Navy Pilot Emission Control Prog. (NPECP)

Marine Diesel Engines

NAVSEA - Philadelphia

Lab Test Phase: Preliminary Results
Shipboard Evaluation Phase: Plans

California ARB
Maritime Air Quality Technical Working Group

10 Nov 04

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Oak Ridge National Laboratory

Overview

- Lab Test Objectives and Scope
- Lab Test Results
- Shipboard Evaluation Plans
- Summary

Navy Pilot Emission Control Prog. (NPECP)

Laboratory Test Phase

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Objectives

- Evaluate emission control cost effectiveness: legacy DDC 2-S engines
- Assess performance of 5 fuels and 5 technologies
- Investigate combination synergies
- Compare PM measurement methods
  - Gravimetric ↔ characterization

Background

➔ contribution to Navy mission

- Environmental quality core component of 21st Century Fleet
- Identify measurement tools to yield high quality Navy data
- Safeguard Navy's most valuable asset –sailors and their health
- Quantify conformity options

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Laboratory Test Phase

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Approach

- Broad partnership: industry & regulators
- ISO 8178 protocol, C1/D1/E5 cycles
- Performance
- Criteria emittents
- PM physical/chemical
- Aldehydes & organics

Accomplishments

- Completed all but one planned test
- Catastrophic engine failure brought lab test phase to early conclusion
- Test data reduction largely completed

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Laboratory Test and Shipboard Evaluation Phases

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Program funds/scope leveraging for NPECP

Fuels (sulfur / mono-arom. [wt%])
1. F-76 (0.47 / ~30) – baseline
2. B-20 (0.38 / ~24)
3. JP-5 (0.12 / ~17)
4. ULSD (0.004 / 28)
5. Fischer-Tropsch (0.003 / 10)

Technology Concepts
1. Std. configuration – baseline
2. Air humidification
3. Cylinder catalytic coating
4. In-cylinder EGR
5. Fuel combustion enhancement
6. Actively-regenerated PM filter

Constituent Pollutants
PM Analysis
1. Gravimetric msmt.
2. Characterization – phys. / chem.

Gaseous Toxics

DOE / MARAD Funded

Naval F/L IPT Funded

NAVSEA 05M Funded

In-Kind Contributions
NAVSEA – Phila.
Technology developers/providers
WVU
Navy shore fclt's } **field**
EPA } **verification**

CARB Funded
(also field verification)

