

## IX. Acronyms and Abbreviations

°C	Degrees Celsius		
°F	Degrees Fahrenheit		
$\eta$	Effectiveness	bhp-hr	Brake horsepower hour
$\Phi$	Fuel/air equivalence ratio	BMEP	Brake mean effective pressure
$\tau_{id}$	Ignition delay time	BSDPM	Brake specific dry particulate matter
$\Delta P$	Pressure drop	BSFC	Brake specific fuel consumption
0-D	Zero-dimensional	bsNO <sub>x</sub>	Brake specific NO <sub>x</sub> emissions
1-D	One-dimensional	btdc	Before top dead center
3-D	Three-dimensional	BTE	Brake thermal efficiency
A	Availability	C/N	Carbon to nitrogen ratio
a.u.	Arbitrary units	CA	Crank angle
AC	Alternating current	CAC	Charge air cooler
A/C	After cooler	CAD	Crank angle degrees
ACE	Advanced Combustion in Engines	CBM	Carbon balance method
ACES	Advanced Collaborative Emissions Study	CDPF	Catalytic diesel particulate filter
Ag	Silver	CFD	Computational fluid dynamics
AHRR	Apparent heat release rate	C <sub>g,i</sub>	Gas species concentration
A/F	Air to fuel ratio	CGIC	Clean gas induction cooler
AFR	Air/fuel ratio	CHEMKIN	Sandia chemical kinetics code
Al	Aluminum	CI	Compression ignition
Al <sub>2</sub> O <sub>3</sub>	Aluminum oxide	CIDI	Compression ignition direct injection
AMDC	Advanced mode diesel combustion	CINL	Cycle integrated natural luminosity
ANN	Artificial neural network	CLD	Chemiluminescence detector
ANL	Argonne National Laboratory	CLEAN	Trademark for Detroit Diesel low-temperature combustion strategy
APA	Air-power-assist	CLEERS	Cross-Cut Lean Exhaust Emissions Reduction Simulations
ASI	Time after the start of injection	cm	Centimeter
atdc	After top dead center	cm <sup>3</sup>	Cubic centimeters
ATDC	After top dead center	CO	Carbon monoxide
atm	Atmosphere	CO <sub>2</sub>	Carbon dioxide
Au	Gold	COV	Coefficient of variation
B100	100% biodiesel	CPER	Counterflow preheating with near-equilibrium reaction
Ba	Barium	CPF	Catalyzed particulate filter
BC	Black carbon	Cr	Chromium
BDC	Bottom dead center	CR	Compression ratio
BET	Named after Brunauer, Emmett and Teller, this method for determining the surface area of a solid involves monitoring the adsorption of nitrogen gas onto the solid at low temperature and, from the isotherm generated, deriving the volume of gas required to form one monolayer adsorbed on the surface. This volume, which corresponds to a known number of moles of gas, is converted into a surface area though knowledge of area occupied by each molecule of adsorbate.	CRADA	Cooperative Research and Development Agreement
		CRC	Coordinating Research Council
		CR-DPF	Continuously regenerating diesel particle filter
		CRF	Combustion Research Facility (at Sandia National Laboratories)
		C <sub>s,i</sub>	Solid species concentration

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Cu	Copper	g/kWh	Grams/kilowatt-hour
CVT	Continuously variable transmission	g/mi	Grams per mile
DC	Direct current	GA	Genetic algorithm
DEER	Diesel Engine Emissions Reduction	GATE	Graduate Automotive Technology Education
deg	Degrees	GC-MS	Gas chromatography – mass spectrometry
DEM	Delayed extended main	GDI	Gasoline direct injection
DGE	Diethylene glycol diethyl ether (CAS 112-36-7)	GHSV	Gas hourly space velocity
DI	Direct injection, direct injected	GM	General Motors
DIB	Di-isobutylene	GUI	Graphical user interface
DNS	Direct Numerical Simulation	GVWR	Gross vehicle weight rating
DOC	Diesel oxidation catalyst	h	Convective heat transfer coefficient
DOE	U.S. Department of Energy	H	Enthalpy
DOHC	Double overhead camshaft	H <sub>2</sub>	Diatomic (molecular) hydrogen
DOM	Discrete ordinates method	H <sub>2</sub> O	Water
DPF	Diesel particulate filter	H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide
DRIFTS	Diffuse reflectance infrared Fourier-transform spectroscopy	H2-ICE	Hydrogen-fueled internal combustion engine
DTTEG	Diesel truck thermoelectric generator	HC	Hydrocarbons
ECM	Electronic control module	HCC	Homogeneous charge compression ignition
ECU	Electronic control unit	HC-SCR	Hydrocarbon selective catalytic reduction
EDS	Energy dispersive spectroscopy	HD	Heavy-duty
EGR	Exhaust gas recirculation	He	Helium
EO	Engine-out	HECC	High-efficiency clean combustion
EOI	End of injection	HEI	Health Effects Institute
EPA	U.S. Environmental Protection Agency	HHV	Higher heating value
EPVA	Electro-pneumatic valve actuator	HIL	Hardware-in-loop
ESC	European Steady State Cycle	hp	Horsepower
η	Effectiveness	HP	High pressure
EWHR	Exhaust waste heat recovery	HR	Heat release
FBMAFS	Forward-backward mass air flow sensor	hr	Hour
FEA	Finite-element analysis	HRR	Heat release rate
FHWA	Federal Highway Administration	HSDI	High-speed direct-injection
FIE	Fuel Injection Equipment	HTCD	Heavy truck clean diesel
FLRS	Full load rated speed engine condition	HTML	High Temperature Materials Laboratory
FSN	Filter smoke number	HVA	Hydraulic valve actuator
FSNR	Fuel specific NO <sub>x</sub> reduction	HWFET	Highway Fuel Economy Test
FTIR	Fourier transform infrared	Hz	Hertz
ft-lb	Foot-pound	IC	Internal combustion
FTP	Federal Test Procedure	I/C	Intercooler
FTP-75	Federal Test Procedure for LD vehicles	ICCD	Intensified charged-coupled device
FVVA	Full variable valve actuation	ICDEM	Individual cylinder delayed extended main
FY	Fiscal year	ICE	Internal combustion engine
G	Gram	ID	Internal diameter
g	Gram		
g/bhp-hr	Grams per brake horsepower-hour		
gIMEP	Gross indicated mean effective pressure		

