

M. David Checkel

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Education

Ph.D. Engineering, Cambridge University, 1981
"Turbulence-Enhanced Combustion of Lean Mixtures"
-experimental work on propane combustion for engines

B.Sc (Mec Eng) University of Alberta, 1976, APEGGA Gold Medalist

Employment

Professor Dept of Mechanical Engineering, University of Alberta (since 1981)

- research on alternative fuels, engine emissions, flammability and flaring.
60+ refereed publications, 70+ other publications
50+ invited lectures /presentations, 60+ research /consulting reports
- 17+ courses developed and taught at undergrad / grad level including:
Combustion, Internal combustion engines, Thermodynamics,
Measurements, Life Cycle Analysis, Numerical Methods
- 40+ graduate students supervised at Ph.D. and M.Sc. levels
- team leader / coordinator for many student team projects including:
Ethanol challenge truck, Formula SAE race car, Solar car,
Heavy lift aircraft, Natural gas truck, Liquid injection propane van,
FutureTruck, Hybrid electric vehicle, Supermileage car.
Vehicles have placed and won at several international competitions.
- project leader Auto21 NCE project on VVT* systems to enable HCCI*
(*Variable Valve Timing, *Homogeneous Charge Compression Ignition)

Other Working Relationships

Chief Engineer Checkel Engineering Inc
-combustion and forensic consulting company since 1995
Combustion simulation software and flammability test equipment
Automotive fuel system development and alternative fuels

Chief Engineer Inert Gas Services Inc
-oilfield R&D company specializing in engine exhaust utilization since 1994

Board of Directors Alternative Fuel Systems (2004) Inc. (now Toronto Venture Exchange)
-engine fuel systems / controls company

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Past Employment

- Visiting Professor National University of Singapore, 1995
Two courses: Combustion Engines and Design Project (Hybrid Bus Design)
- Mechanical Engineer Chevron Standard Ltd, Kaybob South #3 Gas Plant, 1976 - 1978
equipment performance testing, inspection and redesign
noise control, safety audits, fire training
- Research Assistant University of Alberta, Mechanical Engineering Department
Summer 1975, pipe ice formation and water jet cutting of tar sands
- pre-1975 varied experience from a farm background including construction and heavy equipment operation.

Professional Associations and Volunteer Activities

- APEGGA Member and registered Professional Engineer
- CI/CS Member and Past Secretary (Combustion Institute/Canadian Section)
- SAE Member and Alberta Section Vice-Chair/ Student Activities
Chair, International Faculty Advisor Committee
- ASME Member (American Society of Mechanical Engineers)
- Alberta Labour Propane Installation Code Committee Member
- EDKRA Member and Director (Edmonton & District Kart Racing Association)
- Churchill Society Director and Secretary of Cambridge Scholarship Committee

Racing Activities

Team Engineer and Driver

Involved in a range of competitive motorsports, especially Karts and Rally.

Winner: 1999 Edmonton regional championship and
Edmonton Street Thunder race, Yamaha Heavy class

Team Engineer and Crew

Del Pero Racing. Sports Car, Hill Climb Car and CASCAR stock car, 1994-2002

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Teaching

Courses Taught: (using current course numbers where changed, *taught in last 4 years)

ENGG 130	Engineering Statics	-1 st year fundamental course for all Engineering students
MEC E 200	Introduction to Mec Eng	-2 nd year introductory and professional course
MEC E 250	Dynamics	-2 nd year fundamental course (all Engineering students)
MEC E 300	Mechanical Measurements	-3 rd year measurement course for Mec Eng students
MEC E 301	Mech Measurement Lab I	-3 rd year measurement and report writing course
MEC E 303	Mech Engineering Lab II	-3 rd year laboratory measurement course
MEC E 340	Mech Engg Thermodynamics	-3 rd year thermodynamics course
MEC E 390*	Numerical Methods	-3 rd year fundamental course for Mec Eng students
MEC E 409*	Experimental Design Project I	-optional 4 th year design project
MEC E 460*	Design Project	-4 th year design project
MEC E 463*	Systems Design	-4 th year thermo / fluids design course
MEC E 465*	Design Project	-4 th year design project
MEC E 469*	Experimental Design Project II	-optional 4 th year design project
MEC E 541*	Combustion Engines	-specialization elective in combustion engines
MEC E 567*	Life Cycle Analysis	-specialization elective in life cycle analysis
MEC E 620*	Combustion	-graduate combustion course covering all aspects
MEC E 738	Fluid Mechanics	-graduate course in fluid mechanics of fuel injection jets
MEC E 748*	Thermodynamics	-graduate course in energy systems analysis

courses taught at National University of Singapore

ME 4102	Design Project	-Hybrid Electric Vehicle Design
ME 4222	Internal Combustion Engines	-4 th year specialization elective