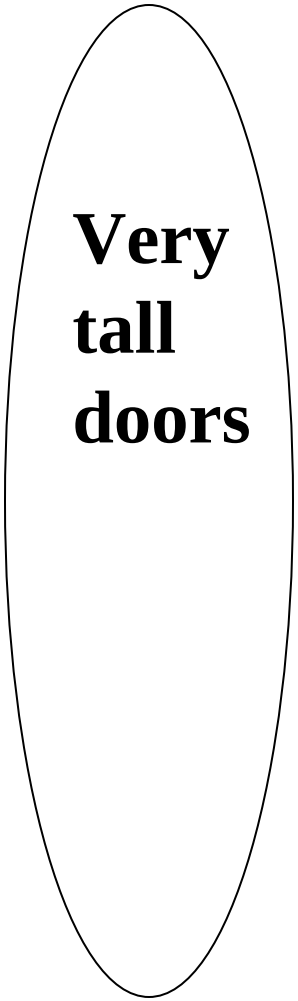
ONR Funded

ORNL Funded

NAVSEA Marine Diesel Engine Test Facility Lab

4,000 bhp medium-speed engine size capability

NAVSEA Marine Diesel Engine Test Facility



Exterior of 2 adjacent test cells

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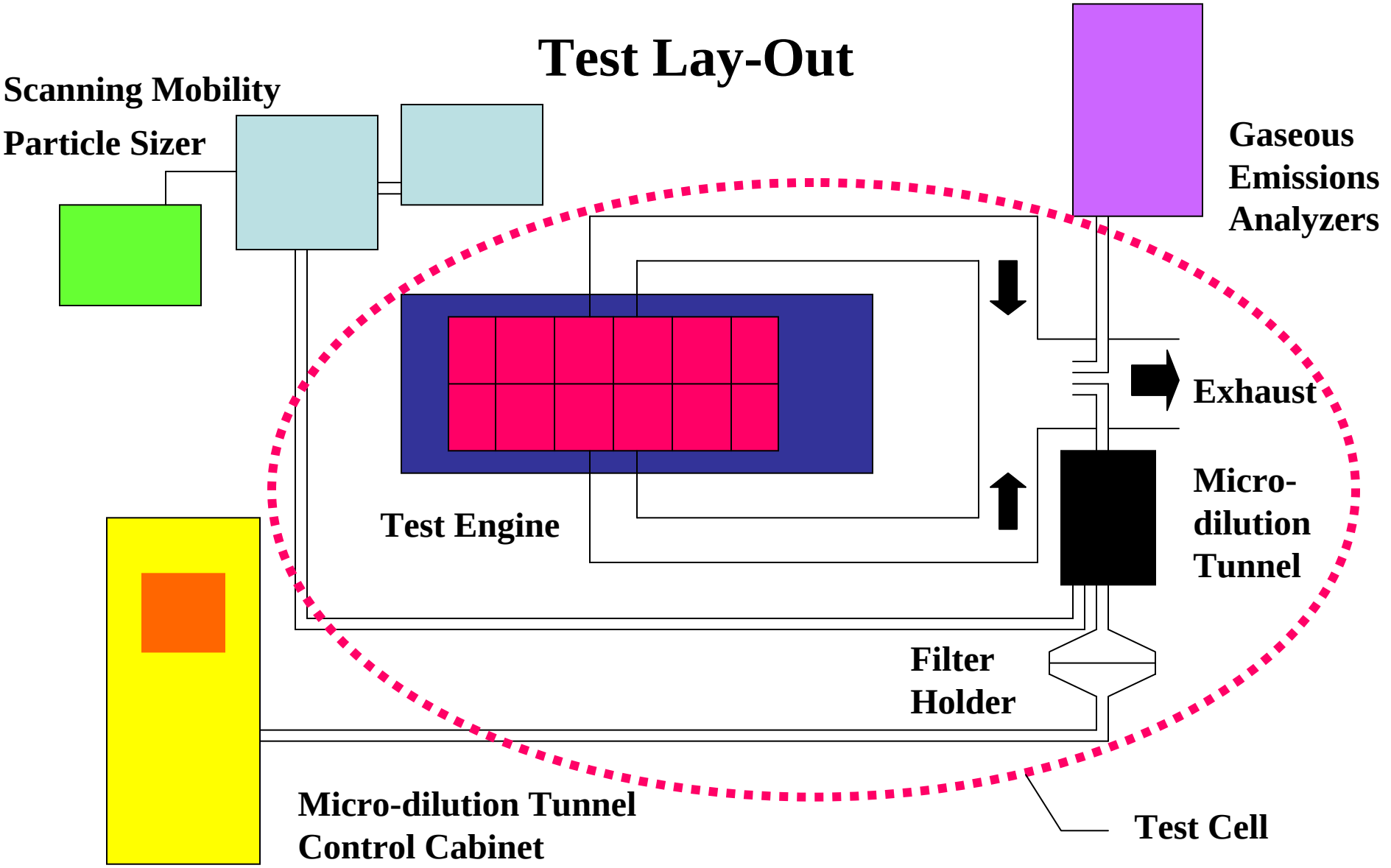

