On The Road To Clear Skies ™

On-Road, In-Use Emissions Test Systems

Mobile Source Technical Review Subcommittee

February 13, 2002

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Why On-Vehicle Testing?

- Despite FTP compliance, air quality goals are not being achieved
- On-road, real-world emissions can be much higher than under FTP test conditions
- Basis for Consent Decree (a major $1.1B penalty for HDE manufacturers)
- On-vehicle testing is US EPA's stated direction for SET and compliance

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Benefits of On-Vehicle Testing

Validation that:

1. **OEMs' OBD II strategies are working to detect excess emissions**
2. **New vehicle fleets are in compliance**
3. **Aging vehicle fleets remain in compliance**
4. **Vehicles will meet NTE limits**
5. **Defeat devices/strategies are not used**

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Benefits of On-Vehicle Testing

6. Calibration of Remote Emission Analyzers
7. Vehicles operating with alternative fuels are in compliance
8. Determine the effectiveness of exhaust after-treatment devices

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Benefits of On-Vehicle Testing

Assisting with:

9. Testing vehicles beyond dynamometer capabilities
10. Detecting and solving driveability problems
11. Developing ECM function, control strategies and calibration
12. Developing realistic mobile source emission models

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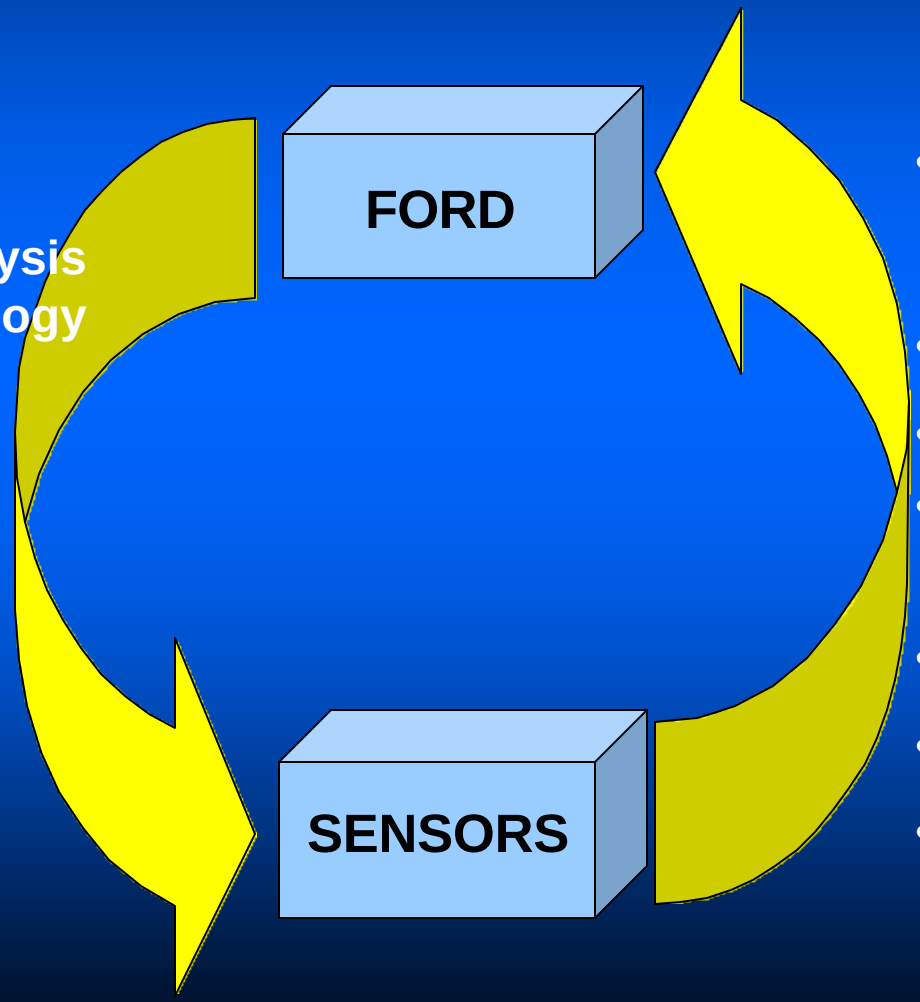
FORD – SENSORS
Three Year Partnership

- Technical Expertise
  - Emissions Analysis
  - Vehicle Technology
- Test Cells
- Dynamometers
- Proprietary Technology
- System Purchases



- Technical Expertise
  Emissions Analysis
  Systems Design
- PREVIEW Hardware
- PREVIEW Software
- Proprietary Technology
- Manufacturing
- Service
- Support

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FORD PREVIEW

- NDIR measurement of HC, CO, CO_2
- UV measurement of NO
- "Wet" exhaust sampling system
- Exhaust flow rates calculated from vehicle interface data

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FORD PREVIEW

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SEMTECH-G:

- **FID measurement of THC**
- **NDIR measurements of CO, CO_2**
- **NDUV measurement of NO**
- **Exhaust flow rates calculated from vehicle interface data or from an ancillary flowmeter**

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SEMTECH-G

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2001 EPA Study

- SEMTECH-G used to measure mass emissions on 18 Ford, GM, Chrysler vehicles.
- Real world, in-use testing by owners.
- Automated data collection at key-on.
- Full FTP correlation testing at EPA labs for each vehicle.