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Graduate Students Supervised

Current Graduate Students: (11)

Sandra Lange	PhD	Development of Life Cycle Analysis Techniques
Vahid Hosseini	PhD	Enhancement of HCCI Operating Range with Partial Fuel Reforming
Paitoon Konsereeparp	PhD	Numerical Modelling of HCCI Combustion
Saran Somanathan	PhD	Life Cycle Analysis and Scale Effects for District Heating Systems
Yutong Gao	MSc	In-Use Emissions of Motor Vehicles
Kevin Frank	MSc	Leak Characterization and Hazards of Leak Detection Systems
Anant Pandya	MSc	Characterization of SCR Catalytic Converter
Hemant More	MSc	Development of Novel SCR Catalytic Converter
Roshan Busawon	MSc	Vehicle Emissions Modelling
Xiangshu Yao	MSc	Using Reformer Gas to Extend Spark Ignition Engine Operation
Fred Jolivet	MEng	Limits of Two Stroke Engine Technology
Zulfiqar Ali Qureshi	MEng	Life Cycle Comparison of Hydrogen & Natural Gas Power

Past Graduate Students: (30)

2005	Brad Kirchmayer	MSc	Modelling of Micro-Electronic Gas Property Sensor
2005	Guofang Jiang	MSc	Turbulent Burning Velocity of Gaseous Fuel Mixtures
2005	Travis Manchur	MSc	Driving Pattern Effects on In-Use Vehicle Emissions
2005	Panfeng Han	MSc	Laminar Burning Velocity at High Temperature and Pressure
2005	Senthil Ponnusamy	MSc	Laminar Burning Velocity of Gaseous Fuel Mixtures
2004	David Arthur	MSc	Using Hydrogen to Extend Engine EGR Limits

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Past Graduate Students (continued):

2003	Jason Olfert	MSc	Development of an Ultra-Sonic Sensor for Automotive Use
2002	Stelvia Matos	PhD	Boundary Selection for LCA of Systems with Toxic Emissions
2002	Jason Hawirko	MSc	Vehicle Emission Factors from Real-Time Measurements
2001	Rob Prybysh	MSc	Toxic and Particulate Emissions of Flare Combustion
2001	Marek Michalski	Meng/MBA	Software Model of Engine Emissions for Vehicles
2001	Emad Abdelgayad	MSc	Effects of Fuel Properties and Oxidizing Catalysts on Emissions
2000	Benlin Liu	Ph.D.	Combustion Optimization in Dual Fuel Engines
2000	Baljit Dhaliwal	M.Sc.	Vehicle Emissions Modelling
1999	Marlo Raynolds	Ph.D.	Life Cycle Assessment of Alternative Vehicle Fuels
1999	Nasser Sallamie	Ph.D.	Pollution Control for Diesel & Dual Fuel Engines
1998	George Skinner	M.Sc.	Measurement of Flare Efficiency in a Wind Tunnel
1997	Oleg Zastavniouk	M.Sc.	Gas Mixing in Natural Gas Injection Systems
1997	Stefan Roberts	M.Sc.	Knock Measurement in Natural Gas / Diesel Engines
1997	Victor Yung	M.Sc.	Energy Use and Emissions of a Hybrid Electric Vehicle
1995	David S.-K. Ting	Ph.D.	Modelling Flame Growth in Turbulent Gas Mixtures
1994	Peter Nowak	M.Sc.	Combustion in Diesel/Natural Gas Dual Fuel Engines
1994	Obika Nwobi	M.Sc.	Emissions from Natural Gas Fuelled Spark Ignition Engines
1994	Ming Jiang	M.Sc.	Heat Loss from Quiescent & Turbulent Combustion Chambers
1994	Clif Johnston	M.Sc.	Stack Downwash Studies with Planar Laser Fluorescence
1992	David S.-K. Ting	M.Sc.	Turbulent Flame Growth in a Combustion Chamber
1991	Robert Campbell	M.Sc.	Processing of Full Color Turbulent Jet Images
1991	Russ Modien	M.Sc.	Enhanced Ignition Systems and Turbulence
1991	Darryl Woycenko	M.Sc.	Combustion and Char Burn-out of Sub-bituminous Coal
1988	Brent McDonell	M.Sc.	Burning Rates of Propane-Air Mixtures