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Laboratory Test Phase

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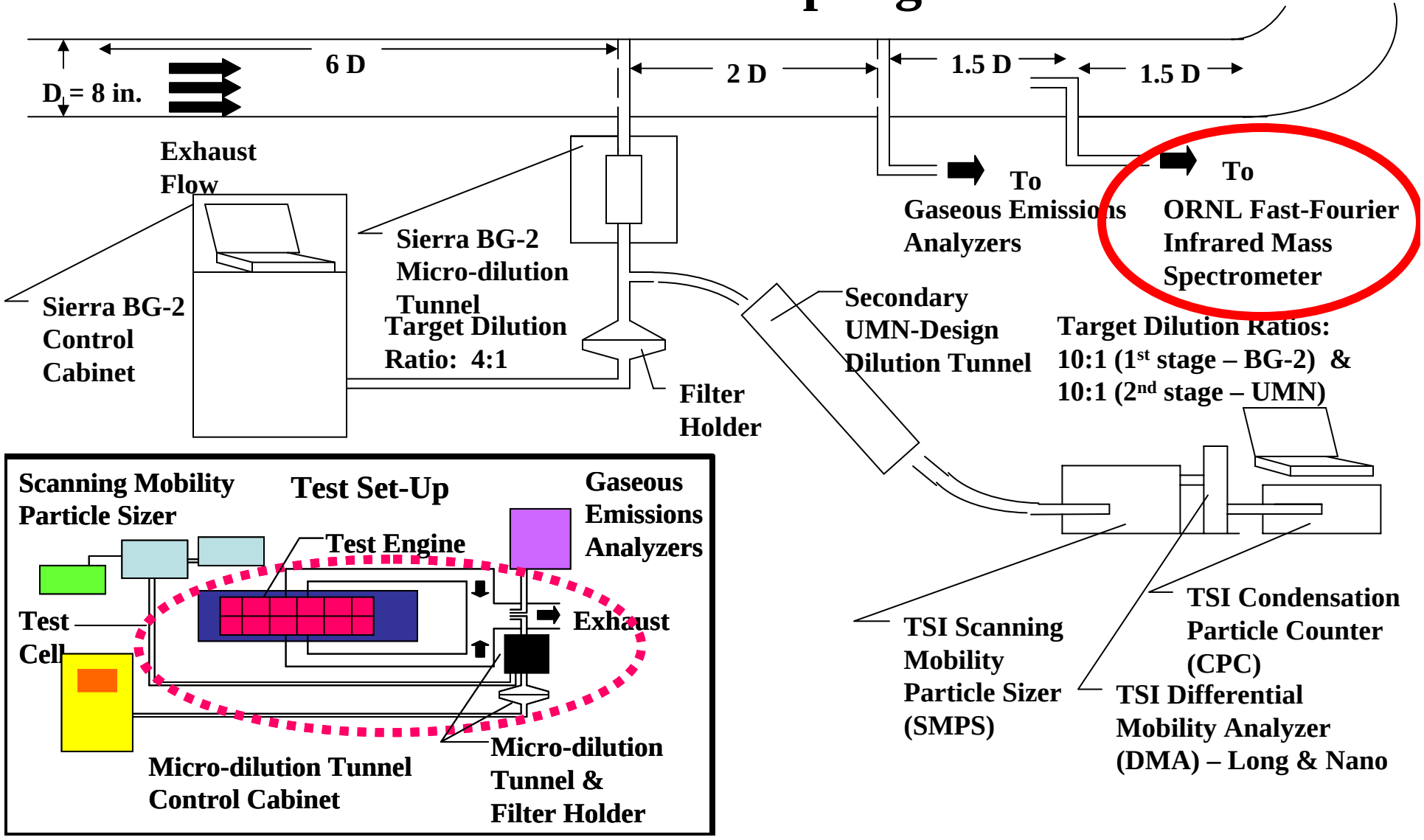
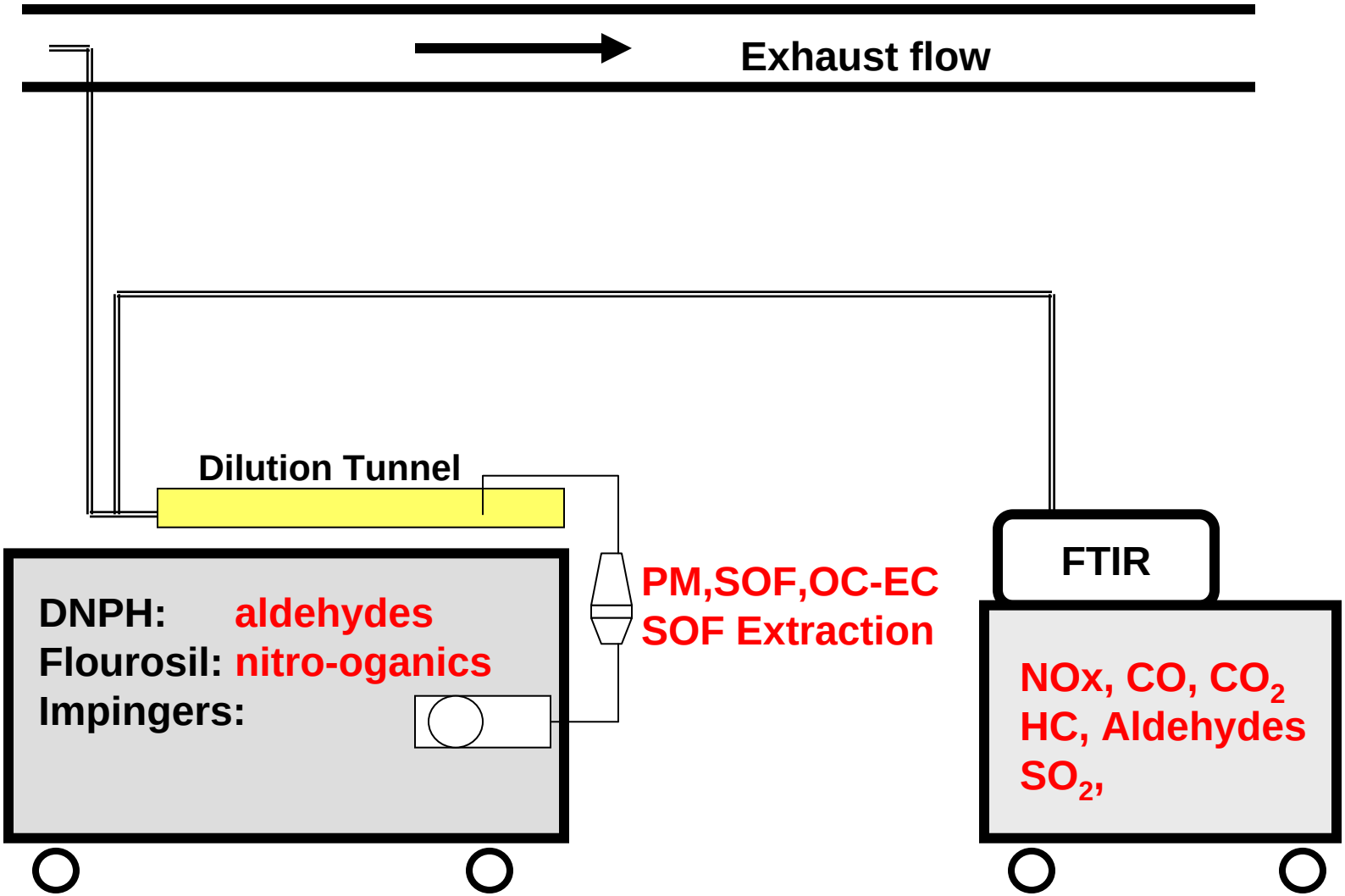
Exhaust Emissions Sampling Trains



ORNL Sampling Train and Analytical Tools



Navy Pilot Emission Control Prog. (NPECP)

