

Faculty of Engineering



UNIVERSITY OF LEEDS

Real Drive Emissions (RDE) and NOx and Particulate Control

Monday 20 – Friday 24 May 2019

Monday – Tuesday: RDE

Wednesday – Friday: NOx and Particulate Control

Image courtesy of Johnson Matthey

Real Drive Emissions (RDE) and NOx and Particulate Control

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

Monday 20 – Friday 24 May 2019

It is possible to book individual days

Course Director:
Professor Gordon Andrews
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, was completely revised in 2016 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. The course has been further revised this year to expand the RDE coverage to 2 days, including a major Chinese RDE programme. 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 is based on the extensive experience in this area of Professor Gordon Andrews and Dr Hu Li, who has 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. Professor 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 should include congested traffic if they are to be realistic. SI, diesel and HDD vehicles real world emissions are covered in this course.

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. This covers modern diesel emission control technologies including the latest particulate and NOx aftertreatment control systems. The course shows the modern Euro 6d diesel is clean on test cycles and in the real world. SI engines with low CO2 emissions require similar aftertreatment systems to diesel vehicles. The series hybrid diesel and SI vehicles are the lowest CO2 transport systems with much lower CO2 emissions than electric vehicles on a well to wheels basis.

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.

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.

Monday 20 May

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

- 08.00 Registration and coffee
- 08.30 **Introduction to the environmental problems of vehicle emissions including GHGs and real world driving**
Professor Gordon Andrews, School of Chemical and Process Engineering, University of Leeds
- 10.00 Coffee
- 10.15 **Remaining compliant: an insight on changing regulations and the current status of RDE legislation**
Piotr Bielaczyc, BOSMAL Automotive Research and Development Institute Ltd., Poland
- 11.15 **Real world driving in congested traffic: implications for roadside air quality**
Professor Gordon Andrews
- 12.15 Lunch
- 13.00 **Practicality, test success and efficiency challenges of operating a real driving emissions test service**
Tom Moakes, HORIBA MIRA
- 14.00 **Real world driving emissions with comparison with NEDC and WLTC test cycles for diesel and SI vehicles, including cold start RDE legislation compliance**
Piotr Bielaczyc, BOSMAL Automotive Research and Development Institute Ltd., Poland
- 15.30 Tea
- 15.45 **Efficient powertrain development for real drive emissions**
Simon Williams, MAHLE Powertrain Ltd
- 16.45 **Cold start PM and PN emissions from PFI and GDI gasoline vehicles**
Professor David Kittelson, University of Minnesota, USA
- 17.30 End of day one
- 17.45 Welcome reception

Tuesday 21 May

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

- 08.15 Registration and coffee
- 08.30 **Engine exhaust particles in the atmosphere. Measurement of HDD vehicle exhausts on the highway using a mobile emissions laboratory**
Professor David Kittelson, University of Minnesota, USA
- 09.30 **HDD SCR performance in real world driving: evidence of catalyst de-light during freewheeling**
Dr. Hu Li, School of Chemical and Process Engineering, University of Leeds
- 10.15 Coffee
- 10.30 **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

- 11.15 **Real driving emissions using fast response analysers**
Dr. Mark Peckham, Cambustion
- 12.00 **Euro 3 diesel car in real world congested traffic: major NOx problem and a significant cause of high road NO2. Evidence of DOC de-light in congested traffic.**
Professor Gordon Andrews
- 12.45 Lunch
- 13.30 **Development of RDE in China**
Dr Xin Wang, National Laboratory of Automotive Performance & Emission Test Beijing Institute of Technology and Visiting Researcher, University of Leeds
- 15.00 Tea
- 15.15 **Hybrid vehicles on real world driving**
Dr Hu Li, School of Chemical and Process Engineering, University of Leeds
- 16.15 **The effects of vehicle technology on CO2 emissions across a range of different drive cycles**
Ben Leach, BP Formulated Products Technology
- 17.30 End of day two