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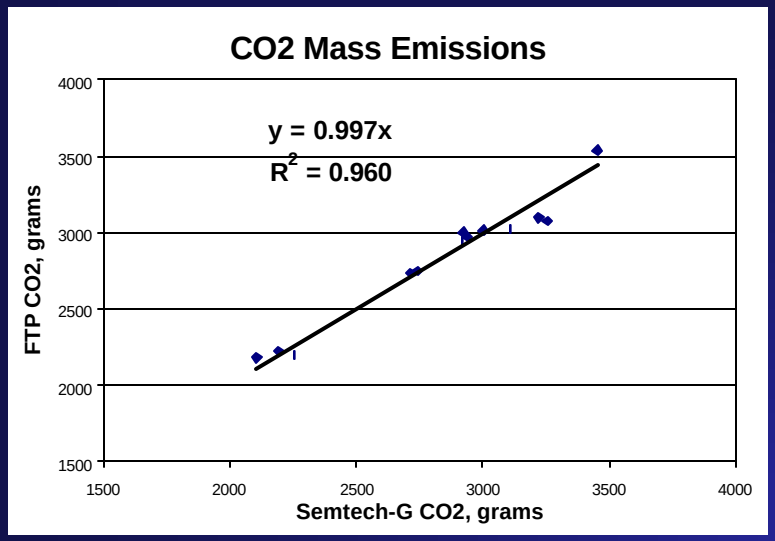
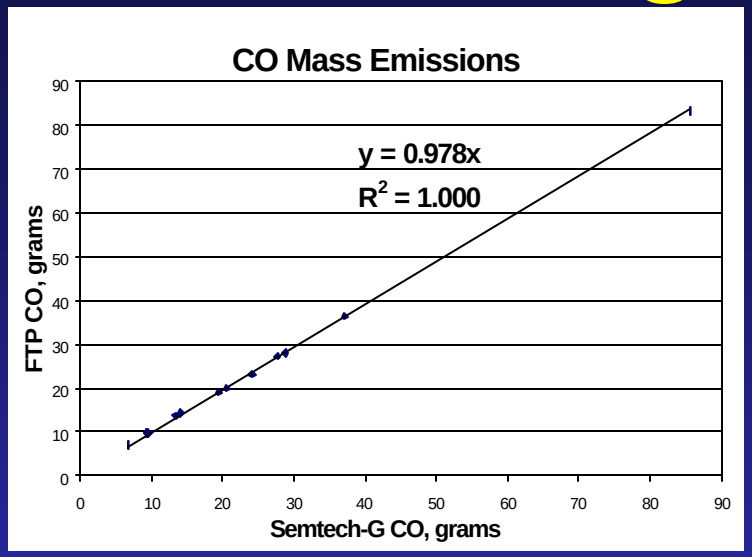
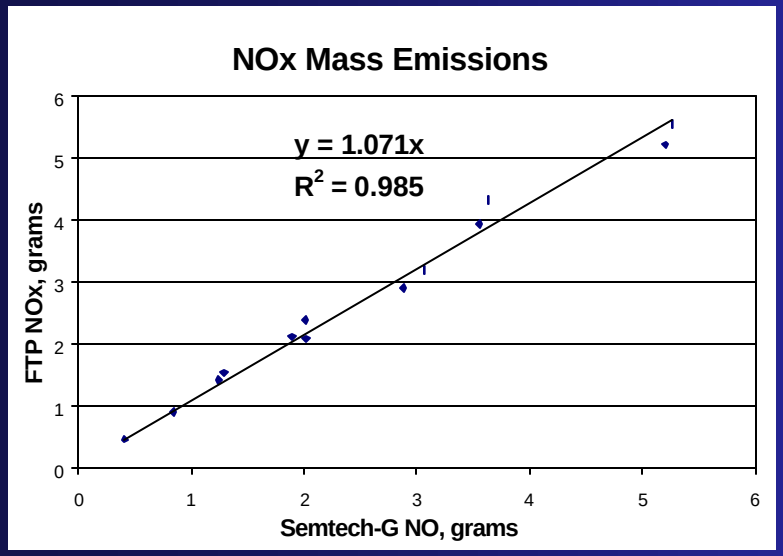
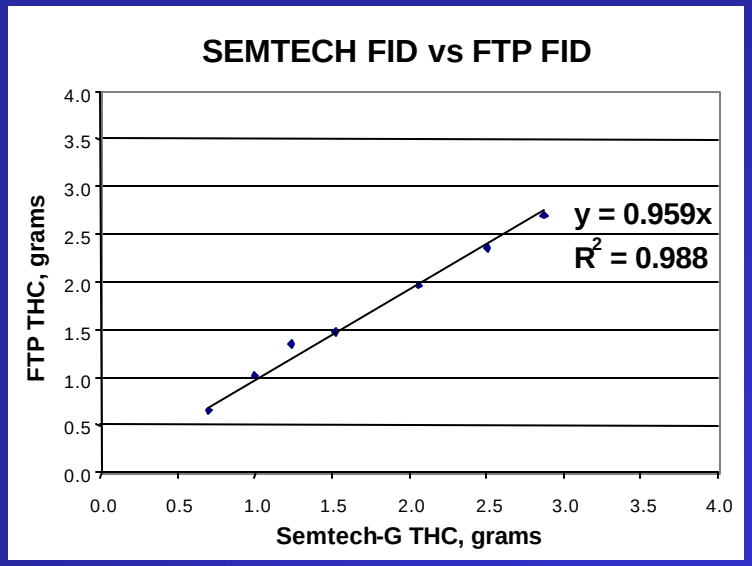
Results of EPA FTP Testing