Laboratory Test Phase

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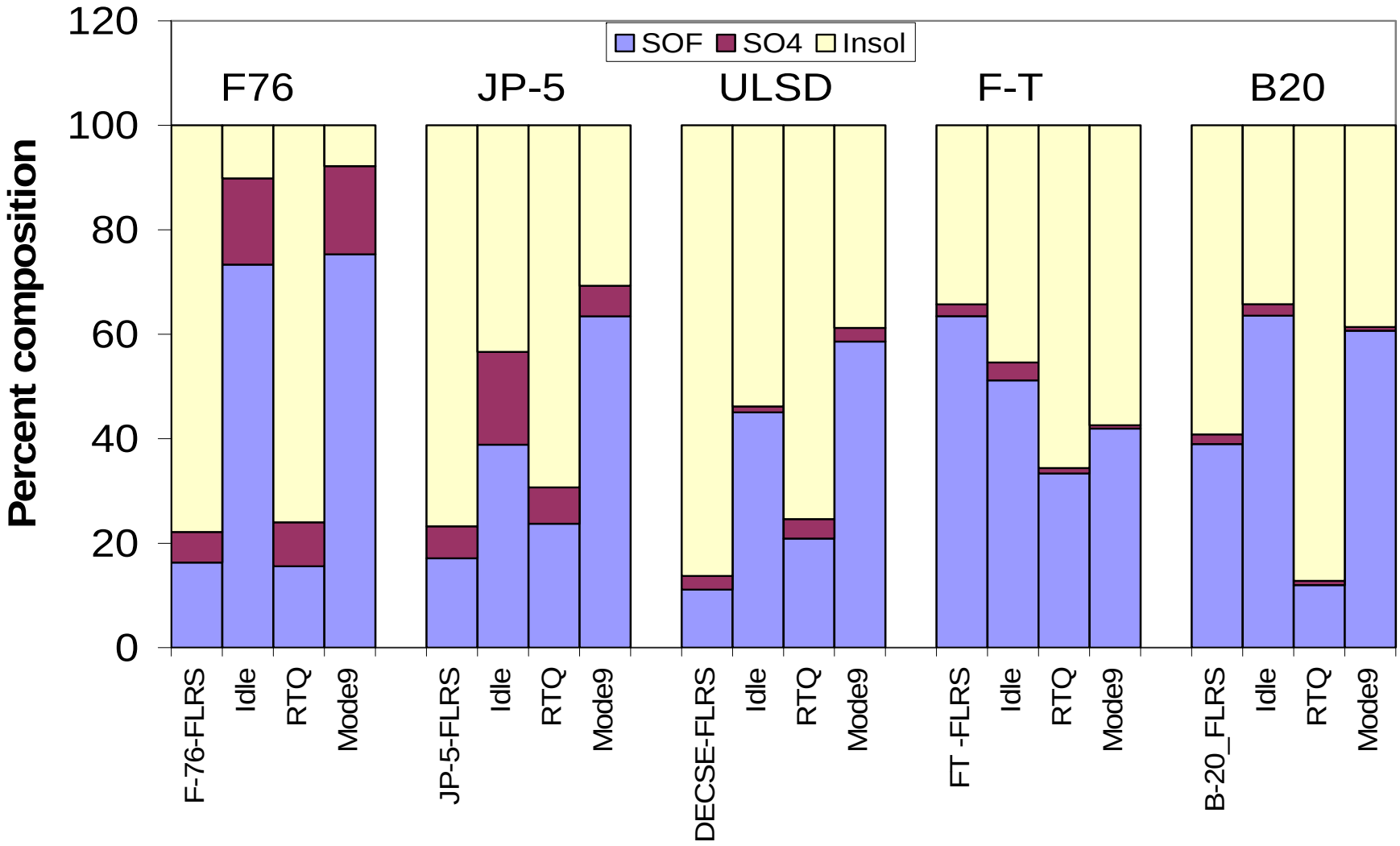
Soluble Organic Fraction Results for Collected PM



