

COLLECTING REAL-WORLD EMISSIONS USING PORTABLE EMISSION MEASUREMENT SYSTEMS (PEMS)



www.cert.ucr.edu/ACT

BACKGROUND

Real-world emissions monitoring in the United States, Europe, and Asia is gaining momentum through the use of Portable Emissions/Activity Measurement Systems (PEMS/PAMS) technology – ranging from fully regulatory compliant PEMS to mini- or micro-PEMS. Real-world vehicle emissions testing is very different from laboratory testing, bringing both considerable benefits and challenges. The most notable benefit is the ability to correctly determine the emissions during a vehicle's actual in-use operation, which has been shown in many situations to be orders of magnitude higher or lower than simulated real-world testing in the laboratory. Understanding real-world operations can be useful in research and development for product optimization, supplementing compliance programs such as heavy duty inspection and maintenance, and for improving emissions inventories. Additionally, a large number of vehicles can be tested within a relatively short period of time and at relatively low cost. However, on-road emissions data is subject to considerable variances, as real-world conditions are often neither well defined nor repeatable, and can exist even among otherwise identical engines. On-road emissions testing therefore requires a different approach than the traditional laboratory testing and substantial skill in properly interpreting testing results.

COURSE PURPOSE

This course will prepare attendees for properly using and understanding the latest regulatory approved AVL PEMS equipment, designing and conducting

successful field tests for a light duty vehicle fleet, and correctly interpreting emissions and operation data from on-road vehicles for the purpose of certification, research and development, and improving emissions inventories. The lessons learned on the light duty fleet are largely applicable to other sources, such as heavy duty trucks, off-road equipment and vehicles and engines, and marine vessels.

COURSE OVERVIEW

Days one through three focus on emissions measurement fundamentals, learning the capabilities of the PEMS equipment, theory of calculations and corrections, as well as a brief review of worldwide emissions standards that largely guide the use of PEMS for compliance testing. Days four and five are dedicated to the design and preparation of a field study, including troubleshooting common problems and data management techniques used in field testing. Days five through ten are dedicated to a field testing campaign in small student groups, and working with the data to correctly understand the aggregation, calculation, and interpretation of the collected data set and its potential implications.

WHO SHOULD ATTEND

This course is recommended for engineers, managers and academics who would like to understand how to use PEMS for compliance, research or emissions inventory purposes. OEMs and regulatory agencies recommend prospective employees for their emissions laboratories take this course.

COURSE DIRECTOR: Dr. Kent Johnson, Associate Research Engineer, CE-CERT, University of California, Riverside

ADDITIONAL COURSE INSTRUCTOR: Mr. Brian Slater, Applications Engineering Specialist / Business Manager Service AVL

ADDITIONAL COURSE INSTRUCTOR: Dr. Tom Durbin, Associate Research Engineer, CE-CERT, University of California, Riverside

ADDITIONAL COURSE INSTRUCTOR: Carl Fulper, Chemical Engineer, U.S. Environmental Protection Agency

EQUIPMENT TO BE UTILIZED: AVL M.O.V.E. PEMS

PROGRAM – WEEK 1

DAY 1: SETTING THE STAGE

- Check-in, Introductions

Safety Practices in the Lab & Field

- Safety Orientation
- Laboratory and Field Safety Procedures

Emissions Measurement Fundamentals

- Emissions from Combustion Equipment and Vehicles
 - On-Road (light-duty and heavy-duty)
 - Off-Road (planes, trains, ships and equipment)
- Pollutants & Health effects
 - Criteria pollutants
 - Greenhouse gases
 - Toxic pollutants
- Factors that Impact Pollution from Combustion Operations
 - Load, Transient Conditions, Ambient Conditions, Fuel Effects, Combustion Effects, Aftertreatment
- Conventional Dynamometer CVS Emissions Measurement Systems
 - History
 - Components
 - Uses – Certification, R&D, QA & Comparisons
- Portable Emissions Measurement Systems (PEMS)
 - History of Development
 - Components – Requirements for Tailpipe Emission Testing
 - Uses – Research, Regulatory, & Other
 - Ambient Conditions (temperature extremes, humidity ranges, and altitude)
 - Importance of Compliance, Enforcement & R&D

The Regulatory Framework

- Emissions Standards for On & Off Road Combustion Equipment and Vehicles
 - US EPA Title 40 part 86 Subpart T → §86.1912

- Manufacturer-Run In-Use Testing Program for Heavy-Duty Diesel Engines
- US EPA Title 40 part 1065 Subpart J → §1065.901
- Field Testing and Portable Emission Measurement Systems
 - European 04_EU_2017-1154
- RDE Package 3 for Light Duty Vehicle
 - European 2016/1718 (582-2011)
- In Service Conformity for HD Vehicles

