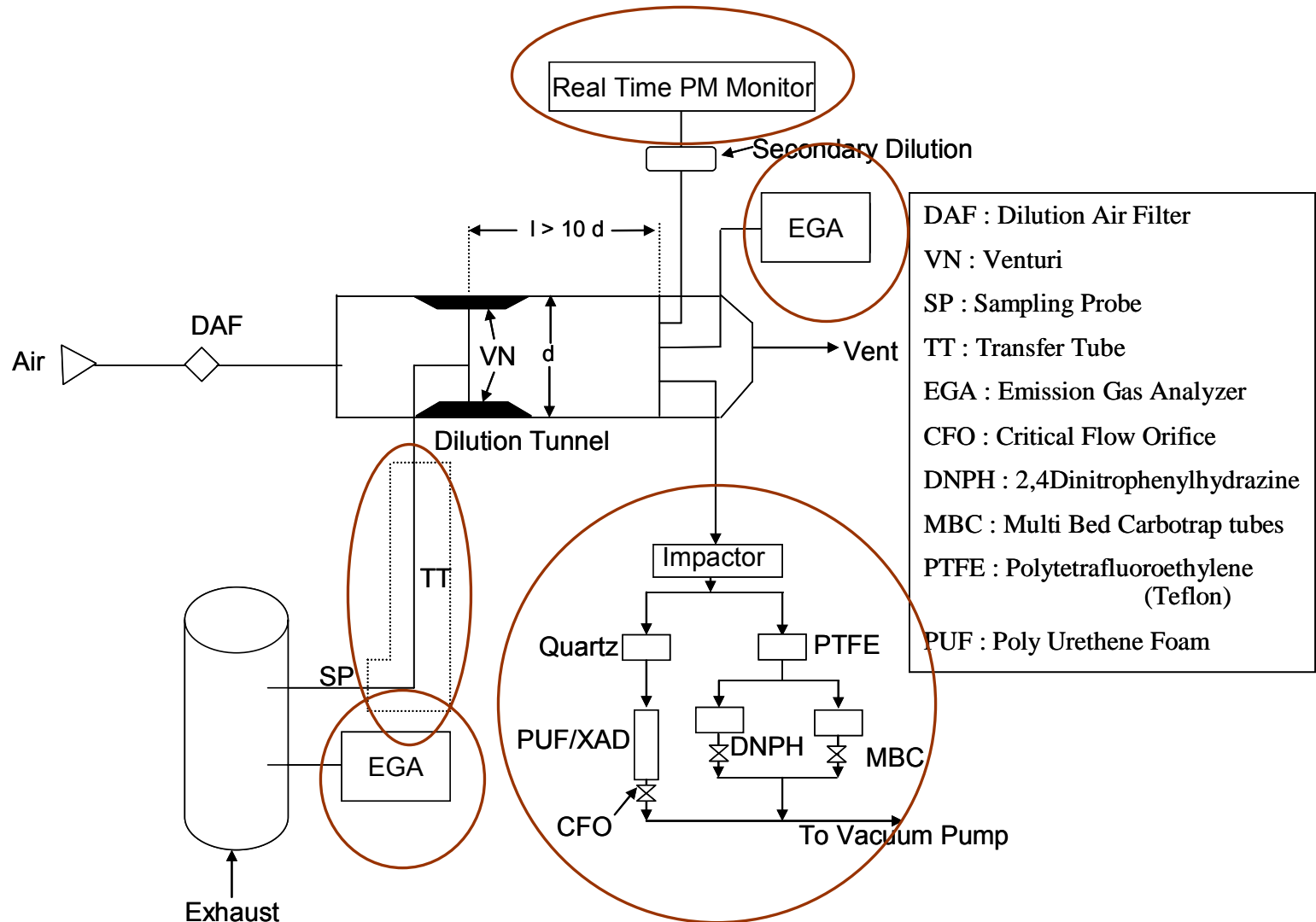
- Heavy Fuel Oil (HFO)
 - Commonly known as bunker fuel or residual oil
 - Residual fraction from crude refining
 - Used on main engine and boiler
 - Very high viscosity and high sulfur content (2.6% m/m)
- Marine Gas Oil and Marine Distillate Oil
 - Refined fraction from crude distillation
 - Used on auxiliary engine
 - Lower sulfur content (0.16 %m/m)