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Laboratory Test Phase

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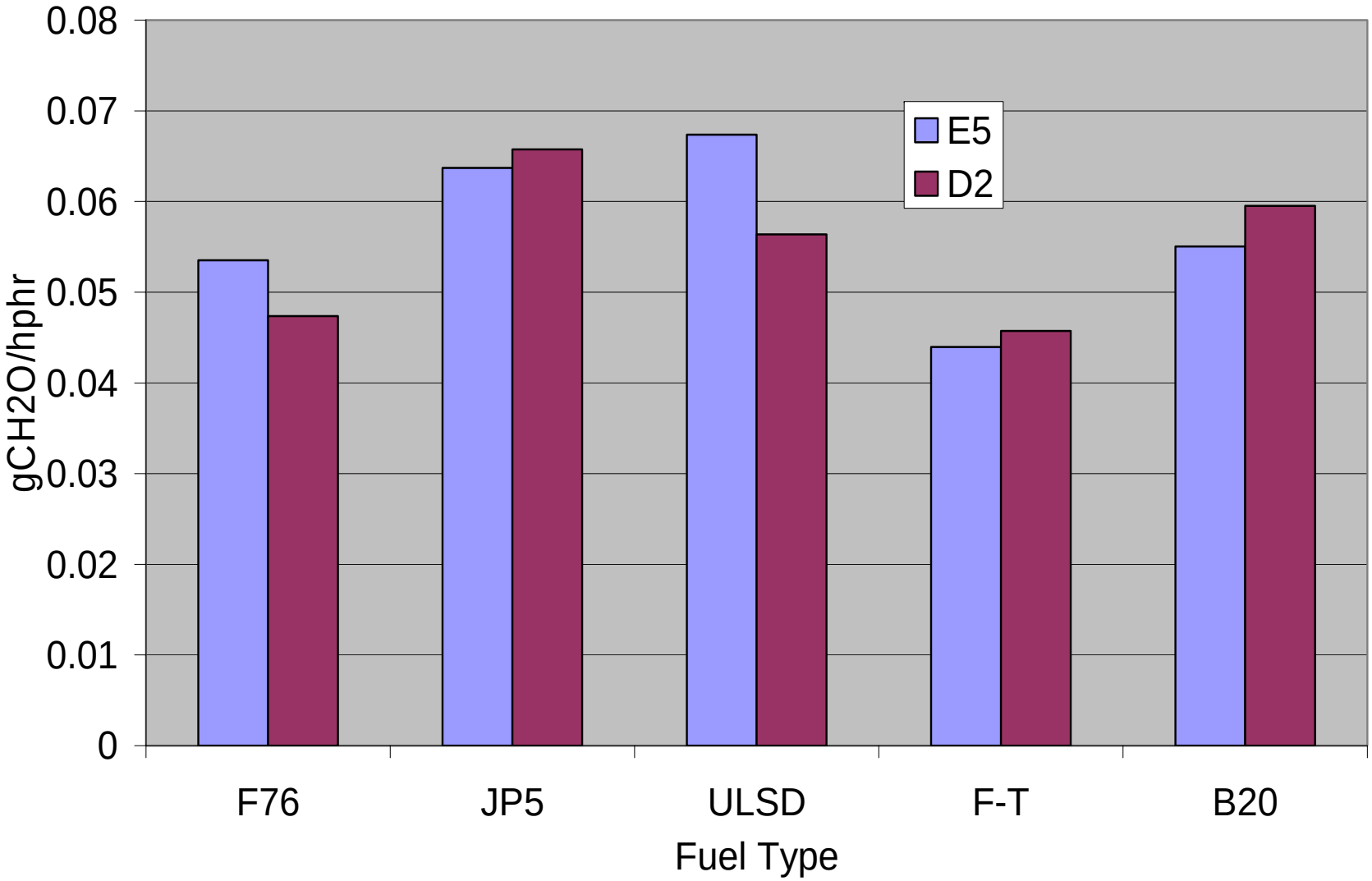
Brake Specific Formaldehyde Levels



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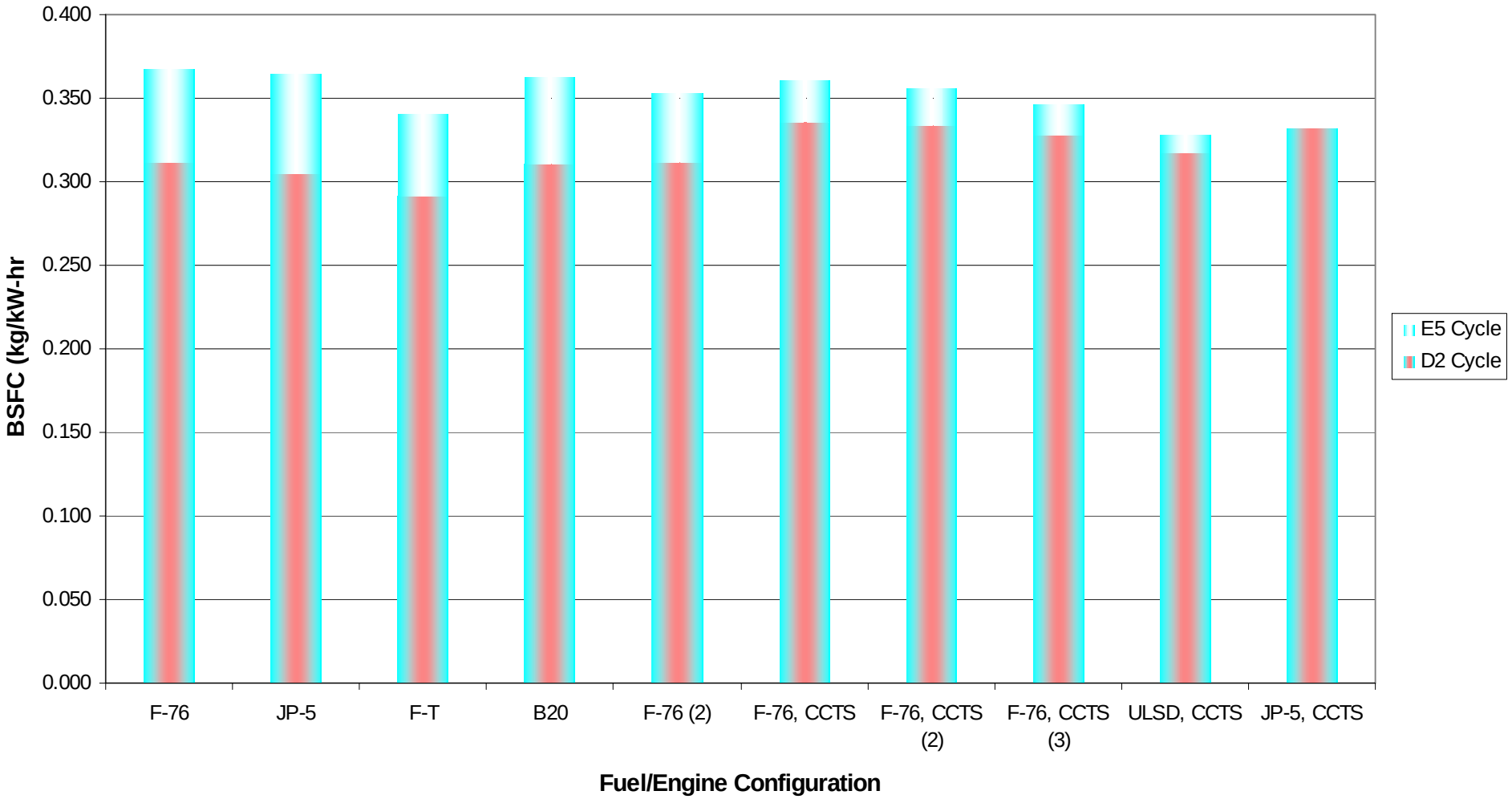
Brake Specific Fuel Consumption



