Advanced Collaborative Emissions Study (ACES)

Cooperative multi-party effort to characterize emissions and possible health effects of new advanced heavy duty engine and control systems and fuels in the market 2007 – 2010.

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Project Overview

Phases:

1. 2007 Engine Emissions Characterization (Southwest Research Institute (SWRI))
   – *CRC Technical Leader*
2. 2010 Engine Emissions Characterization
   – *CRC Technical Leader*
3. 2007/2010 Engine Health Effects Testing (Lovelace Respiratory Research Institute (LRRI)
   – *Short Term biological screening and Long-Term Health Effects Test on 2007 Engines*
   – *HEI Technical Leader*
   – *CRC Technical Monitor*

Overall Project Timeline

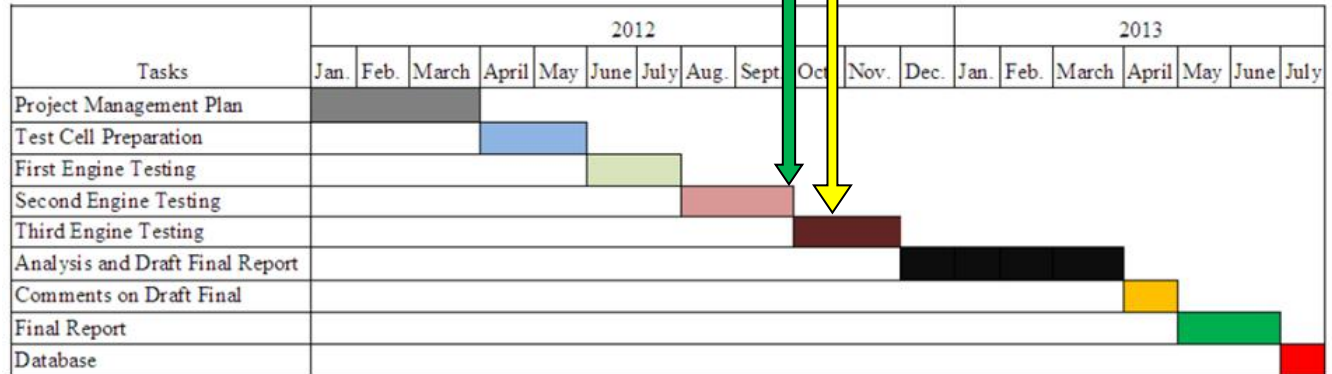|	2007	2008	2009	2010	2011	2012	2013	2014
Phase 1: Testing	▉							
Phase 1: Analysis & Reporting		▉	▉					
Phase 2: Testing						▉		
Phase 2: Analysis & Reporting							▉	
Phase 3: Facilities Development	▉	▉	▉					
Phase 3: Animal Biological Screening and Health Testing				▉	▉	▉		
Phase 3: Analysis & Reporting					▉	▉	▉	▉

Phase 2: Approach

- Phase 1 Protocol

- Focused on FTP, 16-hour Cycle (used in all Phases)

- Engines using a common lubricant supplied by Lubrizol

  – "Degreened" to OEM protocols

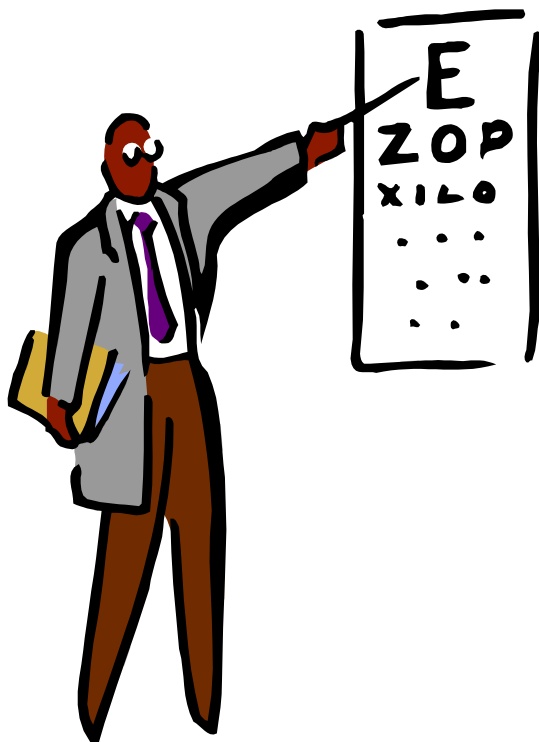- Fuel – commercially sourced from same vendor as Phase 3