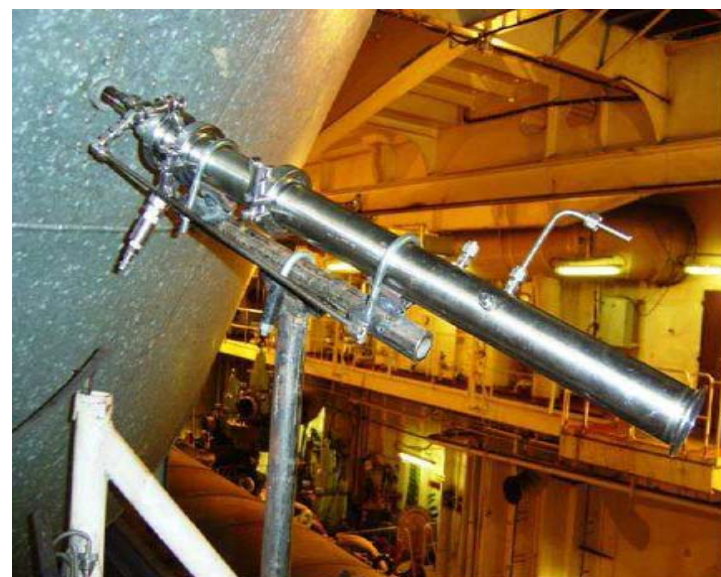
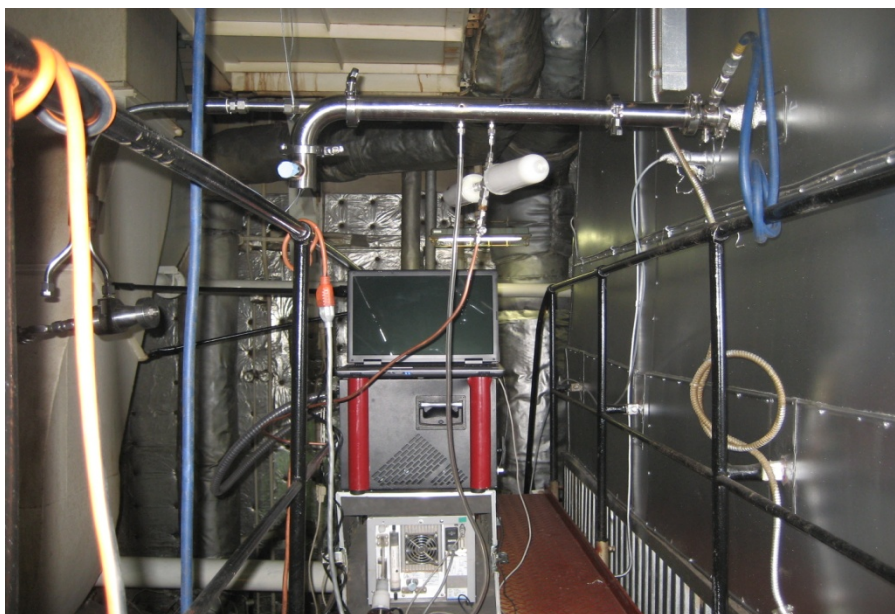