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Sample Publications and Reports (student names are underlined)

Refereed Journal Papers Published or Accepted (1996-2005)

- , R. Liu, D. S-K. Ting and MD Checkel, "Combustion Hazard of Mixing Ammonia with Nitric Oxide", *Jnl of Loss Prevention in the Process Industries*, Vol 16, No 6, pp. 497-506, Nov 2003, 10 pg.
- , S. Ponnusamy, M.D. Checkel and B.A. Fleck, "Maintaining Burning Velocity of Exhaust-Diluted Methane/Air Flames by Partial Fuel Reformulation", *IFRF Combustion Journal*, Art #200506, Sep 2005, 17 pg
- , B.J. Kirchmayer, W.A. Moussa and M.D. Checkel, "Finite Element Modeling of Capacitive Micromachined Ultrasonic Transducers", ANSYS Solutions, Winter 05, 4 pages
- , B Liu, **MD Checkel**, RL Hayes et al, "Expt. & Modeling Study of Variable Cycle Time in a Reversing Flow Catalytic Converter", *SAE Trans, Jnl Fuels & Lubs*, Vol 109-4, 15p, Sep 2001
- , B Liu, **M.D. Checkel** and RE Hayes, "Experimental Study of a Reverse Flow Catalytic Converter for a Dual Fuel Engine", acc. for *Cdn Jnl Chem. Engg.*, Aug 2001 edition, (printing Dec 2001)
- , D.S-K. Ting and **M.D. Checkel**, "Effect of Mean Turbulent Strain Rate on the Flame Speed of Premixed, Growing Flames", *Jnl. Engg. for Gas Turbines & Power*, ASME, **123**, p175-181, 2001
- , B. Liu, RE Hayes, **MD Checkel**, M Zheng and EA Mirosh, "Reversing Flow Catalytic Converter for a Dual Fuel Engine", *Chem. Eng. Sci.*, **56**(8) p2641-2658, 2001
- , N Sallamie, M Kazemeini, M Soltanieh, **MD Checkel**, A Badakhshan, M Zhen and EA Mirosh, "Catalytic Converter Reducing Dual Fuel Engine Emissions", *Scientia Iranica*, **7**(2), p75-81, 2000
- , MA Reynolds, **MD Checkel** & RA Fraser, "The RMEE Method for System Boundary Selection - Part 2: Selecting the Boundary Cut-off Parameter (Zrmee) and Its Relationship to Overall Uncertainty", *Int. J. Life Cycle Assessment*, Vol 5, No 2, p96-104, Mar 2000
- , B Liu, **MD Checkel**, RE Hayes, M Zheng and E Mirosh, "Transient Simulation of a Catalytic Converter for a Dual Fuel Engine", *Cdn J. of Chemical Eng*, Vol 78, p557-568, Jun 2000
- , MA Reynolds, **MD Checkel** and RA Fraser, "The RMEE Method for System Boundary Selection - Part 1: A Means to Systematically and Quantitatively Select LCA Boundaries", *Int. J. Life Cycle Assessment*, Vol 5, No 1, p37-46, Jan 2000
- , MA Reynolds, **MD Checkel**, & RA Fraser, "A Case Study for Life Cycle Assessment (LCA) as an Energy Decision Making Tool: The Production of Fuel Ethanol from Various Feedstocks", *SAE 982205, SAE Transactions, J of Passenger Cars*, 1998, No 6, p2149-2165, Jun 1999
- , MA Reynolds, **MD Checkel** and RA Fraser, "Uncertainty, Sensitivity and Data Quality Assessment for LCVA", *SAE Transactions*, 1998, No 5, p351-368, Jun 1999
- , J.D. Dale, **M.D. Checkel** and P.R. Smy, "Application of High Energy Ignition Systems to Engines", *Progress in Energy & Combustion Science*, Vol 23, pp 379-398, 1997
- , D.S.-K. Ting & **M.D. Checkel**, "Importance of Turbulence Intensity, Eddy Size and Flame Size in S.I. Engine Combustion", *I.Mech.E. Jnl. of Automobile Engg.*, Part D, Vol 211, p83-86, 1997
- , R.P. Campbell, M.D. Checkel, and D.J. Wilson, "Measurements of Time-Varying Jet Isopleths Using Dual Light Sheet PLIF," ASME 96-GT-028, 1996 IGTI Turbo Expo, Birmingham, U.K., Jun, 1996