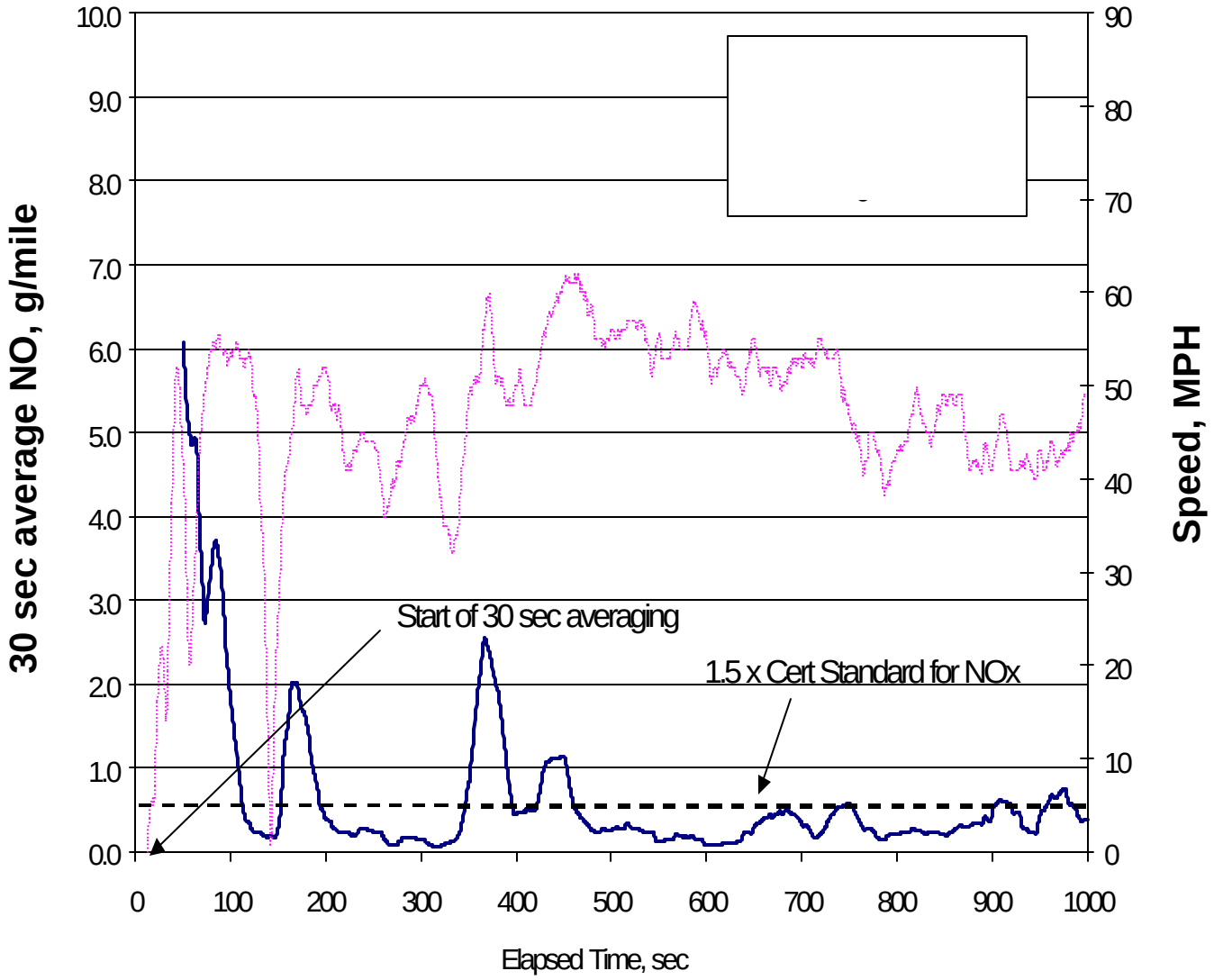






EPA IN-USE STUDY OF AUTOS USING SE M T E C H -G

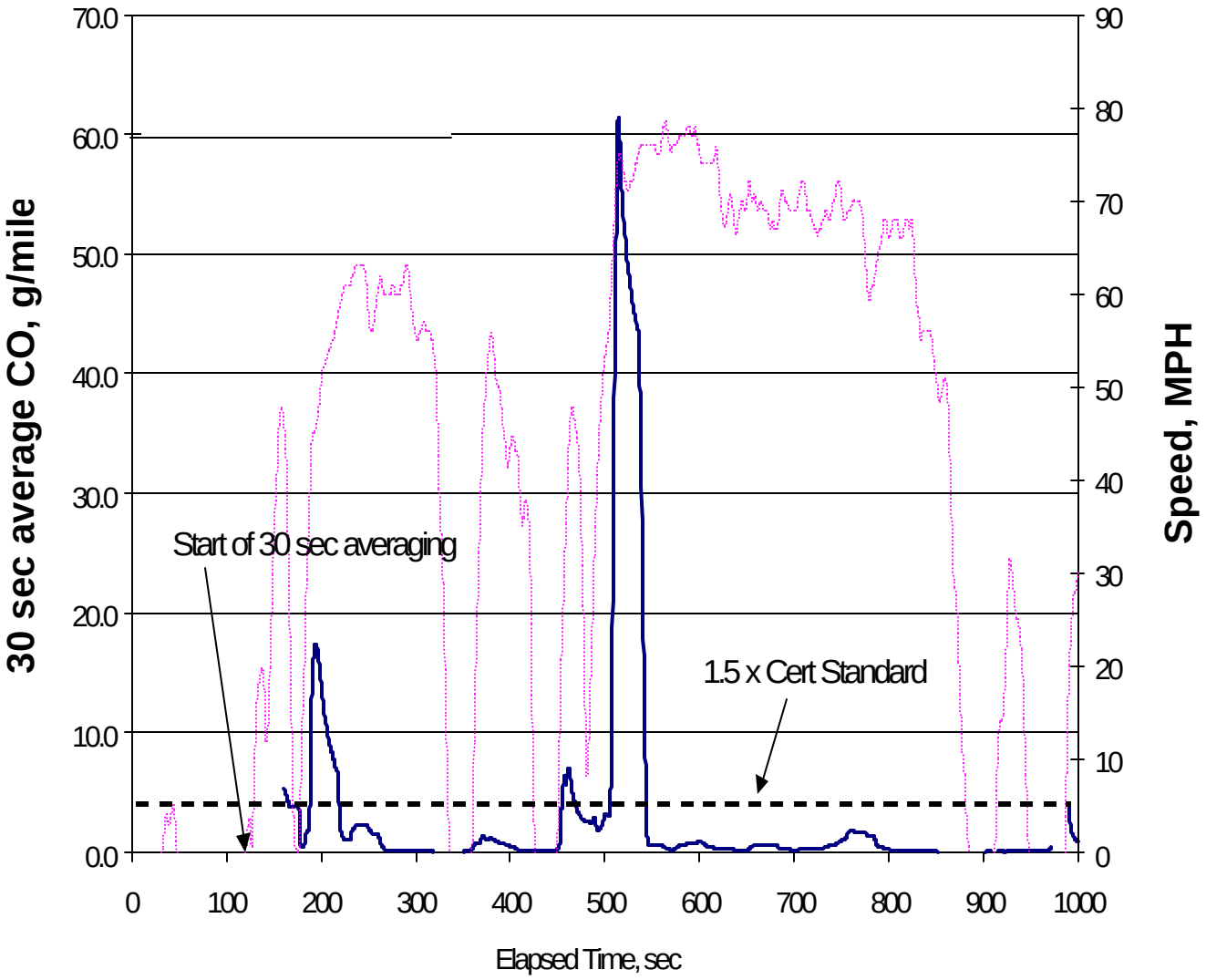
- '97 Tier 1 Passenger car passed FTP testing at EPA
- Repeatedly exceeded 1.5x NOx standard during 30-second window during on-road testing.