Future ideas & tools for improved processes

DAY 2: THEORY OF CALCULATIONS – FROM CONCENTRATION TO EMISSION RATES

Theory of Calculation

- Mass Balance
- Flows
- Mass
- Emission Factors

Corrections

- Drift
- Water
- Calibration
- Linearity
- Quench
- Flow
- ECU Measurement & Interfaces
- Importing Aux Channels
- Mass
- Emission Factors

Managing Data Sets

- Time Alignment
- Drop Outs
- Outliers
- Merging Data Sets
- Overall Data Review with Several Examples

Homework & Classwork: Golden Data Set

DAY 3: GETTING TO KNOW THE INSTRUMENTS

AVL M.O.V.E. PEMS – *in the classroom*

- Features
 - CO₂ & CO Measurements via NDIR = Non-Dispersive Infrared
 - NO & NO₂ Measurements via NDUV = Non-Dispersive Ultra-Violet
 - THC Measurements via FID = Flame Ionization Detector
 - PM/PN Measurements
 - Exhaust Flow Measurement
 - Vehicle Interface & ECU Connection
 - Fuel Flow Measurement
 - Integrated CAN Send and Receive Function
 - Measurement Options – tailpipe, engine out, catalyst efficiency
- Capabilities & QA Parameters
 - Resolution
 - Lower Detection Levels
 - Drift by Time and Temperature
- Common Faults & Explanations

DAY 4: FIELD STUDY

AVL PEMS - *in the laboratory*

- Setup & Startup
- Calibration Check
- Pre- Test
- Verification During Testing
- Post -Test
- Data Extraction
- Simple Maintenance
- Installation on a Vehicle –mounting options, power options, vibration isolation
- Review & Troubleshooting with Golden Data Set
- Classwork with other Examples
- Q&A for Calculation Homework

DAY 5: PREPARATION FOR FIELD TEST ASSIGNMENTS

- Review of Homework
- Design of Field Test Assignments
- Team Assignments, Identify and Prep Vehicles for Testing

PROGRAM – WEEK 2

DAY 1 – DAY 2: PEMS IN-USE TESTING

- Individual Field Studies (mornings)
- Data Review and Analysis (afternoons)

DAY 3: PEMS IN-USE TESTING

- Individual Field Studies (mornings)
- Data Review and Analysis (afternoons)
- Introduction to Road to Laboratory

DAY 4: DATA ANALYSIS & SUMMARY OF LESSONS LEARNED

- Review of Best Practices, Resources, Ongoing Support Opportunities
- Preparation of Presentations on Field Studies, Lessons Learned
- Preview of New Instruments & Software Coming Down the Line

DAY 5: PRESENTATIONS & AWARDS

- Presentation from Groups on Field Studies & Lessons Learned
- Celebration, Lunch, & Award Certificates

FOR MORE INFORMATION, CONTACT MARKETING @ CECERTMARKETING@CERT.UCR.EDU

WWW.CERT.UCR.EDU/ACT

Further Information

Venue

The venue for the course will be at the University of California, Riverside, Bourns College of Engineering, Center for Environmental Research and Technology (CE-CERT) facilities. www.cert.ucr.edu

Physical Address:

1084 Columbia Avenue, Riverside, CA 92507

Course fees

The following course fees include the cost of tuition, course materials, and lunches for the days of attendance.

2018 Introductory Rate:

\$2,500 for full 10 days

Accommodations

[Mission Inn Hotel and Spa](#)

951.784.0300

[Marriott Riverside/UCR](#)

951.276.1200

[Dynasty Suites Hotel](#)

951.369.8200

*Delegates are responsible for their own evening meals. A list of alternative hotels is available upon request.

Terms and Conditions for Booking

Payment in full should accompany your booking. Fees must be paid in full no later than 15 working days before the course commences. Failure to pay may result in attendance being refused.

Registrations are accepted on the understanding that the printed program is given in good faith but may have to be re-scheduled for the speakers changed for reasons outside our control. The University of California, Riverside reserves the right to cancel or postpone the course, in which case fees will be refunded in full. In the event of cancellation, the University will not be held liable for delegates travel or accommodation expenses.

How to Book:

To book this course:

1. Please visit our training website www.cert.ucr.edu/act and click on registration to apply.
2. Payment:
 - Via Check
 - Via Wire Transfer

Please contact Kathy Vang, kathyv@engr.ucr.edu, for more details.

Policies

A/V: Personal Audio or Video Recording is not permitted in the classroom or laboratory.

Course Materials: Course materials are for participants only and are not for resale.

Course Schedule: The University of California Riverside, CE-CERT and/or its instructors reserve the right to adjust course outlines, schedules, and/or materials. Course times and total hours are approximate and may be adjusted by the instructor(s) as the situation warrants.

Privacy Policy: The University of California, Riverside - CE-CERT does not share, sell or rent its mailing lists. You have our assurance that any information you provide will be held in confidence.

Program Accessibility: Potential delegates who have any special requirements should contact the course coordinator as soon as possible.

Returned Check: A \$30 fee will be charged for returned checks

*laptop is required, Windows operating system
Minimum Windows 7, i5 operating system