Status

Phase 2

- 3 Manufacturers provided engines:
  - Cummins, DDC, Volvo
- Engine "X, Y" testing complete
- Engine "Z" testing in progress

Tasks	2012											2013						
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July
Project Management Plan																		
Test Cell Preparation																		
First Engine Testing																		
Second Engine Testing																		
Third Engine Testing																		
Analysis and Draft Final Report																		
Comments on Draft Final																		
Final Report																		
Database																		

Phase 2 Measurements

Analyte Class	Notes	Method
Regulated Emissions	NOx, NMHC, CO, PM, CH4, CO2, N2O	CFR Part 1065
N_2O, NH_3, isocyanic acid and methyl isocyanate	Real Time, Raw Exhaust	FTIR
NOx, NO, NO_2	Real Time Dilute	Cchemi. (NO_2 by difference)
Ions	Water Impinger (4 slpm), 47 mm TX-40 filter (28 slpm)	IC
Fuel/Oil PM Contribution	47 mm TX-40 filter, selected samples only, 28 slpm	DFI/GC
Hydrogen Ion	H^+, water impinger, 4 slpm	Titration
Cyanide Ion	Impinger, 4 slpm	IC
VOC ($C_1 – C_{12}$)	Tedlar ® bag	GC/FID
Carbonyl compounds	DNPH impingers, 4 slpm	HPLC
Alcohols	DI water impinger, 4 slpm	GC/FID
Selected VOCs	Solid sorbent, 1 slpm (nitromethane, nitropropane, hydrogen sulfide, carbonyl sulfide)	GC/MS
Dioxins/Furans	One sample per engine, on 16-hr integrated sample, gas- and particle-phase extracts analyzed together, 1700 slpm	GC/MS
Real Time Total PM	1Hz, 10 slpm	DMM-230
Real Time Soot	1Hz, 2 slpm	MSS
Real Time PM Size and Number	1Hz, 10 slpm	EEPS
Metals and Elements	47 mm Teflo® filter, 28 slpm	ICP/MS, ICP, EDXRF
PAH	Gas- and particle-phase extracts analyzed together, except 16-Hour integrated sample, 1700 slpm	GC/MS
Nitro-PAH	Gas- and particle-phase extracts analyzed together, except 16-Hour integrated sample, 1700 slpm	GC/MS
Hopanes, Steranes	Gas- and particle-phase extracts analyzed together, except 16-Hour integrated sample, 1700 slpm	GC/MS
Polar compounds	Gas- and particle-phase extracts analyzed together, except 16-Hour integrated sample, 1700 slpm	GC/MS
Other SVOC (C_{14}-C_{40})	Gas- and particle-phase extracts analyzed together, except 16-Hour integrated sample, 1700 slpm	GC/MS
Nitrosamines	Thermosorb N®, 1 slpm	GC/MS
OC/EC	Quartz filters, 58 slpm	TOR and TOT
Particle-Phase Urea Compounds	TX-40 filter, 90 mm, ~336 slpm	ESI-MS