Measuring Emission Factors

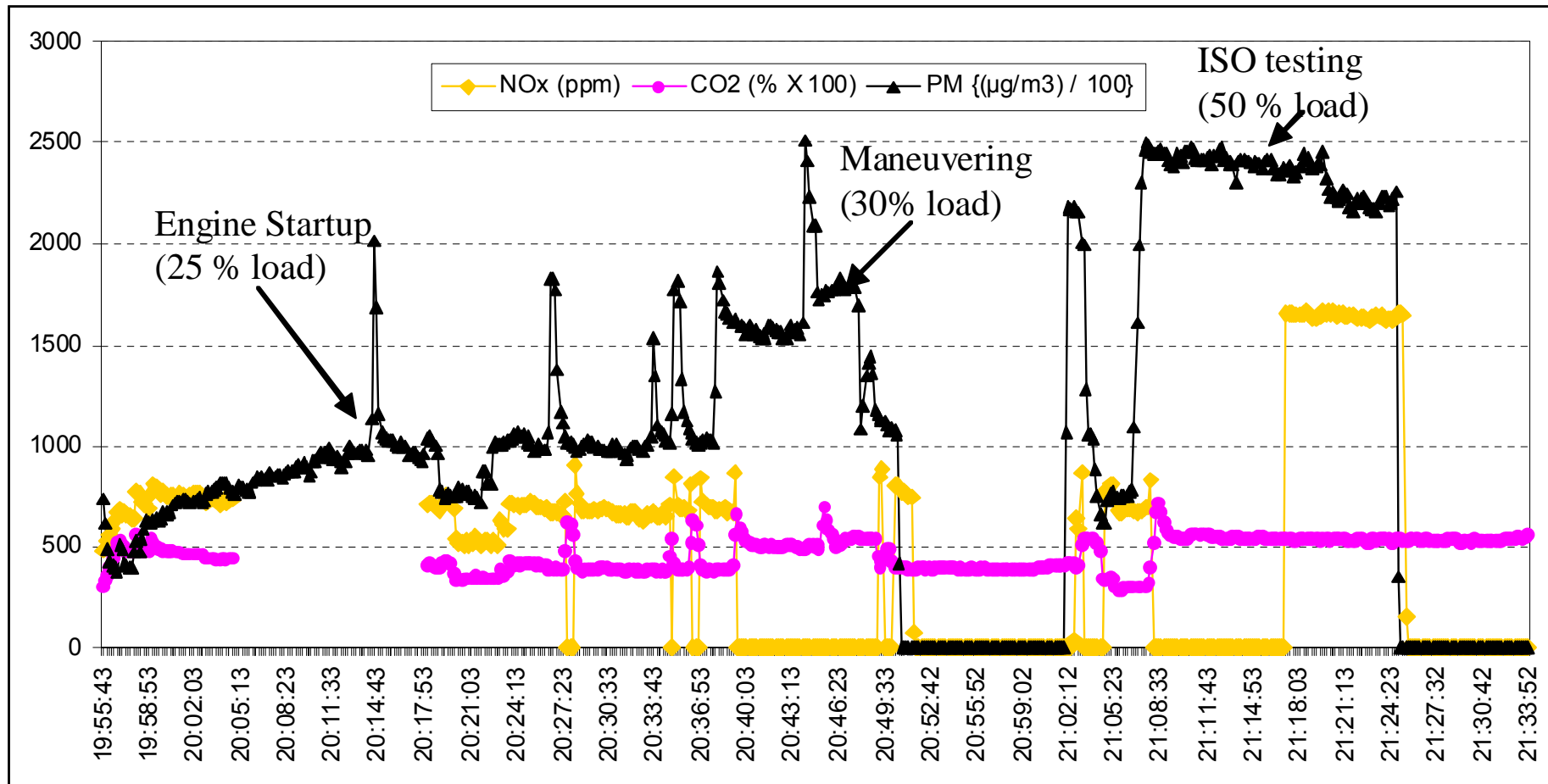
- Requires close collaboration of the ship owner and Chief Engineer to coordinate schedule.
- Engine operation
 - Follow European ISO 8178-4 standard cycles
 - At sea: follow in-use conditions
- Gases monitored by ISO/EPA methods
 - NO_x Chemiluminescence detector
 - CO, CO₂ Non dispersive infrared
 - HCs GC/FID
 - SO_x Calculate from fuel
- Measure particulate matter (PM)
 - Use ISO 8178-1 partial dilution method
- Emission factor determined from power setting & calculated mass flow