EPA IN-USE STUDY OF AUTOS USING SE M T E C H -G

- 2000 Domestic LEV Passenger Car tested at EPA:
  - FTP CO: 0.7 g/mi
  - Cert Std: 3.4 g/mi

- 30 second avg CO g/mi exceeded 1.5 x cert std on several occasions.



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ON-ROAD, IN-USE DIESEL VEHICLE EMISSIONS ANALYZER

SEMTECH-D

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SEMTECH-D

(DIESEL VEHICLE ANALYZER)

Technologies employed:

- HC: Heated FID (200°C)
- CO: NDIR (35°C)
- CO_2: NDIR (35°C)
- NO: NDUV (60°C)
- NO_2: NDUV (60°C)
- CPU: AMD 586
- Vehicle ECM Interface(s)
- Wireless Communications
- GPS

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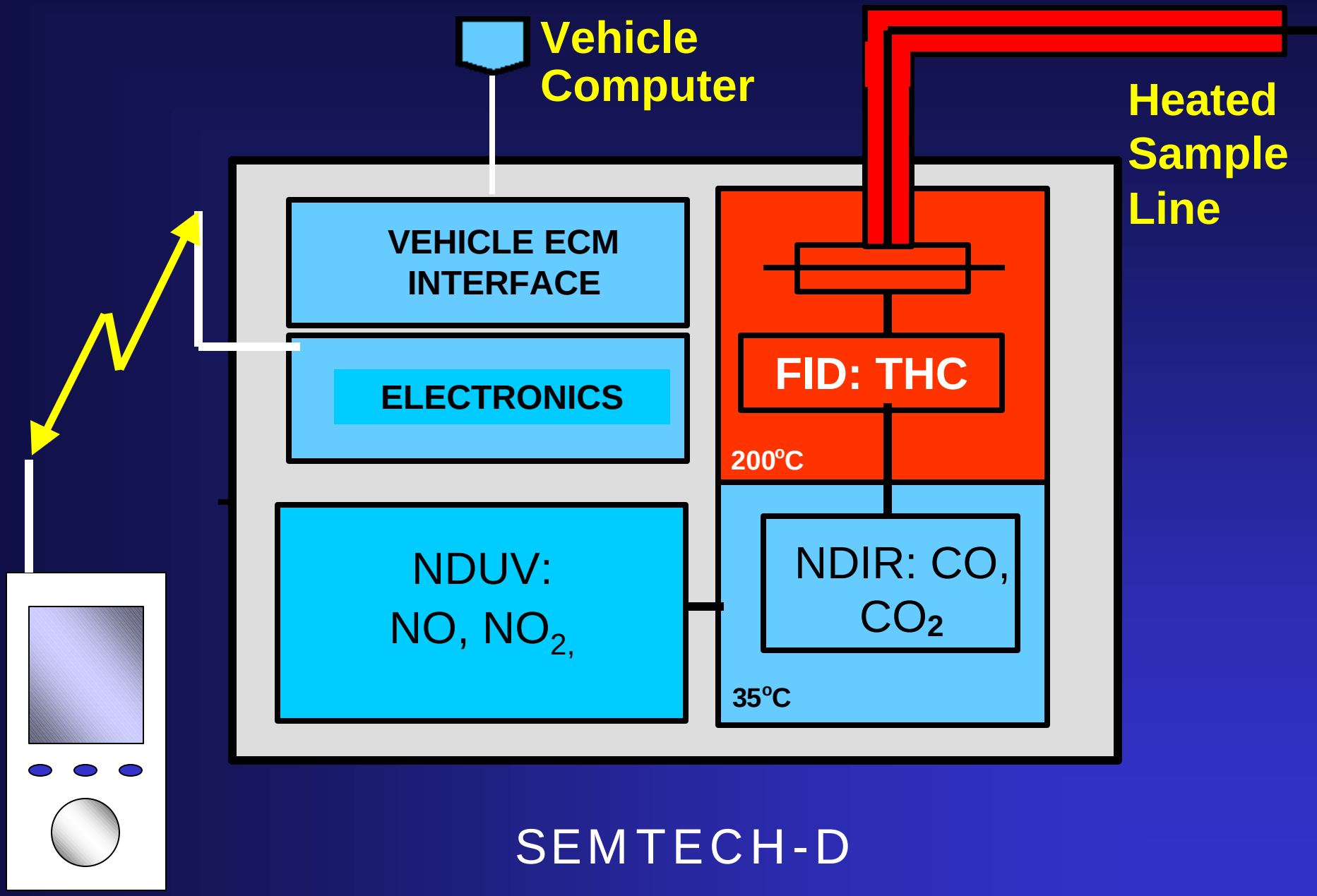
Vehicle Computer
Heated Sample Line
VEHICLE ECM INTERFACE
ELECTRONICS
FID: THC
200°C
NDUV: NO, NO2,
NDIR: CO, CO2
35°C

SEMTECH-D

SEMTECH-D Data Display

File Help

Pause | Stop | Play | Timestamp: 9:07:10 AM | File: C:\EPA 12-3 Demo\11_c_test4b.csv

Instantaneous Results:

Data name	Value	Units
ENVIRONMENT:		
Ambient Temp.	22	deg C
Ambient Pres.	972	mbar
Relative Humidity	24	%
Humidity	29	grains/(lb air)
Grade	4.5	%
VEHICLE DATA:		
Engine Speed	1107	RPM
Vehicle Speed	29.7	MPH
Engine Load	72.8	%
Throttle Position	6	%
Fuel Rate	0.001608	gal/s
Fuel Mass Flowrate	4.939	g/sec
Fuel Economy	5.13	mpg
Oil Temp.	152	deg F
Oil Pres.	300.2	kPa
Coolent Temp.	148	deg F
Barometric Pres.	99.1	kPa
RESULTS:		
Exhaust Flow	134.42	SCFM
Torque	588	lbf-ft
Brake Horsepower	123.96	bhp
Avg Fuel Economy	7.17	mpg
NOx Correction Factor	0.806	
CO2	7.9643	%
CO	0.024	%
THC	21	PPM
NO	1466	PPM
NO2	30.8	PPM
O2	11.1765	%
Mass CO2	15.641	gps
Mass CO	0.02999	gps
Mass NOx	0.30865	gps
Corrected Mass NOx	0.24877	gps
Mass HC	0.0013	gps