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Selection of Other Refereed Contributions (1996-2005)

- , A De, D.S.-K. Ting and MD Checkel, "Effects of Temperature and Pressure on Stretched, Freely Propagating, Premixed, Laminar Methane-Air Flame", SAE 2006-01-0494, SAE International Congress, Detroit, April 2006, 19 pg
- , T.B. Manchur and M.D. Checkel*, "Time Resolution Effects on Accuracy of Real-Time NO_x Emission Measurements", *Emissions Measurement and Testing 2005*, 2005-01-0674, SAE 2005 World Congress, Detroit, April 2005, 17 pg
- , B. Emami*, R. Liu, D.S.-K. Ting and M.D. Checkel, "A Numerical Study on the Burning Velocity of a Spherical, Premixed Methane-Air Flame", *SP-1969 Modelling of SI and Diesel Engines 2005*, paper 2005-01-1124, SAE 2005 World Congress, Detroit, April 2005, 9 pg
- , H. Mahmudi, P.C. Flynn and M.D. Checkel, "Life Cycle Analysis of Biomass Transportation: Trains vs. Trucks", paper 2005-01-1551, SAE 2005 World Congress, Detroit, April 2005, 7 pg
- , B. Emami, R. Liu, D.S.-K. Ting and M.D. Checkel, "Rapid Distortion of Homogeneous Turbulence Between Cylinders", *2004 ASME Intl. Mech. Engg. Congress*, IMECE2004-60428, Anaheim Oct 2004, 7 pg
- , BJ Kirchmayer, WA Moussa and **MD Checkel**, "Finite Element Modeling of a Capacitive Micromachined Ultrasonic Transducer", paper W3A4, Intl Conf on MEMS, Nano & Smart Systems, Banff 2003, 6 pg
- , R.Liu, DS-K Ting & **MD Checkel**, "Characteristics of Ammonia-Nitric Oxide Combustion", paper IJPGC2003-40111, ASME Int. Join Power Gen Conf, Atlanta 2003, 7 pg
- , C Bond, K Boyle, N Freeman, D Orr, D Brewin, R Christenson, M Cannon & ***MD Checkel**, "Design & Devpt of 2003 UofA HEV ", paper 2003-01-1268, SAE Intl Congress, Detroit 2003, 7 pg
- , DM Arthur, **MD Checkel** & CR Koch, "Developing Hydrogen Infrastructure Through Near-Term Intermediate Technology", Hydrogen & Fuel Cells Conference, Vancouver, 2003, 9 pg
- , R. Liu, D.S.-K. Ting and MD Checkel, "Ammonia as a Fuel for SI Engines", SAE Powertrain & Fluid Systems, *SP 1809 Alternative Fuels*, paper 2003-01-3095, October, 2003 7 pg
- , JD Hawirko and **MD Checkel**, "Real-Time, On-Road measurement of Driving Behaviour, Engine Parameters and Exhaust Emissions", SAE SP-1714, 2002-01-1714, SAE, May 2002, 14 pg
- , B Dhaliwal and **MD Checkel**, "Tailpipe Emissions Comparison Between Propane and Natural Gas Forklifts", SAE paper 2000-01-1865, Intl Fuels & Lubricants Mtg, Paris, Jun 2000, 10 pg
- , B Dhaliwal, N Yi and **MD Checkel**, "Emissions Effects of Alternative Fuels in Light-Duty and Heavy-Duty Vehicles", SAE 2000-01-0692, SAE Intl Congress, Detroit, Mar 2000, 16 pg
- , MA Raynolds, **MD Checkel** & RA Fraser, "Application of Monte Carlo Analysis to Life Cycle Assessment", SAE 1999-01-0011, *Topics in Autom. Life Cycle*, SP-1249, SAE, Mar 99, p9-17
- , N. Sallamie, **MD Checkel**, M Zheng, A. Badakhshan, M. Kazemeini & M Soltanieh, "Catalytic Converter Performance in Dual Fuel (Natural Gas / Diesel) Engines", Energy Sources Technology, ETCE99-6705, ASME, Houston, Feb 99, 10 pg
- , MA Raynolds, **MD Checkel** and RA Fraser, "A Life-Cycle Comparison of Ethanol Feedstock Options and Technologies for Canada", Comb. & Global Climate Change, 18 p, Calgary, May 99
- , **MD Checkel**, A Brownlee and L Doblanko, "Optimizing Vehicle Fuel Consumption and Emissions Through Traffic Management Using Vehicle and Traffic Forecasting Models", Combustion and Global Climate Change, Calgary, May 1999, 11 pg
- , MA Raynolds, **MD Checkel**, RA Fraser and RA Macintosh, "A Case Study for LCVA as an Energy Decision Making Tool: Conv. and Reform. Gasoline", 4th APISCEU, Bangkok, 1997, 23 pg