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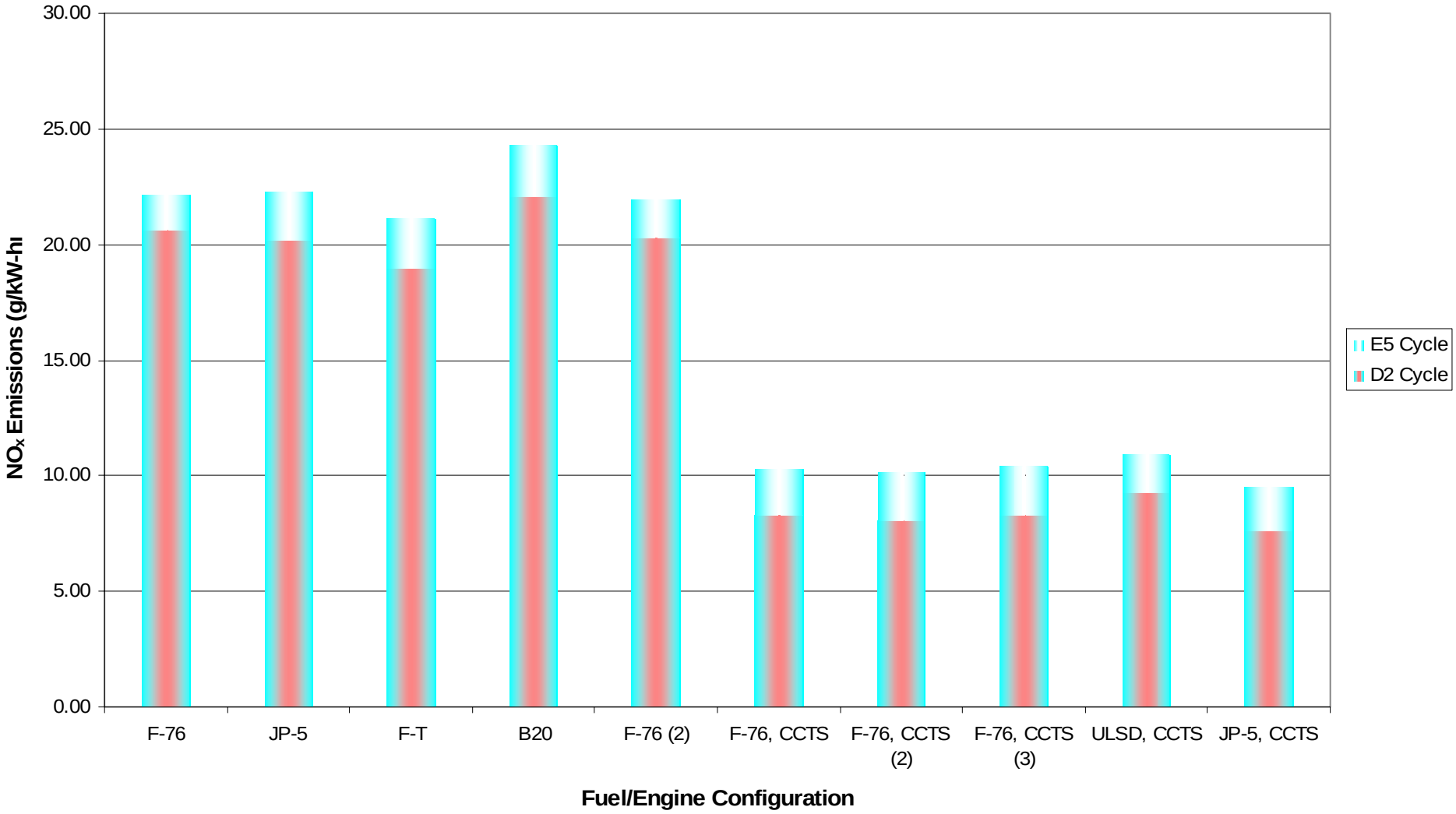
Brake Specific NOx Emissions



