# Course Contents

**Automotive Lubrication 201 – Diesel**  
**STLE Annual Meeting 2012**

**Course Chairman:** Edward P. Becker, General Motors Corporation, Pontiac, MI

Edward P. Becker is a Past President and Fellow of STLE. He holds a Ph.D. in Mechanical Engineering from the University of Michigan and has been with General Motors for over 27 years, mostly in the Powertrain division working on a variety of GM engines and transmissions. He is a licensed Professional Engineer in Michigan.

This brand new course provides a comprehensive overview of the various aspects of a typical diesel engine tribological system including modern fuels and lubricants. Lubrication and surface engineering principles will be applied to provide a unified approach to practical diesel powertrain systems.

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## DIESEL ENGINE HARDWARE OVERVIEW presented by Dr. Edward P. Becker, General Motors Corporation, Pontiac, MI

This presentation will cover basic diesel engine components, critical tribological contacts and the frictional losses at these contacts. An overview of materials used for these components will be provided. The basic concepts of boundary, mixed and hydrodynamic lubrication regimes and their relationship to minimum oil film thickness will be provided, along with strategies for reducing friction in these interfaces.

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## DIESEL ENGINE OILS presented by Bruce Matthews, General Motors Corporation, Pontiac, MI

Diesel engine oil is a remarkable fluid designed to meet the requirements of a specification whose purpose is to ensure an engine's good health throughout its lifetime. All General Motors light duty diesel vehicles are required to use an engine oil licensed to the dexos specification. Marketing claims aside it is the specification that drives the composition of the engine oil from the base oil selection to the additive package. Each additive in the package has a very specific function which is important to ensure the proper performance of an engine oil in whatever conditions the light duty vehicle may face around the globe.

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## AUTOMATIC TRANSMISSION FLUIDS presented by Roy Fewkes, General Motors Corporation, Pontiac, MI

Automatic Transmission Fluids provide a variety of functions in modern automobiles, including torque transfer, cooling, hydraulic power, and component protection. The basic components of ATFS will be discussed, including base oils and additive packages, to meet differing OEM requirements. Recent work related to the development of a “universal” ATF for service fill will be presented.
DIESEL AND BIODIESEL FUELS presented by Elana Chapman and Shailesh Lopes, General Motors Corporation, Pontiac, MI

Elana Chapman is currently a Fuels/Biofuels Engineer in the Fuels Group, part of the Fuels, Lubricants and Laboratory Organization at General Motors Powertrain. She was previously a Project Engineer in the Advanced Diesel Group of Advanced Engineering before moving to the Fuels Group at GM Powertrain. Elana received her PhD degree in Fuel Science from the Pennsylvania State University, and MS in Mechanical Engineering in 2008. She also received a MS in Fuel Science from Pennsylvania State University in 2002, and a BS degree in Mechanical Engineering from the University of Dayton in 1992. Much of her research work at Penn State focused on the use of dimethyl ether as an alternative fuel in compression ignition engines, including the performance and emissions characteristics of the fuels, in addition to the physical properties of the fuel in the fuel system. These issues led her down a path of study with other researchers into the issues of lubricity and lubrication of the fuel in fuel systems. She currently works with spark ignition engine and vehicle projects related to performance and emissions from conventional fuels and biofuels.

Shailesh Lopes is currently a Senior Fuels/Biofuels Engineer in the Fuels Group, part of the Fuels, Lubricants and Laboratory Organization at General Motors Powertrain. Shailesh Lopes received his PHD degree in Chemical Engineering- Biofuels Specialization, from University of Missouri- Columbia in 2007 and a BS degree in Chemical Engineering from University of Mumbai-India. Shailesh Lopes is technical expert in field of compression ignition biofuels and conventional petroleum diesel fuel chemistry with strong track record of successful contributions in areas of renewable biodiesel fuels technologies, bio-based chemicals and sustainable engineering technologies.

