

Faculty of Engineering



UNIVERSITY OF LEEDS

NO_x and Particulate Real Drive Emissions (RDE)

Monday 6 – Friday 10 June 2016

Image courtesy of Johnson Matthey



New course
development
for 2016

NOx and Particulate Real Drive Emissions (RDE)

(previously Diesel Particulate and NOx Emissions, 1985-2015)

Monday 6 – Friday 10 June 2016

Course Director:

Professor Gordon Andrews. Energy Research Institute, School of Chemical and Process Engineering

Course aims

This course, which is based on our long standing CPD course on Diesel Particulate and NOx Emissions, has been completely revised to include real-world driving emissions and the development of European Real Drive Emissions (RDE) legislation and the reasons for modern SI and Diesel vehicles to have higher emissions in real-world congested traffic than they do on legislated test cycles. This leads to worse air quality in cities. The technology of SI and Diesel engines for low CO2 is converging and SI engines have significant particulate emissions relative to modern diesels with particulate filters. This is leading to the requirement for Gasoline Particulate Filter for gasoline direct injection engines (GDI), but this is likely to be extended to PFI gasoline in the future as the use of rich mixtures in transient acceleration leads to the generation of soot.

The Real Drive Emissions additions to the course are based on the extensive experience in this area of BOSMAL and Prof. Gordon E. Andrews, both of whom have published on RDE for over 12 years and been researching in this area for 20 years. This experience includes both SI and Diesel passenger car and truck RDE. Prof. David Kittelson also has considerable experience in on-road emissions measurements with vehicles measuring their own exhausts and for chase vehicles and his work has concentrated on particulate and particle size emissions. The issue of whether current EU proposals for RDE testing address the issue of poor air quality in cities will be discussed, as such RDE testing must include congested traffic and cold start if they are to be realistic. Currently the proposals do not address these issues.

The course covers the sources of emissions of CO, HC, NOx and PM in SI and diesel engines and on the design and operation of catalytic and particulate emissions reduction systems for both vehicles. The latest technology for emissions reduction from SI and diesel engines is reviewed and the consequences for NOx, CO, HC and PM emissions of CO2 legislation that is making fuel consumption the primary driver in engine development at present. Engine calibration methodology that can reduce fuel consumption at the expense of NOx and PM engine out emissions is reviewed, which leads to RDE problems if the aftertreatment system for NOx and PM emissions cannot cope with the more transient demands of RDE in congested traffic with longer cold starts.

Intended Audience

The course is relevant to vehicle manufacturers, engine consultancies and emissions control R&D with an interest in RDE and engine and emissions control technology for Euro 6 and beyond as well as for technology for future CO2 emissions reduction. This course does not cover the specialist area of fuel composition influences on emissions as these are relatively low in modern vehicles. This is a change from our previous courses in this area. The course is also relevant to those who need to understand real world traffic emissions from an air quality viewpoint and to those involved in emissions regulation formulation and enforcement.

Please note, the programme of presentations is very intense and participants are free to choose the presentations most relevant to them.

Accreditation

This course is in association with the Institution of Diesel and Gas Turbine Engineers, which is devoted to the advancement of Diesel and Gas Engines, Gas Turbines and related products and technology.

The Energy Institute has approved the University of Leeds – Faculty of Engineering as an Approved Training Provider.

Programme

Monday 6 June

Real-world driving for SI and diesel vehicles, fuel economy and emissions

- 08.00 Registration and coffee
- 08.30 **Introduction to the environmental problems of vehicle emissions including GHGs and the role of black soot emissions. The requirements for CO2 reductions from vehicles and the potential solutions – hybrid vehicles and range extended hybrids.**
Professor Gordon Andrews, Energy Research Institute, School of Chemical and Process Engineering, University of Leeds
- 10.00 Tea/Coffee
- 10.15 **Test cycles and their difference from real world driving. Introduction to Real World Driving, WLTC and RDE. Influence of cold start and congested traffic for both SI and diesel vehicles. Comments on the proposed RDE regulations.**
Professor Gordon Andrews
- 11.15 **Current developments in RDE legislation and testing (PEMS) for Euro 6c. Current developments in WLTP test cycle and comparison of vehicles on NEDC and WLTP. Is WLTP more real world? Will emissions increase or decrease? Low CO or low NOx, conflicts in RDE. Will RDE legislation lead to improved air quality in cities?**
Piotr Bielaczyc, BOSMAL Automotive Research and Development Institute Ltd
- 12.15 Lunch
- 13.00 **Future developments in WLTP and RDE and PEMS (PN). Extension to low ambient temperatures and non-regulated compounds (aldehydes, benzene, PAH, SO2 etc.). PN emissions from gasoline vehicles, GDI and PFI. Proposals for raw exhaust gas PN measurements with micro-dilution tunnels.**
Piotr Bielaczyc, BOSMAL Automotive Research and Development Institute Ltd
- 14.00 **Real world driving emissions with comparison with test cycles for diesels and SI vehicles. Is the RDE legislation adequately real world enough to generate emissions source data for air quality modelling in cities.**
Piotr Bielaczyc, BOSMAL Automotive Research and Development Institute Ltd
- 15.00 Tea/Coffee
- 15.15 **Engine exhaust particles in the atmosphere. Measurements of vehicle exhausts on the highway using a mobile emissions laboratory.**
Professor David Kittelson, University of Minnesota, USA
- 16.15 **Real world NOx emissions from state of the art diesel buses. Recalibration of the bus engines to reduce the RDE emissions to those similar to the legislated test cycle.**
Professor David Kittelson, University of Minnesota, USA