Flow Diagram of the Sampling System

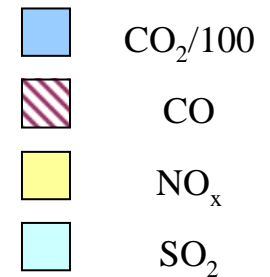
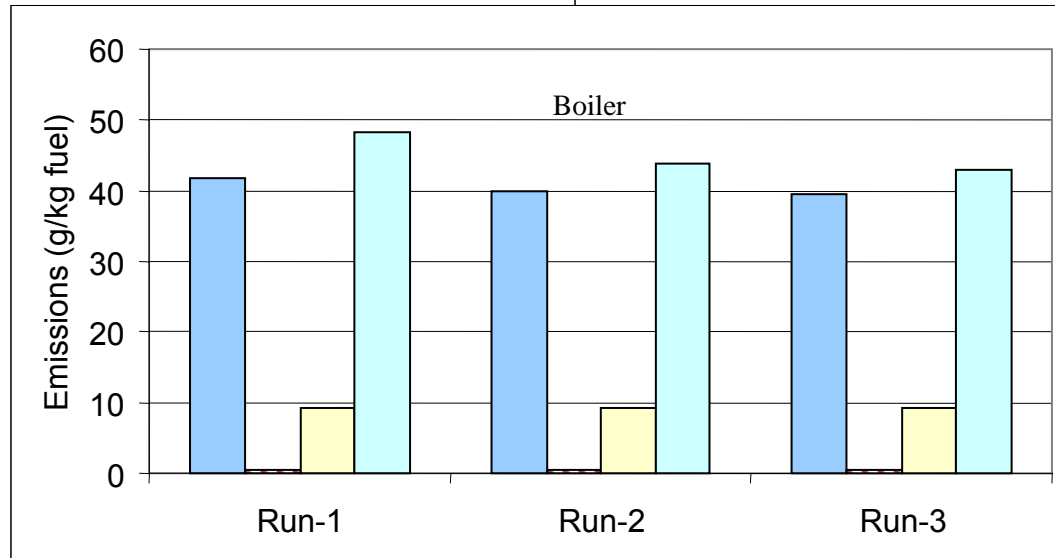
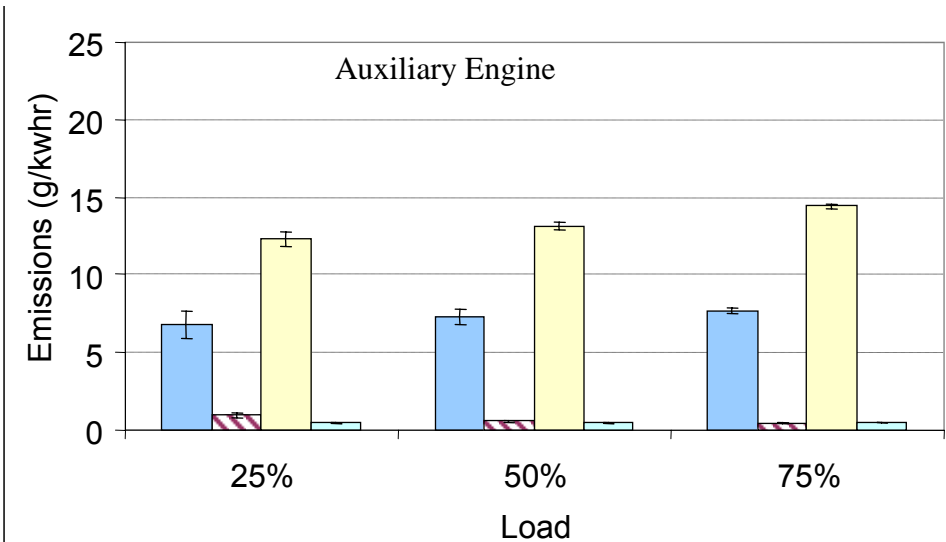
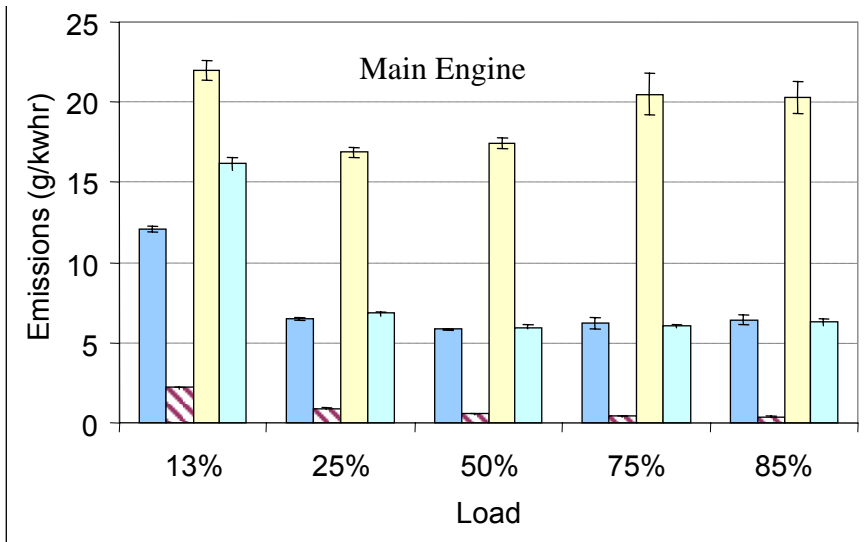