Phase 2 Sampling
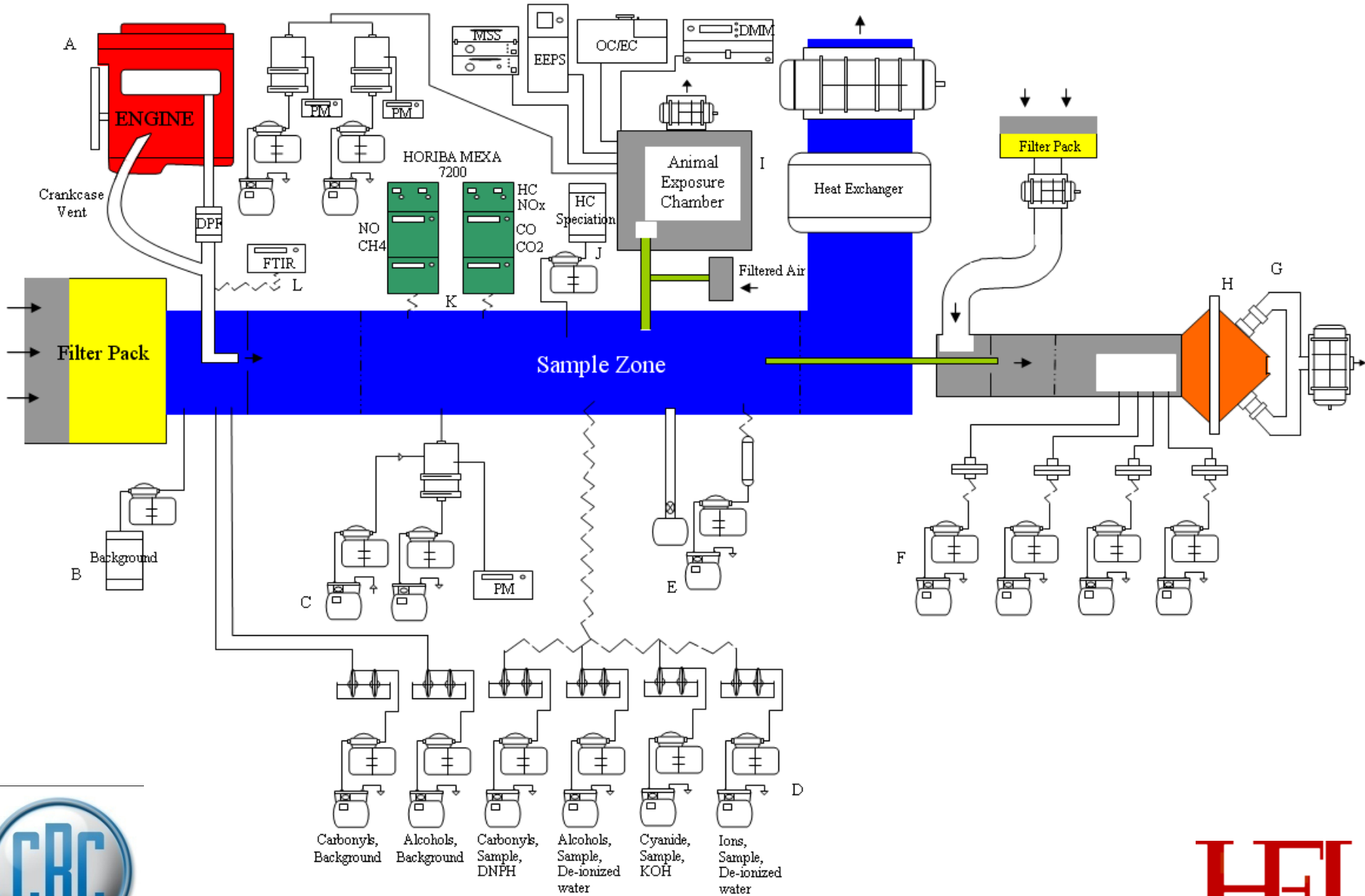
New for Phase 2: Urea Compounds

- Dr. John Storey (Oak Ridge National Laboratory)
- Particulate-phase urea compounds
  - Large (90 mm) filter
  - Sampling over entire 16 hour aging cycle
  - Atmospheric Pressure Chemical Ionization Mass Spec (APCI-MS)
  - ammelide, ammeline, biuret, cyanuric acid, melamine, triuret, and urea

CRC ACES Panel

Reynaldo Agama	Caterpillar, Inc.		Jeff Marley	Volvo Group Trucks Technology
Ewa Bardasz	Lubrizol Corporation		Carl Maronde	National Energy Technology Laboratory
Nick Barsic	John Deere		Mani Natarajan	Marathon Petroleum Company LP
Maria Costantini	Health Effects Institute		Ralph Nine	National Energy Technology Laboratory
Christopher Dea	Caterpillar, Inc.		Jeff Shaffer	Volvo Powertrain North America
Dominic DiCicco	Ford Motor Company		Rashid Shaikh	Health Effects Institute
Timothy A. French	Truck & Engine Mfrs Association		Shirish Shimpi	Cummins, Inc.
Rob Graze	Caterpillar, Inc.		Joseph H. Somers	US Environmental Protection Agency
Garry Gunter	Phillips 66		John M. Storey	Oak Ridge National Laboratory
Thomas D. Hesterberg	Navistar, Inc.		Chris Tennant	Coordinating Research Council
Donald Keski-Hynnila	Detroit Diesel Corporation		Steven S. Trevitz	Volvo Powertrain North America
Dan Kieffer	Paccar Inc.		Annemoon van Erp	Health Effects Institute
George Lin	Caterpillar, Inc.		Timothy Wallington	Ford Motor Company
Chris Laroo	US Environmental Protection Agency		Matt Watkins	ExxonMobil Research & Engineering
Hector Maldonado	California Air Resources Board		Andre Welch	Ford Motor Company
M. Matti Maricq	Ford Motor Company			

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