IMEP	Indicated mean effective pressure	LRRI	Lovelace Respiratory Research Institute
I/O	Input-output	LTC	Low-temperature combustion
IR	Infrared	m <sup>2</sup>	Square meters
ISFC	Indicated specific fuel consumption	MAS	Magic-angle spinning
ITEC	International Truck and Engine Corporation	MB	Mercedes Benz
ITH	Intake throttle valve	MCH	Methylcyclohexane
IVA	Intake valve actuation	MECA	Manufacturers of Emission Controls Association
IVC	Intake valve closing	mg/mi	Milligram per mile
J	Joule	mi	Mile
JPL	Jet Propulsion Laboratory	min	Minute
JWHR	Jacket water heat rejection	MIT	Massachusetts Institute of Technology
k	thousand	MK	Modulated Kinetics
k	Mass transfer coefficient	ML	Monolayer
K	Kelvin	mm	Micrometer
kg	Kilogram	mm	Millimeter
KIVA	Combustion analysis software developed by Los Alamos National Laboratory	Mn	Manganese
KIVA-CTC	KIVA characteristic time combustion	mol	Mole
KIVA-RIF	KIVA representative interactive flamelet	mol/s	Moles per second
kJ	Kilojoules	MET	More Electric Truck
kJ/L	Kilojoules per liter	MPa	Megapascals
kJ/m <sup>3</sup>	Kilojoules per cubic meter	mph	Miles per hour
kPa	Kilopascal	ms	Millisecond
kW	Kilowatt	MSATs	Mobile source air toxics
L	Liter	MSU	Michigan State University
L/D	Length-to-diameter ratio	MTU	Michigan Technological University
LANL	Los Alamos National Laboratory	N <sub>2</sub>	Diatomic nitrogen
LAST	Lead, Antimony, Silver, and Tellurium, an n-type TE material	N <sub>2</sub> O	Nitrous oxide
LAST/T	LAST/Tin, a p-type TE material	N <sub>2</sub> O <sub>3</sub>	Nitrogen trioxide
lbs	Pounds	Na	Sodium
LD	Light-duty	NCO	Isocyanate
LDT	Light-duty truck	NEDC	New European Drive Cycle
LES	Large eddy simulation	NH <sub>3</sub>	Ammonia
LEVII	Low Emission Vehicle II	nm	Nanometer
LHV	Lower heating value	Nm	Newton meter
LIDAR	Light detection and ranging	NMEP	Net mean effective pressure
LIDELS	Laser-induced desorption with elastic light scattering	NMHC	Non-methane hydrocarbon
LIF	Laser-induced fluorescence	NMOG	Non-methane organic gases
LII	Laser-induced incandescence of soot	NMR	Nuclear magnetic resonance
LLNL	Lawrence Livermore National Laboratory	NO	Nitric oxide
LNT	Lean NOx trap	NO <sub>2</sub>	Nitrogen dioxide
LP	Low pressure	NOx	Oxides of nitrogen (NO and NO <sub>2</sub> )
LPEGR	Low pressure exhaust gas recirculation	NRE	NOx reduction efficiency
		NRT	NOx reduction technology
		NSLS	National Synchrotron Light Source
		NSR	NOx storage and reduction