NTE Zone Results:

Data name	g/sec	avg. g/BHp-hr
NTE HC	0.0013	0.052
NTE NOx Cor...	0.249	5.88
NTE NOx	0.309	7.33
NTE CO	0.030	1.48
NTE CO2	15.6	403.9

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SEMTECH-D

Data Display

NTE Zone Status: IN OUT

NTE Zone Duration: 16 seconds

Longest NTE Zone Duration: 57 seconds

DeLorme Topo USA 3.0 - Great Lakes and Plains Region - MapFolio1

HELP

DELORME Topo USA

Zoom Level: 13-0

0° (N)

Latitude N42° 17.942'

Longitude W83° 52.955'

Elevation: 905 feet

Find | Print | MapFolio | Draw | GPS | Navigate | Profile | 3-D | Prefs | NetLink

Settings | Status | GPS Log

Speed: MPH 29

Heading: T 358

Latitude N42° 17.0488'

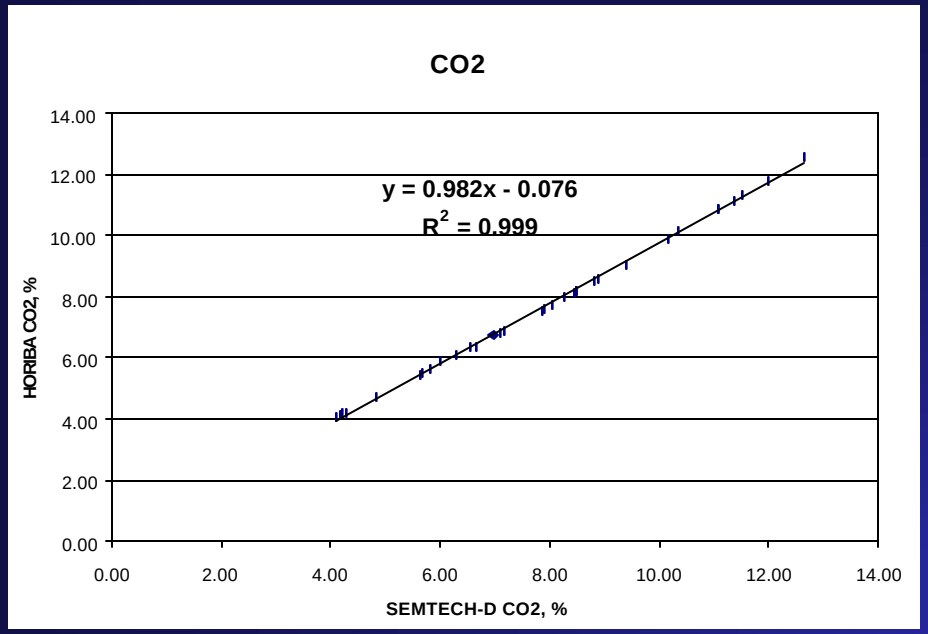
Longitude W83° 46.8238'