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Some Unrefereed Contributions, (Invited or Published based on review of abstract) (1996-2005)

- , MD Checkel and R Busawon, "Transportation Emissions Modelling for Better Choices", Video conference presentation to Transport Canada, Alberta Transportation and Edmonton Transportation Planning, July 2005, 1 hour
 - , MD Checkel, "From Carbon to Hydrogen, Why's it Taking so Long?", Expert Panel Presentation to Auto21 2005 Scientific Conference, Toronto, June 2005
 - , H. More, RE Hayes, B Liu, M Votsmeir and MD Checkel, "Effects of washcoat geometry on light-off in monolith reactors", *4th Intl Conference on Environmental Catalysis*, Heidelberg, June 2005
 - , A Pandya, B Liu, RE Hayes and MD Checkel, "A reverse flow reactor with lean NO_x Catalyst for a Lean Burn Natural Gas Engine", *54th Cdn Chemical Engineering Conf*, Calgary, October 2004
 - , P. Han, *MD Checkel and BA Fleck, "Effects of Reformer Gas on Burning Velocity of Methane with Diluents at Elevated Temperature", CI/CS Spring Technical Meeting, May 2004, 6 pg
 - , S. Ponnusamy, *MD Checkel and BA Fleck, "Partial Fuel Reforming to Maintain Burning Velocity at High Dilution Levels", CI/CS Spring Technical Meeting, May 2004, 6 pg
 - , T. Manchur, *MD Checkel, "Time Resolution and Accuracy of Real-Time, On-Road Emission Measurements", CI/CS Spring Technical Meeting, May 2004, 6 pg
 - , B. Emami, R. Liu, D.S-K. Ting and MD Checkel, "Turbulence Distortion by Expanding Reaction Zones", CI/CS Spring Technical Meeting, May 2004, 6 pg
 - , DM Arthur & **MD Checkel**, "Life Cycle Analysis for Dynamic Hydrogen Multi-fuel for Motor Vehicles", paper 2003-23, Comb Inst / Cdn Sect, Spring Tech Mtg, Vancouver 2003, 9 pages
 - , Rui Liu, DS-K Ting & ***MD Checkel**, "Combustion Characteristics of Ammonia/Nitric Oxide Mixtures", paper 2003-12, Comb Inst / Cdn Sect, Spring Tech Mtg, Vancouver 2003, 6 pages
 - , P. Han, S. Ponnusamy, BA Fleck, **MD Checkel**, JD Dale, "Turbulent Flame Speeds, a Review Leading to Studies of Reformed Fuels", CI/CS Spring Tech Mtg, 5 pg, Windsor, May 2002
 - , **MD Checkel**, "The Promise and Problem of Alternative Fuels", Institute of Engineering, Tribhuvan U, Kathmandu, Nepal, Special Lecture, 1 hour, Feb 5, 2002
 - , **MD Checkel**, "Vehicle Emission Inventories using second-by-second vehicle modelling with traffic forecasting model output", invited address to NRCan Transp. Energy Symp, Toronto, 2001
 - , RA Prybysh, **MD Checkel** and LW Kostiuk, "Measuring Particulate Emissions from Continuous Flares using FFID Technology", Comb. Inst. / Cdn Section, p 37.1-37.6, Montreal, May 2001
 - , M Ackerman, R Bailey, A Laidlaw, F Menu, **MD Checkel**, "The University of Alberta 4-Stroke Snowmobile Conversion", *SP-1649 Clean Snowmobile Challenge*, SAE 2001-01-3659, 8 pg, 2001
 - , **MD Checkel**, R. Smith, A Laidlaw, C Olsen, J Dugal, et al, "The University of Alberta E85 Silverado", *SP-1618 2000 Ethanol Vehicle Challenge*, 10 pg, SAE, 2001
 - , **MD Checkel**, "Evaluating Alternative Fuels and Energy Sources", feature presentation, NRC IRAP Industrial Technology Advisors Conference, London, Jun 2000
 - , **M.D. Checkel** and O. Zastavniouk, "Development of a Rich Flammability Test Apparatus for Liquid/Vapour Mixtures", paper 32, CI/CS Spring Technical Meeting, p7.16-20, Toronto, 1998
 - , V Yung and **MD Checkel**, "Energy Use and Emissions Effects of Operating a Hybrid Electric Vehicle", CI/CS Spring Technical Meeting, Halifax May 1997, pg 722-728
- ... 58. and 39 other conference invited presentations or publications.