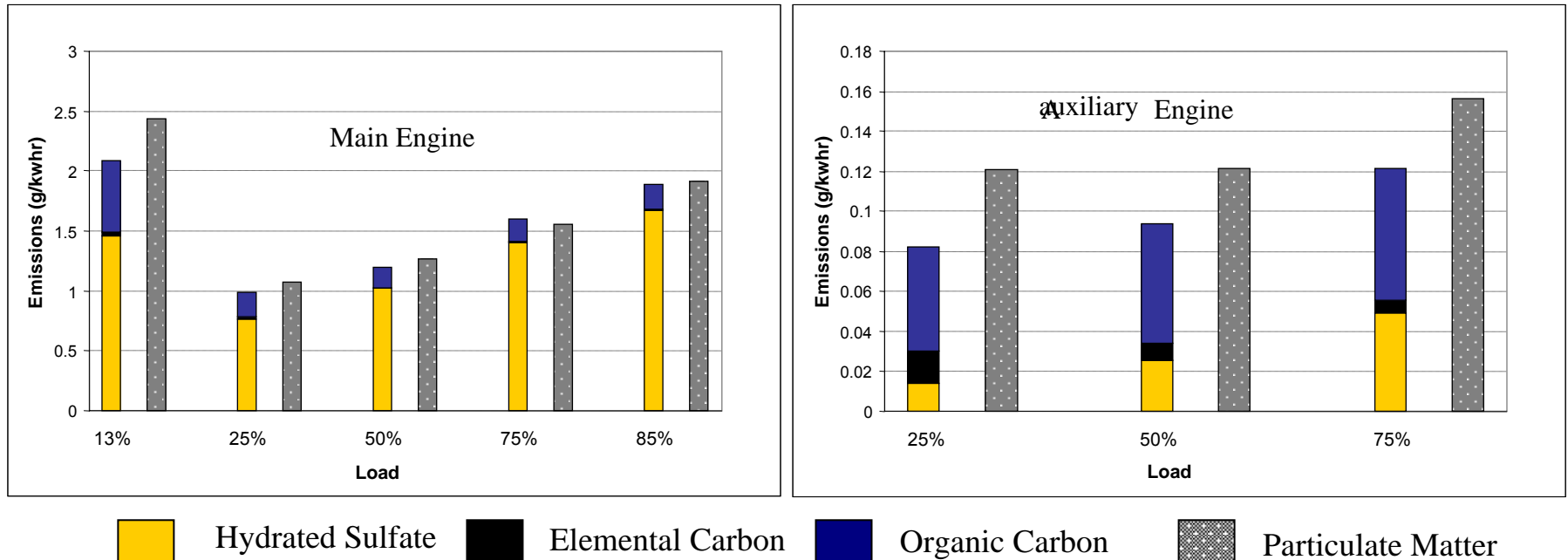
Example: Real Time Gas & PM Emissions for Main Engine