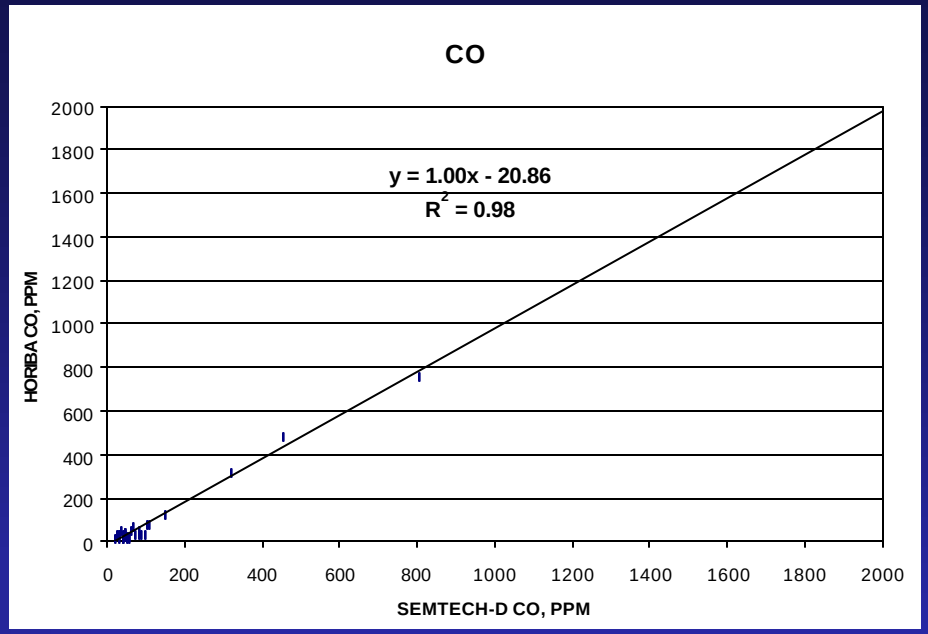
Elevation 948.16 feet

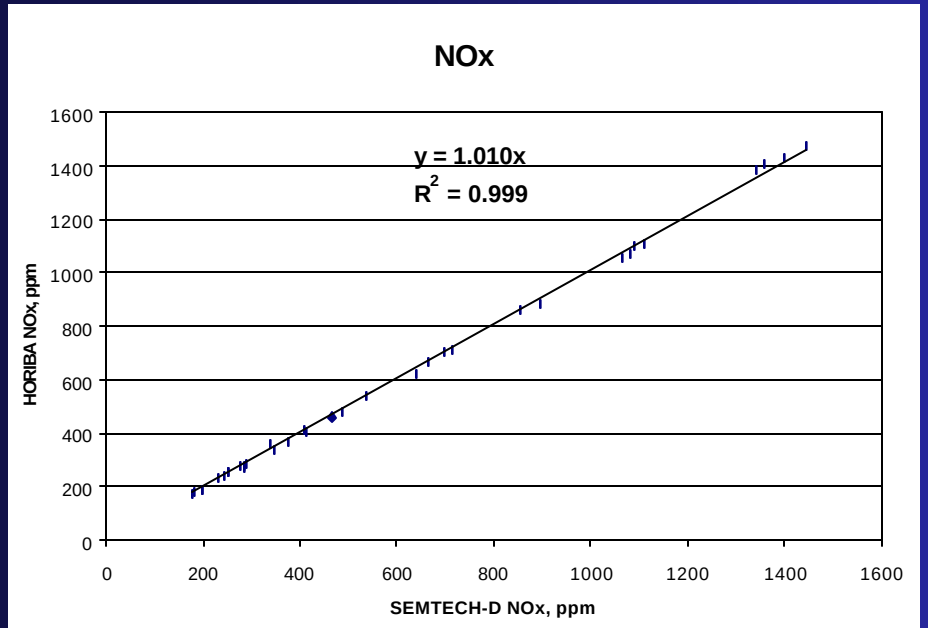
3-D

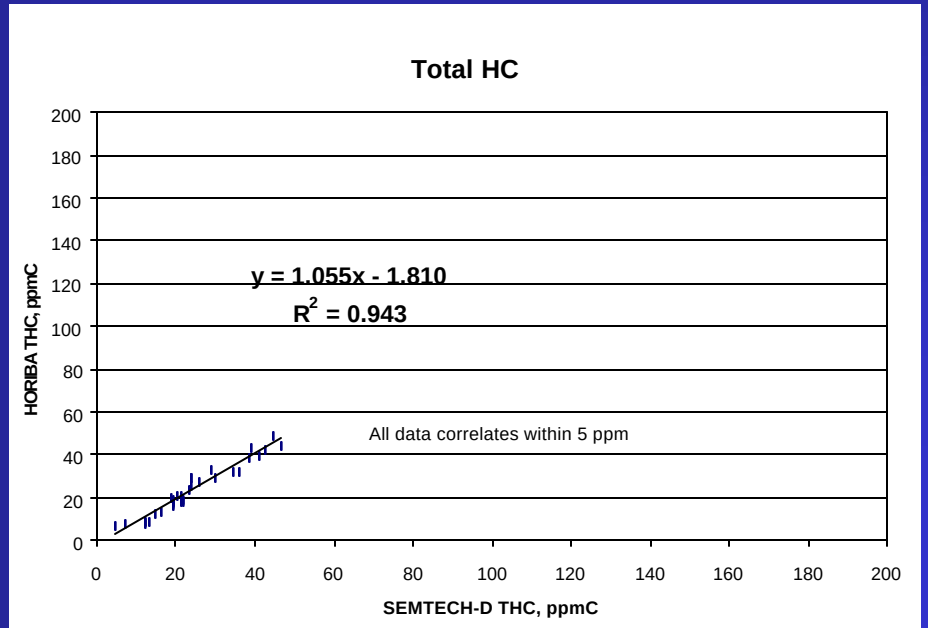
Satellite Info

Steady State Correlation

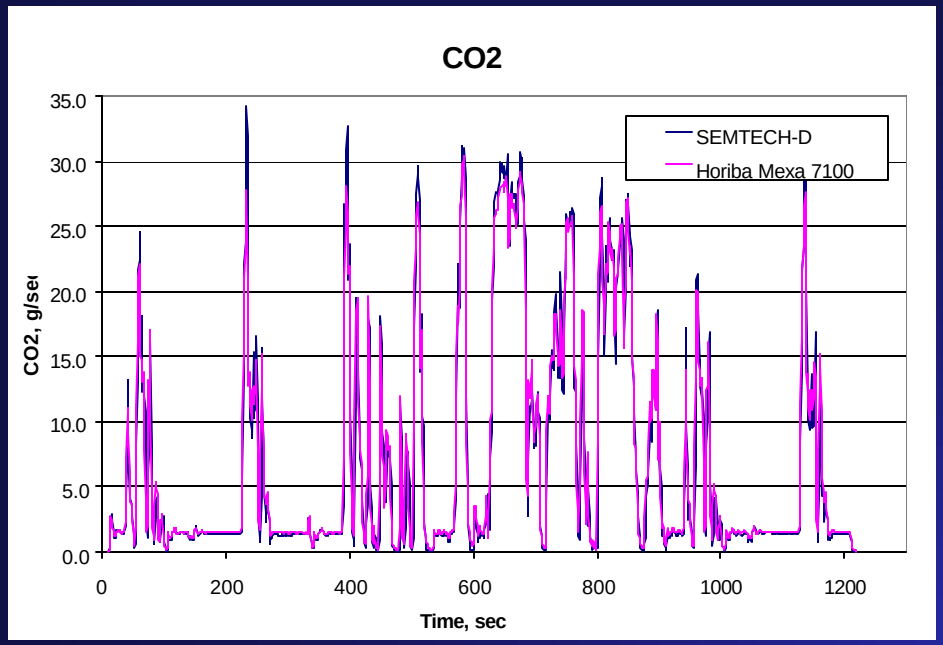


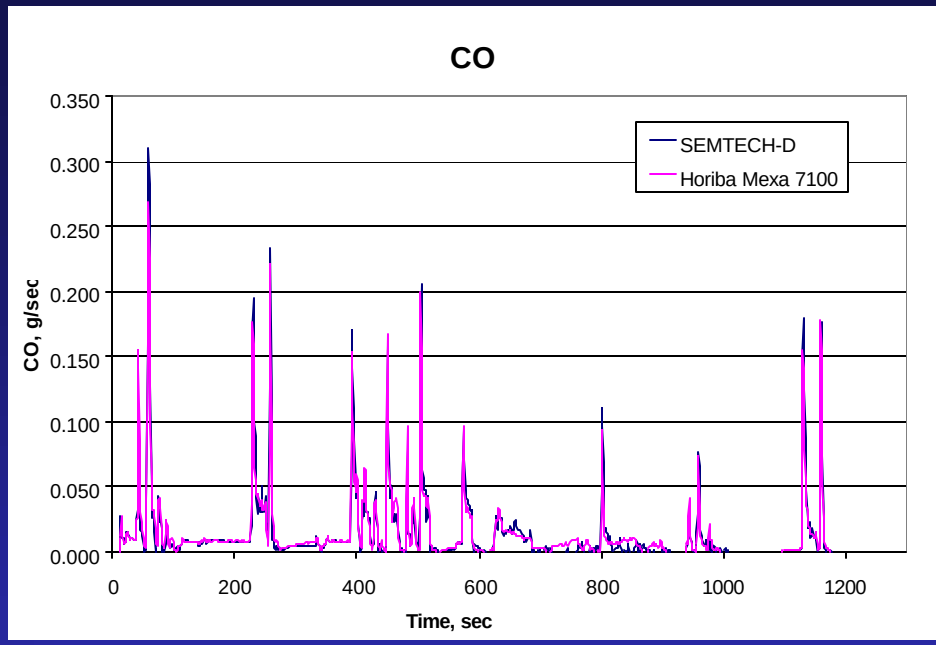


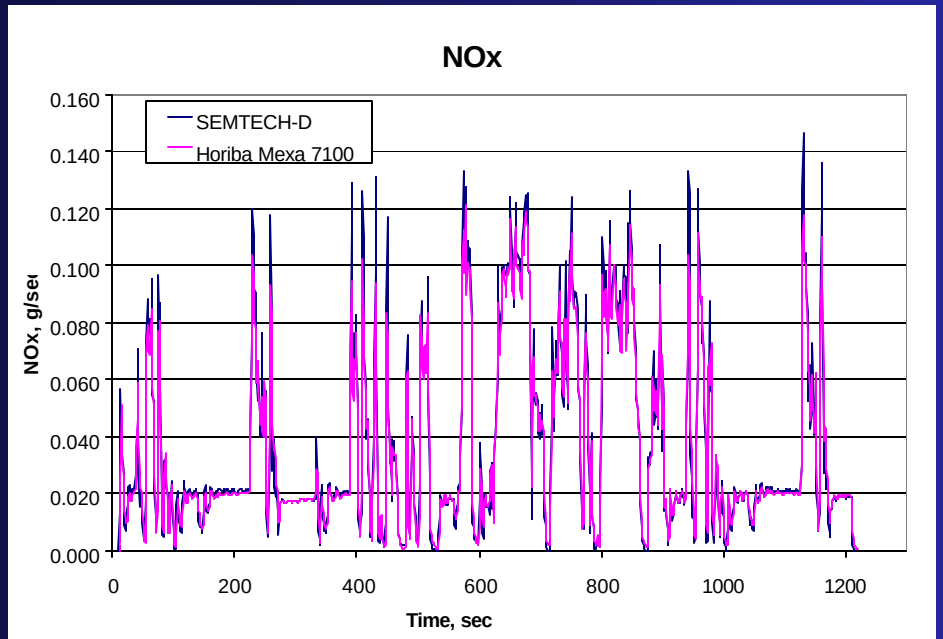


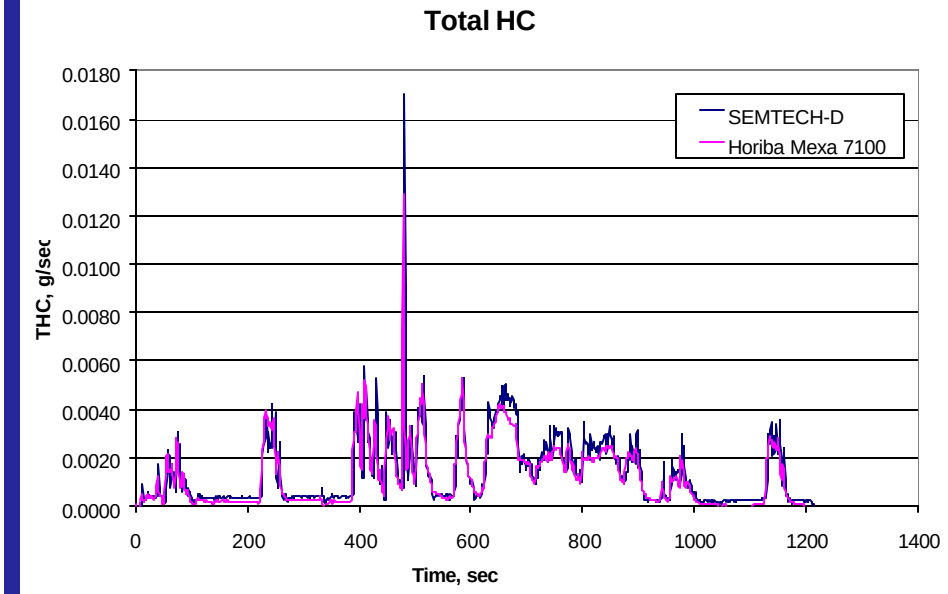


Transient Mass Correlation

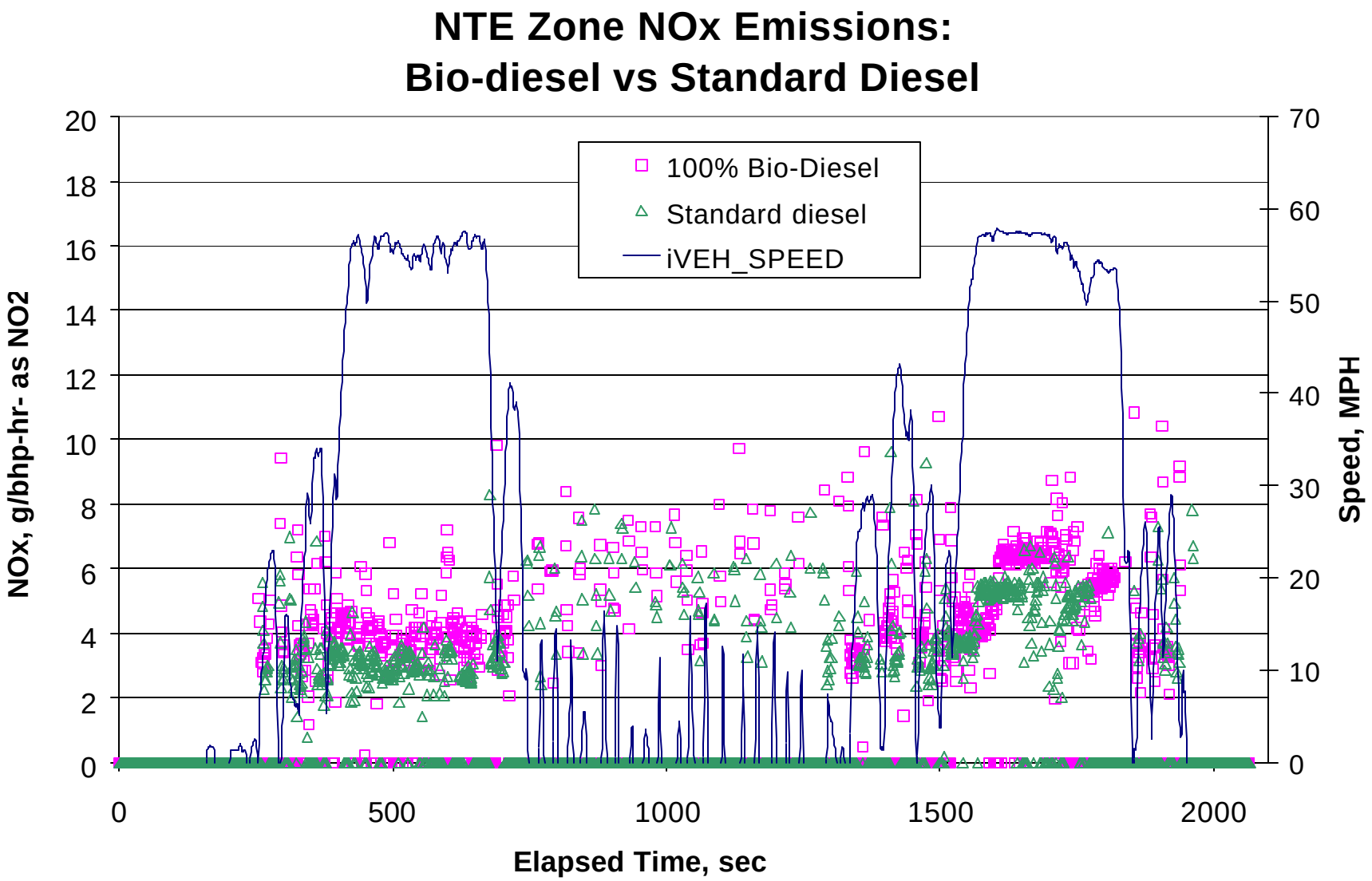








CARB On-Road Evaluation of Alternate Fuels Vehicle deploying SEMTECH D



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ON-VEHICLE

SEMTECH-D

STATIONARY