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Sample of Technical Reports and Articles (1996-2005)

- , A Pawliw and MD Checkel, "Biodiesel Promotion Program: Final Report", prepared for Natural Resources Canada, October 2004, 11 pg
 - , MD Checkel, "Burning Properties of Kerosine", prepared for Shores Belzil Jardine, Jan 2004, 19 pg
 - , N Algar, H Atwal, C Bond ... and MD Checkel, "Design and Development of the 2004 University of Alberta Future Truck", US Dept of Energy and Natural Resources Canada Future Truck Competition, Jun 2004, 19 pg
 - , MD Checkel, TM Manchur, M Akins and L Thomas, "Measurement of Tailpipe Exhaust Emissions with Conventional and Additized Gasoline", prepared for Alberta Research Council, Aug 2003, 9 pg
 - , B. Liu and **MD Checkel**, "Research Work Under the Reversing Flow Catalytic Converter Test Program, Sep 00-Jun 01", for Alternative Fuel Systems & NSERC Industrial PDF, 84 pg, Sep 2001
 - , **MD Checkel**, E Abdelgawad, J Hawirko and R Prybysh, *Particulate Matter Emission Profiles of Alberta Heavy Duty Vehicles*, for Alberta Environment, 37 pg + 102 pg Appendices, June 2001
 - , **MD Checkel**, B Campbell, T Dew and S Abboud, *Review of Edmonton's Greenhouse Gas Emissions Reduction Strategy*, 41 pg, August 2001
 - , **MD Checkel**, R Vukadin, B Liu & B Dhaliwal, "Sampling and Measurement of Tailpipe Particulates from Alberta-Based Vehicles", for Cdn Petroleum Products Inst., 58 p, Jun 99
 - , B Dhaliwal & **MD Checkel**, "Indoor Vehicle Emissions Project: Effect of Propane to NGV Conversion on Forklift Emissions", Northwestern Utilities & Gas Tech. Canada, 25p, Mar 99
 - , **MD Checkel**, "Engine Emissions of Alternative Fuelled Vehicles" report and software for Edmonton Transportation, Planning & Forecasting Dept, 11p, Oct 97
 - , **MD Checkel** and PH Newman, "Dual Fuel Conversion System Developed for Isuzu Truck Engine", Diesel Progress, p44-46, Feb 97
 - , **MD Checkel**, "Truck and Bus Emissions, City of Edmonton Transp Master Plan", 67p, Nov 96
- .. 41 (and 29 more technical reports and articles).