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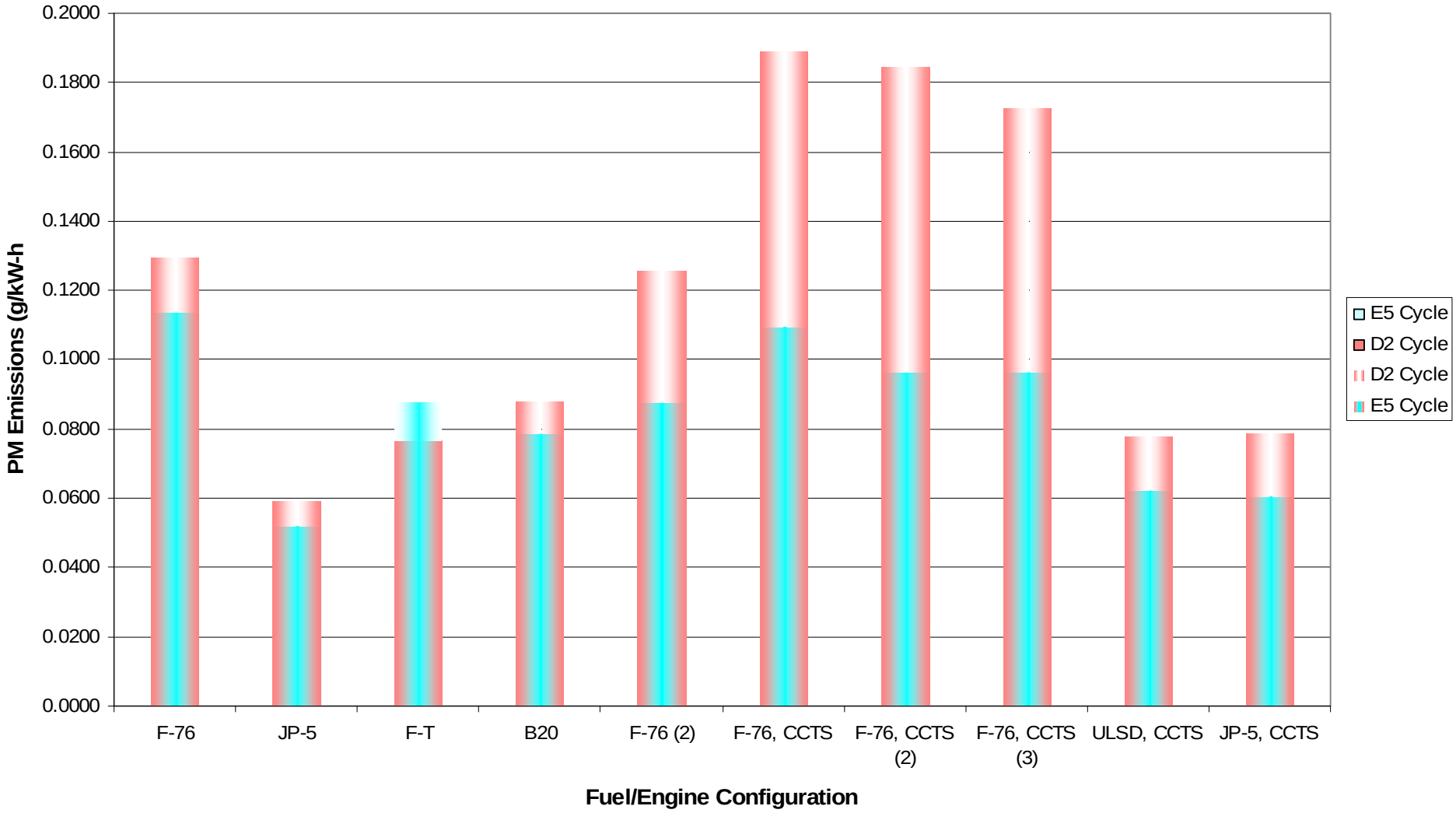
Brake Specific PM Emissions