16.45 **Cold start PM and PN emissions from PFI and GDI gasoline vehicles.**

Professor David Kittelson, University of Minnesota, USA

17.15 End of day one

17.45 Welcome reception

Tuesday 7 June

Control of engine out NOx and soot emissions in diesel and spark ignition vehicles

- 08.15 Registration and coffee
- 08.30 **Processes that influence particulate and carbon formation**
Professor Gordon Andrews
- 10.30 Coffee
- 10.45 **NOx formation and control in SI and Diesel engines**
Professor Gordon Andrews
- 12.45 Lunch
- 13.30 **EGR for NOx control in SI and diesel engines**
Professor Gordon Andrews
- 14.45 Coffee
- 15.00 **Ultrafine and nanoparticles in diesel, SI and GDI engines.**
Professor David Kittelson, University of Minnesota, USA
- 16.00 **Measurement of ultrafine and nanoparticles from engines, including measurement instruments and measurement uncertainty**
Professor David Kittelson, University of Minnesota, USA
- 17.30 End of day two

Wednesday 8 June

Hydrocarbons and Three Way Catalysts

- 08.15 Registration and coffee
- 8.30 **CO and HC**
Professor Gordon Andrews
- 9.30 **Lube oil review for SI and Diesel Emissions**
Professor Gordon Andrews
- 11.00 Coffee
- 11.15 **The lubricant contribution of future low emissions engine (SI and Diesel) design.**
Professor Gordon Andrews
- 13.00 Lunch
- 13.45 **GDI fuel injectors and fuel/air in cylinder mixing**
Speaker to be confirmed
- 14.45 **Introduction to emission control by catalysts**
Dr Claus Goermann, Johnson Matthey plc
- 15.30 Coffee
- 15.45 **Three-way catalyst substrate development**
Dr Marty Murtagh, Corning Inc
- 16.30 **Three-way catalysts (TWCs)**
Dr Claus Goersmann, Johnson Matthey plc
- 17.30 End of day three
- 19.00 Course dinner

Thursday 9 June

Particulate and NOx after treatment with minimum CO2 penalty

- 08.15 Registration and coffee
- 08.30 **Diesel oxidation catalysts (DOCs)**
Dr Claus Goersmann, Johnson Matthey plc
- 09.30 **Diesel particle traps – overview**
Dr Marty Murtagh, Corning Inc
- 10.45 Coffee
- 11.00 **The regeneration of particulate filter systems**
Dr Claus Goersmann, Johnson Matthey plc
- 12.00 **Particulate Trap Substrates for GDI engines – gasoline particulate filters (GPF)**
Dr Marty Murtagh, Corning Inc
- 13.00 Lunch
- 13.45 **NOx adsorber catalysts**
Dr Claus Goersmann, Johnson Matthey plc
- 14.45 **Selective catalytic reduction (SCR)**
Dr Claus Goersmann, Johnson Matthey plc
- 16.00 Tea
- 16.15 **Integrated emissions control**
Dr Claus Goersmann, Johnson Matthey plc
- 17.30 End of day four