Example: Gaseous Emissions

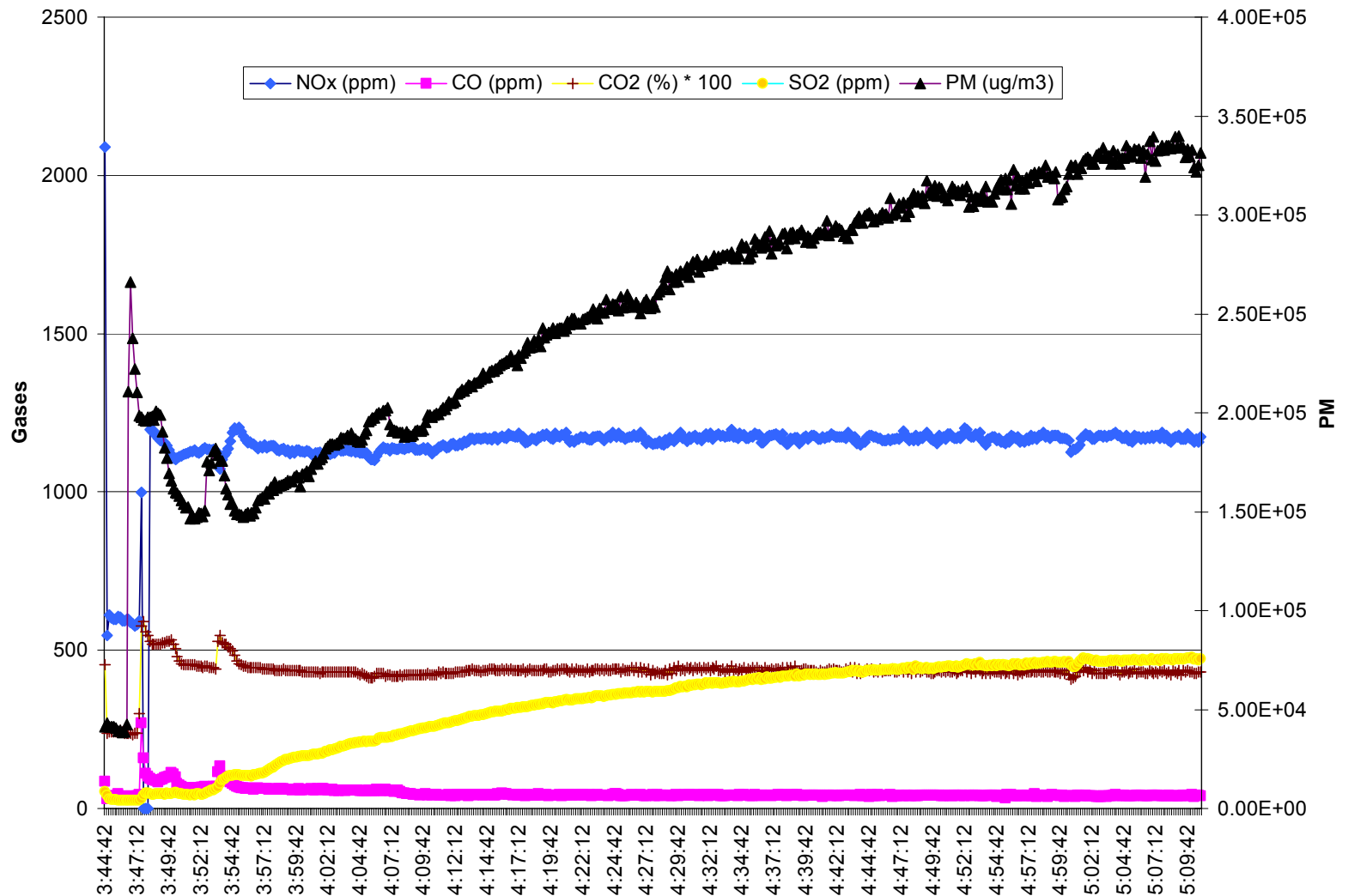


Example: PM Emissions & Fractions



- Hydrated sulfate (75%) + EC (5%) + OC (25%) \approx PM
- Sulfur from fuel to Sulfate Conversion
 - Main Engine : 1.4% to 5% as engine load increased from 25% to 75%
 - Auxiliary Engine : 1.9% to 3.9% as engine load increased from 25% to 85%

Example: Gas & PM Emissions on Going from Distillate to Heavy-fuel Oil



Summary

- Methods developed for measuring emissions on ships at sea
- Prior study showed switching from heavy-fuel oil to distillate fuel:
 - Lowered NO_x by 5 – 10%
 - Lowered PM up to 80% since primarily sulfate and related to fuel sulfur
 - There is a transition time to convert from one fuel to another.
- Current research will provide a measure of the benefits of switching to a cleaner burning fuel..