Strict light and heavy diesel vehicle emissions reduction requirements are forcing most of the engine and aftertreatment system design and vehicle fuel specification changes to meet these new aggressive standards. Diesel fuel specifications are becoming increasingly stringent across the globe, particularly with respect to sulfur content, and in some areas, aromatics content. This trend has resulted in reduction in the lubrication properties of the diesel fuel especially of the ultra low sulphur diesel fuels. With regard to the engine and fuel system, the major change is the operation at ever increasing system fuel pressures. These factors have the potential to reduce fuel system durability and result in equipment failures. In addition, increasing use of biodiesel in the diesel fuel offers unique challenges. In general, biodiesel use is beneficial for fuel system performance due to enhanced lubricity of the fuel. However, use of biodiesel has a tendency to produce increased engine oil fuel dilution especially on vehicles equipped with diesel exhaust after treatment filters. This high fuel dilution reduces the wear protection of engine oil and thereby can result in reduced fuel system durability and potential failure. This presentation discusses the influence of biodiesel and low sulfur diesel fuels on tribology characteristics of modern diesel engine vehicles equipped with sophisticated emission control technology.

EFFECT OF BIO-DIESEL ON ENGINE OIL PROPERTIES IN LABORATORY AGING TESTS AND IN VEHICLES presented by Arup Gangopadhyay, Ford Motor Company, Dearborn, MI

Arup Gangopadhyay is a Technical Leader responsible for the Lubrication Science group in Ford Research and Advanced Engineering. He has been in Ford for 20 years and his research interests are in the area of friction reduction for fuel economy improvements and durability improvements in engines, transmissions, and axles. He has a Ph.D. in Metallurgical Engineering. He published over 50 papers in refereed journals and he is a Fellow of STLE.

Today’s diesel engines used for transportation are mostly equipped with diesel particulate filters (DPF) to meet stringent emissions standards. As the pores in the filters get plugged with soot, the DPFs require regeneration by post injection of fuels in the cylinders which raises the DPF temperature high enough to burn soot. Post injection of fuels also results in high fuel dilution in engine oil, reducing oil viscosity and minimum oil film thickness. This causes concern for wear of engine components. Use of biodiesels makes the situation worse because it stays in the oil sump longer due to its higher boiling temperature range and its lower oxidative stability than mineral diesel. Laboratory oil aging tests showed significant changes in oil properties in the presence of bio-diesel. The presentation will cover the results of laboratory aging tests as a function of bio-diesel content and also analysis of drain oils collected from a fleet of medium-duty trucks using B-20 fuel.
FUNCTIONAL CHARACTERIZATION OF KEY DIESEL ENGINE COMPONENTS THROUGH APPLICATION DEPENDENT SURFACE TEXTURE SPECIFICATION AND DATA FILTRATION presented by Jack Clark, Surface Analytics LLC & Colorado State University, Dearborn, MI

Jack Clark is a senior manager, lecturer, and graduate engineer with over thirty years of experience in systems development, surface finishing and mechanical design. He has broad knowledge in form and surface metrology instrument design, including developments on interferometric, SEM, and other high resolution surface analysis devices. He has applied this metrology experience to automotive engine design, computer imaging, and process automation. Mr. Clark has owned businesses and licensed technology that enhances part functionality, improves first pass acceptance, and reduces production and warrantee costs. He currently owns and operates Surface Analytics, LLC consulting and is a Faculty Affiliate at Colorado State University.

Many components in diesel engines require specialized surface textures to enable superior performance over the much extended service/warrantee life required by regulatory entities and the end customer. To that end, the engine manufacturers have been key in establishing specific drawing callouts to ensure the moving/lubricated components will be compatible and survive the extreme loads, varied lube conditions, contaminants, and high temperatures experience in diesel applications. This module will discuss surface texture, evolved parameters, and specialized data filtration that allows designers to accurately specify the surfaces required for functional performance.