Friday 10 June

Diesel fuel injection and engine design trends for low NOx, PM and CO2 emissions

- 08.15 Registration and coffee
- 08.30 **Technology of HD Euro VI truck engines and future trends towards improved fuel economy. European engine strategies for Euro 6 and beyond.**
Speaker to be confirmed
- 10.00 Coffee
- 10.15 **Unit injection and common rail fuel injection systems**
Mark Smith, Delphi Diesel Systems
- 11.30 **Modern turbocharger systems**
Shaheenur Kabir, Cummins Turbo Technologies Ltd
- 12.45 Lunch
- 13.30 **Transient gas and particulate emissions measurements from diesel passenger cars**
Harry Bradley, Cambustion Ltd
- 14.15 **Emissions Control Strategy on Large Heavy Duty Engines**
Dr Esmail Karimi, Technomot/Niro Engineering Ltd
- 15.15 Tea
- 15.30 **Homogeneous charge and partially premixed diesel engines for low NOx and low soot emissions**
Professor Gordon Andrews
- 16.30 **SNCR: SCR – urea mixing and control; influence on PM**
Professor Gordon Andrews
- 17.30 End of day five and course

View the full programme online at
www.engineering.leeds.ac.uk/short-courses/

Administration Details

Venue

The venue for the course will be Weetwood Hall Conference and Hotel, an award winning, flexible conference centre and hotel in the north of England. The hotel is ideally situated 15 minutes north of the centre of Leeds in wooded grounds at the junction of the Otley Road and the outer ring road. It is just 15 minutes from Leeds Bradford International Airport and a short distance from the A1, M1, M606, M621 and M62 motorways. Further details can be found at www.weetwood.co.uk

Course Fees

The following course fees include the cost of tuition, course materials, lunches and light refreshments for the day(s) of attendance: Full five days **£1700**. Any one day **£425**.

Accommodation

Bed and breakfast accommodation is available at the course venue, Weetwood Hall Conference Centre and Hotel.

We have negotiated the following special rates per night:

Friday – Sunday evening, bed and breakfast **£78**

Monday – Thursday evening, bed and breakfast **£82**

To take advantage of the special rates we have negotiated with the hotel for our course delegates, please book using the instructions below:

1. Log onto: <http://www.engineering.leeds.ac.uk/short-courses/>
2. Select 'Course title'
3. Click on the 'Accommodation Booking' link in the left hand column
4. Complete the following fields: arrival date, departure date, rooms, adults, children.
5. Click the 'Check Availability' button (N.B. you will not need to click on 'Click Here for Special Rates' or enter a promotional code as this is already completed for you).
6. Proceed with your booking as instructed by the booking system.

Delegates are responsible for their own evening meals except on Wednesday 8 June 2016 when the course dinner is included. A list of alternative hotels is available on request.

If you are unable to complete your accommodation using the online booking system please contact Weetwood Hall Hotel directly at the contact details given on their web page at www.weetwood.co.uk

Please note that bookings via the "Accommodation Booking" link must be made two weeks before the course commences at the latest to qualify for the special rates and to guarantee room availability. Any accommodation requests after this date should be made direct with the hotel and will be subject to availability and rates.

Course Dinner

The course dinner will be held at a Leeds city centre restaurant and is included in the course fee. This will take place on Wednesday evening and transport from and to Weetwood Hall Hotel is provided. The dress code is smart casual. If you would like to attend please indicate on the registration form.

Special Requirements

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

How to Book

Booking for this course should be completed through our secure online store. To complete your booking please follow the instructions below:

Online Booking

1. Log on to our online store at:
<https://store.leeds.ac.uk/>
2. Select Conferences and Events in the left-hand navigation bar.
3. Select CPD Faculty of Engineering
4. Select the course or event for which you wish to register and click on "Book".
5. If you are a new user, please follow the instructions to register. If you already have an account log in as instructed.
6. Complete the application process as directed by the booking system.

You will receive an automatic confirmation email within 24 hours of your booking.

For online booking queries and for all other enquiries please contact:

Jenna Kellett

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F: + 44 (0) 113 343 2511

E: cpd@engineering.leeds.ac.uk

W: www.engineering.leeds.ac.uk/short-courses/

Terms and conditions for booking

Payment in full should accompany your booking. The course fee is exempt from VAT. 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 programme is given in good faith but may have to be re-scheduled or the speakers changed for reasons outside our control. The University of Leeds 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.

Delegates will receive a full refund for cancellations made within 7 days of online booking, except where the booking has been made for an event commencing within the next 7 days. Where a delegate wishes to cancel a registration after this 7 day period, written cancellations received up to 15 working days before the course will be subject to an administrative charge of 20% of the total remittance. After this date the full fee is chargeable and no refunds will be made, this also applies for non-attendance but copies of the course documents will be sent. Substitutions may be made at any time.

If you are unable to complete your registration using the online booking system please contact the CPD, Conference & Events Unit to discuss alternative arrangements.