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NTE	Not-to-exceed	psi	Pounds per square inch
NTP	National Toxicology Program	psig	Pounds per square inch gauge
NTRC	National Transportation Research Center	Pt	Platinum
NVO	Negative valve overlap	PWM	Pulse width modulated
NZ-50	Near-Zero Emissions at 50% Thermal Efficiency	Q	Heat
O <sub>2</sub>	Diatomic (molecular) oxygen	Q1, Q2, Q3, Q4	First, second, third and fourth quarters
O <sub>3</sub>	Ozone	OTR	Over-the-road
OEM	Original Equipment Manufacturer	QW	Quantum well
OFCVT	Office of FreedomCAR and Vehicle Technologies	R&D	Research and development
OH	Hydroxyl	RANS	Reynolds Averaged Navier Stokes
OH*	Hydroxyl radical that emits ultraviolet photons	RCF	Rapid compression facility
OH PLIF	Planar laser-induced fluorescence of OH	RGF	Residual gas fraction
ORC	Organic Rankine Cycle	Rh	Rhodium
ORNL	Oak Ridge National Laboratory	ROI	Rate of injection
P	Pressure	rpm	Revolutions per minute
PCM	Power control module, powertrain control module	RT	Room temperature
PCP	Peak cylinder pressure	S	Entropy
PCCI	Premixed charge compression ignition	S	Sulfur
PCS	Power control subsystem	SAE	Society of Automotive Engineers
PDF	Probability density function	SCF/min	Standard cubic feet per minute
PFI	Port fuel injection, port fuel injected	SCI	Stoichiometric compression ignition
Phi	Equivalence ratio	SCORE	Sandia Compression-ignition Optical Research Engine
PHx	Primary heat exchanger	SCOT	Staged combustion with oxygen transfer
PID	Proportional, integral, and derivative	SCR	Selective catalytic reduction
PIV	Particle image velocimetry	sec	Second
PLII	Planar laser-induced incandescence	SEM	Scanning electron microscopy
PLIF	Planar laser induced fluorescence	Si	Silicon
PLRS	Planar laser Rayleigh scattering	SI	Spark ignition
PM	Particulate matter	SIDI	Spark ignition direct injection
PMT	Photomultiplier tube	SF	Scaling factor
PNGV	Partnership for a New Generation of Vehicles	SFC	Specific fuel consumption
PNNL	Pacific Northwest National Laboratory	SFTP	Supplemental Federal Test Procedure
Post80	Late cycle injection after the main fuel pulse at 80° after top dead center	SLPM	Standard liters per minute
PPCI	Partially premixed compression ignition	SMPS	Scanning mobility particle scanner
ppm	Parts per million	SMR	Steam reformation
PRF	Primary Reference Fuels (iso-octane and n-heptane),	SNL	Sandia National Laboratories
PRF80	PRF mixture with an octane number of 80 (i.e., 80% iso-octane and 20% n-heptane)	SNR	Signal-to-noise ratio
PRR	Pressure rise rate	SO <sub>2</sub>	Sulfur dioxide
		SOC	Start of combustion
		SOI	Start of injection
		SOF	Soluble organic fraction
		SO <sub>x</sub>	Oxides of sulfur
		Sp	Mean piston speed
		SpaciMS	Spatially resolved capillary inlet mass spectrometer

SR	Steam reforming	UTRC	United Technologies Research Center
SU	Stanford University	UV	Ultraviolet
SUV	Sports utility vehicle	V	Volt
SV	Space velocity	VAT	Variable admission turbine
SwRI	Southwest Research Institute	VCR	Variable compression ratio
T	Temperature	VCT	Variable cam timing
TAGS	Tellurium, antimony, germanium and silver	VDC	Volts – direct current
TAP	Temporal Analysis of Products	VGC	Variable geometry compressor
TCR	Thermo-chemical recuperation	VNT	Variable nozzle turbine
TDC	Top dead center	VOCs	Volatile organic compounds
TDL	Tunable diode laser	VPTNA	Volvo Powertrain North America
TE	Thermoelectric	VTG	Variable turbine geometry
TEG	Thermoelectric generator	VVA	Variable valve actuation
TEM	Transmission electron spectroscopy	VVT	Variable valvetrain
TGM	Thermoelectric generator module	W	Work
THC	Total hydrocarbon	WAVE	Ricardo engine and one-dimensional gas dynamics simulation software
TP	Tailpipe	W	Watt
TPD	Temperature-programmed desorption	WGS	Water-gas-shift
TPGME	Tri-propylene glycol monomethyl ether	WGSR	Water-gas-shift reaction
TPR	Temperature-programmed reduction	WHR	Waste heat recovery
TPRX	Temperature-programmed reaction	WOT	Wide open throttle
TPS	Throttle position sensor	WREL	Watt Road Environmental Laboratory
TP-XRD	Temperature programmed x-ray diffraction	wt%	Weight percent
u	Gas velocity	XANES	X-ray absorption near-edge spectroscopy
U	Internal energy	XPS	X-ray photoelectron spectroscopy
UCB	University of California Berkeley	XRD	X-ray diffraction
UEGO	Universal exhaust gas oxygen	Y	Yttrium
UHC	Unburned hydrocarbons	yr	Year
ULSD	Ultra-low sulfur diesel	Zn	Zinc
UM	University of Michigan	ZT	Dimensionless thermoelectric figure of merit; equal to: (electrical conductivity)(Seebeck coefficient) ^2(temperature)/(thermal conductivity)
UNIBUS	Uniform bulky combustion system		
US06	Supplemental Federal Test Procedure (SFTP)		
UTM	Universal Transverse Mercator (mapping projection methodology)		