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Other Applications for On-Vehicle Testing Systems

- Low cost alternative to certification grade analytical systems for:
  - End of production line test
  - Comparative studies of aftertreatment devices
  - Engine “screening” in test cells

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New Technologies

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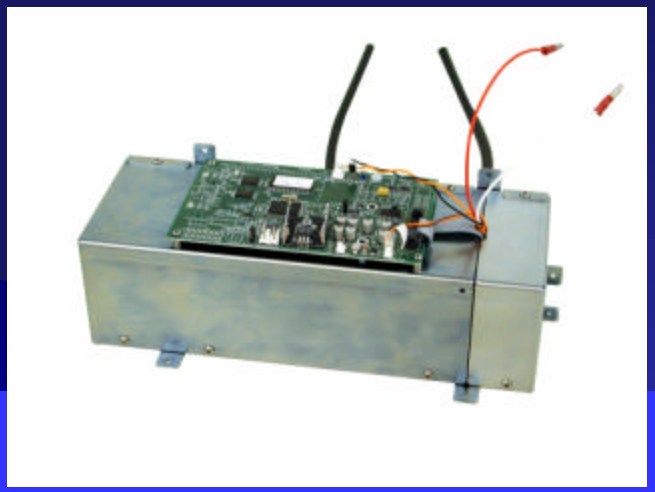
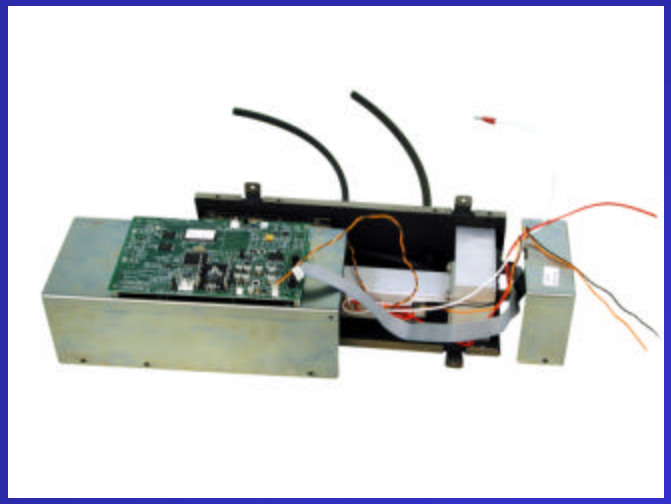
NDUV NO/NO2 Analyzer





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NDUV NO/NO2 Analyzer

- EDL technology (20,000 hrs)
- Simultaneous NO & NO2 measurement
- Continuous output
- 0 – 5000 ppm
- Accuracy 10 ppm; 3% of reading
- Resolution 1 ppm
- T_{90} ~ 2 – 3 seconds
- Continuous refinements beyond BAR specifications

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PM-100
Particulate A nalyzer

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Particulate Analyzer

- Laser light scattering technology
- 100 nm minimum particle size
- Individual particle counts
- Proprietary dilution system
- 1 second scan rate
- Particles bins providing counts and size in 100nm increments
- Raw & dilute exhaust measurement

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