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Laboratory Test Phase

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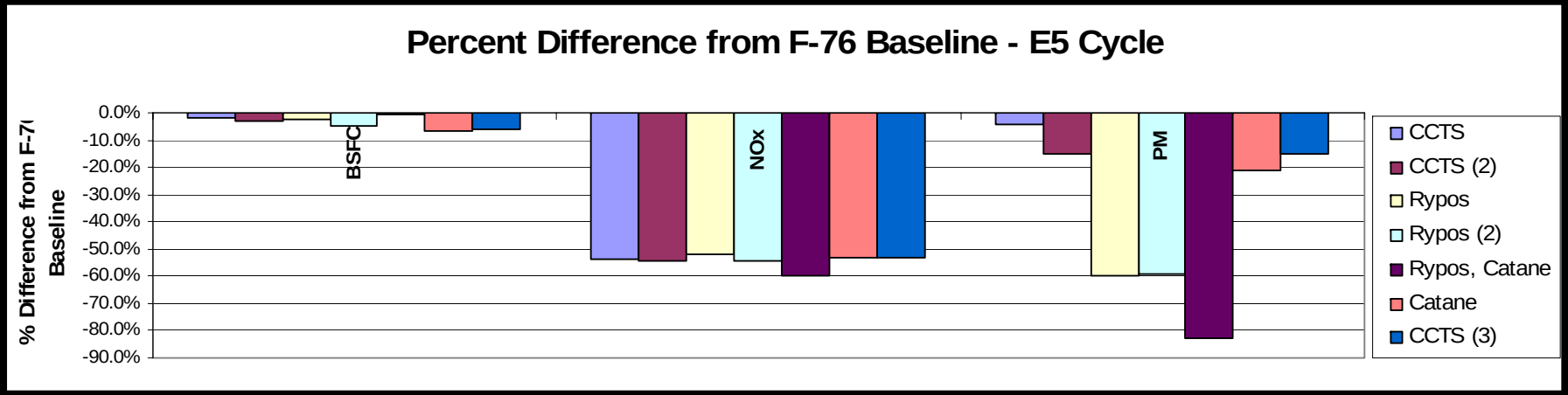
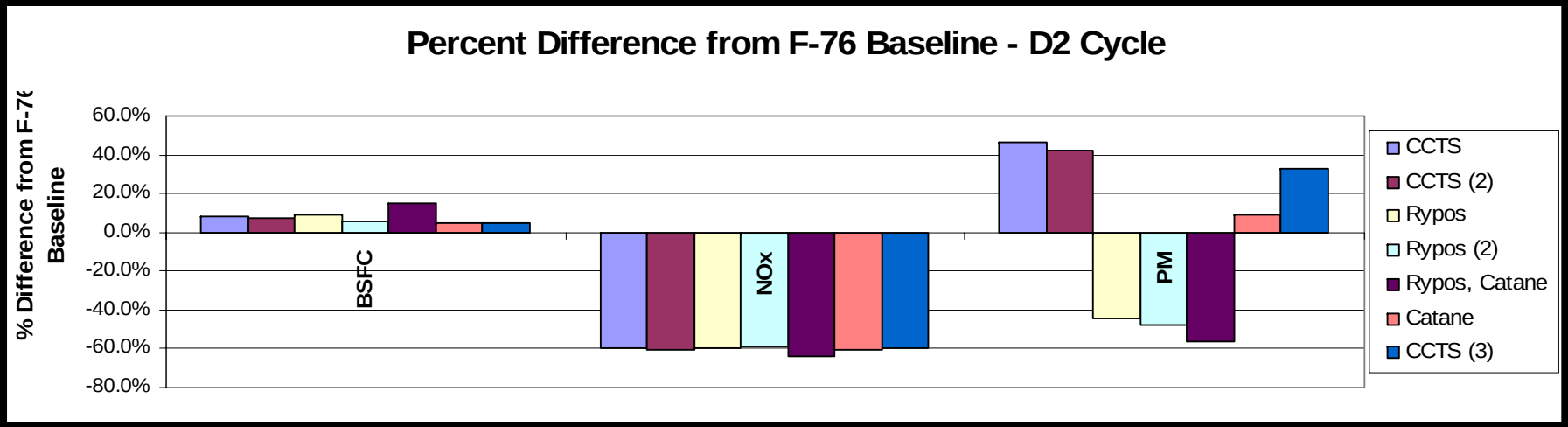
Comparison of Emission Control Technologies





Navy Pilot Emission Control Prog. (NPECP)

Shipboard Evaluation Phase

Suison Bay Ready Reserve Force (RRF) – San Francisco

Objectives

- Real world reliability and durability evaluation
- Assess performance of 1 low sulfur fuel and 1-2 technologies

Background

- Maritime Administration (MARAD) YSD self-propelled barge crane
- High operating hour installation
- Propulsion: twin DDC 12V-71N engines
- Representative marine work boat load profile
  25% idle, 25 % 30% load, and 50% 95% load

Navy Pilot Emission Control Prog. (NPECP)

Shipboard Evaluation Phase

Suison Bay Ready Reserve Force (RRF) – San Francisco

Approach

- Continued partnership: MARAD, tech. providers, ORNL, & navy
- Refurbish lab test engine for eval. engine
- Baseline port propulsion engine
- Switch out port engine w/ eval. engine
- Break in eval. engine
- Measure perf. and emis. of eval. engine
- Operate for 6-9 mo.
- Measure perf. and emis. degradation

Accomplishments

- Completed one failure analysis
- Engine ready to be shipped for teardown/analysis
- Initiated planning to coordinate

Summary

- For the DDC 12V-72, fuel substitution has mixed emissions results
- NOx Emissions
  - little change: JP-5, Fischer-Trospch
  - decrease: Ultra low Sulfur Diesel
  - increase: Biodiesel blend
- PM changes depend on load
- Formaldehyde increases with all but F-T