Wednesday 22 May

Fundamentals of SI and diesel gaseous emissions

- 08.15 Registration and coffee
- 08.30 **Diesel and SI engine thermodynamics and turbocharging**
Professor Gordon Andrews
- 09.15 **Diesel ignition delay and apparent ignition delay in SI engines**
Professor Gordon Andrews
- 10.00 **The Nissan MK concept with long ignition delay using EGR**
Professor Gordon Andrews
- 10.30 Coffee
- 10.45 **Diesel and SI engine processes that influence particulate formation**
Professor Gordon Andrews
- 11.45 **Factors influencing carbon formation in diesel and SI engines**
Professor Gordon Andrews
- 12.30 Lunch
- 13.15 **CO and HC emissions from SI and Diesel Engines**
Professor Gordon Andrews
- 14.15 **NOx formation and control in SI and diesel engines**
Professor Gordon Andrews
- 14.45 **EGR for NOx control in SI and diesel engines**
Professor Gordon Andrews
- 15.30 Tea
- 15.45 **Ultrafine and nanoparticles in diesel, SI and GDI engines**
Professor David Kittelson, University of Minnesota, USA
- 16.45 **Three-way catalyst (TWC) substrate development**
Dr Ameya Joshi, Corning Inc
- 17.30 End of day three
- 19.00 Course dinner

Thursday 23 May

Particulate and NOx after treatment with minimum CO2 penalty

- 08.15 Registration and coffee
- 08.30 **Introduction to emission control by catalysts**
Dr Claus Goersmann, Johnson Matthey plc
- 09.00 **Three-way catalysts**
Dr Claus Goersmann, Johnson Matthey plc
- 09.45 **Diesel oxidation catalysts (DOCs)**
Dr Claus Goersmann, Johnson Matthey plc
- 10.15 Coffee
- 10.30 **Diesel Particulate Filters (DPFs) – overview**
Dr Ameya Joshi, Corning Inc
- 11.30 **The regeneration of particulate filter systems**
Dr Claus Goersmann, Johnson Matthey plc
- 12.30 Lunch
- 13.15 **Particulate trap substrates for GDI engines – gasoline particulate filters (GPF)**
Dr Ameya Joshi, Corning Inc
- 14.15 **NOx adsorber catalysts**
Dr Claus Goersmann, Johnson Matthey plc
- 15.00 Tea
- 15.15 **Selective catalytic reduction (SCR)**
Dr Claus Goersmann, Johnson Matthey plc
- 16.15 **SNCR: SCR – urea mixing and control; influence on PM**
Professor Gordon Andrews
- 17.00 **Integrated Systems**
Dr Claus Goersmann, Johnson Matthey plc
- 17.30 End of day four

Friday 24 May

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

- 08.15 Registration and coffee
- 08.30 **Common rail fuel injection systems**
Dan Mellors, Delphi
- 10.00 Coffee
- 10.15 **Turbocharging for Low Emission Heavy Duty Diesels**
Vishal Seeburrun, Cummins Turbo Technologies Ltd
- 11.30 **Emissions control strategy on large heavy duty engines**
Dr Esmail R Karimi, Niro Engineering Ltd
- 12.30 Lunch
- 13.15 **Cold start and implication for real world emissions in urban driving**
Professor Gordon Andrews
- 14.45 **Review of RCCI and HCCI**
Professor Gordon Andrews
- 15.45 **Lube oil review for SI and diesel emissions**
Professor Gordon Andrews
- 16.30 Tea and end of course

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

Please note that, although the organisers remain devoted to the programme specified, they reserve the right to vary the programme in detail if required to do so by factors beyond their control.

Further Information

Venue

The venue for the course will be Weetwood Hall Conference Centre and Hotel, which offers first-class hotel facilities, a business centre and ample parking facilities. Weetwood Hall 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 **£1800**. Any one day **£450**. (Monday – Tuesday – RDE £900
Wednesday – Friday – NOx and Particulate Control £1350)

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 for our delegates:

Friday – Sunday evening, bed and breakfast **£82**

Monday – Thursday evening, bed and breakfast **£86**

To take advantage of these special rates, please book by contacting the hotel direct on 0113 230 6000 (Stevie Standerline or Emma Barker),

E: reservations@weetwood.co.uk. Please quote “University of Leeds CPD Unit” and the course name when contacting Weetwood Hall to book accommodation.

Please note that accommodation bookings 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 will be subject to availability and rates. A list of alternative hotels is available on request. Delegates are responsible for their own evening meals except on Wednesday 22 May when the course dinner is included.

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.

Accessibility

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:

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W: www.engineering.leeds.ac.uk/short-courses
Twitter: @LeedsUniCPD
LinkedIn: CPD, Conference and Events Unit,
University of Leeds

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.

The CPD Unit take your privacy seriously and we will only use your information to provide information on our CPD courses and relevant engineering events. We will not pass your details to any other organisations. If you have opted in to receive details of future CPD courses from us you can unsubscribe at any time by emailing us at cpd@engineering.leeds.ac.uk and your details will be removed from our database.