

CLEERS 2016 – Panel discussion

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**Meeting Tier 3 and the potential future  
impact of on-board emissions  
measurements and real-world/on-road  
emissions standards**

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Matti Maricq

**Chemical Engineering, Research & Advanced Engineering  
Ford Motor Company**



**Research and  
Advanced Engineering**

# Meeting Tier 3 measurement requirements: An emissions testing point of view

greenhouse gas cap



	Tier	Bin	NMOG	NO <sub>x</sub>	PM	HCHO	N <sub>2</sub> O
fleet average	2	5	90	70	10	18	
	2	3	55	30	10	11	
	2	2	10	20	10	4	
			NMOG + NO <sub>x</sub>				
fleet average	3	30	30		3	4	10
	3	20	20		3	4	

(from DieselNet)

- Emissions standards are significantly lower than Tier 2
- New instruments are required; e.g. QCL, partial flow diluters
- Measurement accuracy more critical to engineering decisions

# New instrumentation in emissions test cells

- Quantum cascade laser – to measure N<sub>2</sub>O
  - INNOVA – to measure ethanol
  - FTIR – to measure NMOG & Formaldehyde
  - Micro soot sensor – to measure soot
  - Partial flow diluter – for improved gravimetric PM mass
  - Solid particle counter – to support EU PM standard
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- Many of these, while commercially available, are still development projects in terms of integrating them into light duty chassis dynamometer cells (e.g. QCL, FTIR, PFD)
  - Little user experience in performance and maintenance
  - Getting these to provide reliable data for development and certification of Tier 3 vehicles remains a major challenge

# PEMS work at Ford

- Ford PEMS activities:
  - ❑ On-board FTIR – 1990's
  - ❑ PREVIEW 2000 – 2004
  - ❑ Joint work on SEMTECH with Sensors 2004 – 2008
- Purpose
  - ❑ Understand differences between real world and lab
  - ❑ Investigate vehicle operating conditions not seen in dynamometer testing



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# PEMS – advantages & disadvantages

- Advantages – record emissions under true driving conditions
  - Wide range of speed and acceleration
  - Variety of traffic situations
  - Different driver styles
- Disadvantages
  - Measurement accuracy less than in test cells
  - Non-reproducible test conditions
  - Difficult to test aftertreatment efficiency (pre – post measurements)

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## PEMS or PAMS?

- PEMS = portable emissions measurement system
- PAMS = portable activity monitoring system
  
- Vehicle doesn't know that it's being run on the road or dynamometer (ambient temperature, pressure are exceptions)
- Vehicle responds to the sequence of speed – load demands determined by its characteristics (size, weight) and the driver
- Real world trips often analyzed in terms of VSP bins (vehicle specific power), e.g., Liu and Frey, Environ. Sci. Technol. 2015
  
- PAMS can be used to compare drive cycles used for vehicle testing to real world driving patterns

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## Impact of real world testing?

- In EU – probably yes
  - But not because testing is in real world
  - NEDC cycle is unrepresentative
  - A more realistic lab test cycle would likely have same impact
- In US – probably no
  - US emissions tests includes US06 drive cycle – more aggressive than real world
  - Real world data shows Tier 2 having desired impact in real world – i.e., lower NO<sub>x</sub>, HCs, CO (Liu & Frey 2015)

Any test is only as good as its design. Real world testing covers more scenarios but with less emissions accuracy and little repeatability. A good dynamometer test can cover the needed scenarios, but allow higher quality emissions measurements.

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