

APPENDIX 4 METHODOLOGY AND ASSUMPTIONS FOR ESTIMATING EMISSIONS

**Table A4.1 Methodology and Assumptions for Estimating HC, NO_x and CO
Exhaust Emission Factors, Scenario 1**

Vehicle Category	Fuel	Methodology/Assumptions
Passenger	Petrol	Reference exhaust emission rates and deterioration rates established using vehicle testing data from EPANSW (1995) and the Federal Office of Road Safety (FORS, 1996). For post catalyst vehicles, deterioration according to vehicle travel capped at pre catalyst vehicle emissions (150,000 km travel).
	Diesel	Exhaust emission rates adopted from Cox and Apelbaum (1999), Scenario 1.
	LPG/CNG	Petrol emission factors scaled according to FORS data as reported by Parsons (1998): Pre catalyst – scale petrol emission factors by 0.5 HC, 0.7 NO _x , 1.0 CO Post catalyst - scale petrol emission factors by 1.2 HC, 1.1 NO _x , 1.9 CO
Light Commercial	Petrol	As for passenger vehicles for HC and CO, NO _x scaled by 1.15 (EPANSW, 1995)
	Diesel	Exhaust emission rates adopted from Cox and Apelbaum (1999), Scenario 1.
	LPG/CNG	As for passenger vehicles
Rigid and Non-Freight Trucks	Petrol	Assume equal to USEPA Heavy Duty Vehicles, 1985 vintage.
	Diesel	Exhaust emission rates adopted from Cox and Apelbaum (1999), Scenario 1.
	LPG/CNG	As for buses (shown below)
Articulated Trucks	Diesel	Exhaust emission rates adopted from Cox and Apelbaum (1999), Scenario 1.
Buses	Petrol	As for rigid/non-freight trucks scaled by 0.7. Factor based on ratio of petrol fuel consumption of buses to that of rigid/non-freight trucks from current SMVU.
	Diesel	Exhaust emission rates adopted from Cox and Apelbaum (1999), Scenario 1.
	LPG/CNG	As for petrol fuelled buses, scaled by 0.4 HC, 1.7 NO _x , 0.2 CO. Factors scaled according to data for 1990 vintage vehicles as reported by Parsons (1998).
Motor Cycles	Petrol	Assume equal to USEPA motor cycles, HC 1988+, NO _x 1980+ and CO 1982+.

Table A4.2 Methodology and Assumptions for Estimating HC, NO_x and CO Exhaust Emission Factors, Scenario 2

Vehicle Category	Fuel	Methodology/Assumptions
Passenger	Petrol	Reference exhaust emission rates and deterioration rates for ADR 37 and ADR 27 vehicles established using vehicle testing data from EPANSW (1995) and FORS (1996). For post catalyst vehicles, deterioration according to vehicle travel capped at pre catalyst vehicle emissions (150,000 km travel). Euro 2 and 3 emission limits adopted as reference rates for these vehicles. Deterioration rates based on Euro specification of 20% deterioration from 0 to 80 000 km. Reference emission rates modified to account for fuel specifications proposed for this Scenario.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for this Scenario.
	LPG/CNG	Petrol emission factors scaled according to FORS data as reported by Parsons (1998): Pre catalyst – scale petrol emission factors by 0.5 HC, 0.7 NO _x , 1.0 CO Post catalyst - scale petrol emission factors by 1.2 HC, 1.1 NO _x , 1.9 CO
Light Commercial	Petrol	As for passenger vehicles for HC and CO, NO _x scaled by 1.15 (EPANSW, 1995)
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3. Reference emission rates adjusted according to fuel quality changes for this Scenario.
	LPG/CNG	As for passenger vehicles
Rigid and Non-Freight Trucks	Petrol	Pre 2003 and post 2003 emission rates equal to USEPA Heavy Duty Vehicles, 1985 and 1996 vintage respectively. Deterioration as for USEPA heavy duty vehicles, 1985 vintage.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for this Scenario.
	LPG/CNG	As for buses (shown below)
Articulated Trucks	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3
Buses	Petrol	Pre 2003 : emission rates as for rigid/non-freight trucks scaled by 0.7. Factor based on ratio of petrol fuel consumption of buses to that of rigid/non-freight trucks from current SMVU. Post 2003 : as for rigid/non-freight trucks.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for this Scenario.
	LPG/CNG	As for petrol fuelled buses, scaled by 0.4 HC, 1.7 NO _x , 0.2 CO. Factors scaled according to data for 1990 vintage vehicles as reported by Parsons (1998).
Motor Cycles	Petrol	Assume equal to USEPA motor cycles, HC 1988+, NO _x 1980+ and CO 1982+.

Table A4.3 Methodology and Assumptions for Estimating HC, NO_x and CO Exhaust Emission Factors, Scenarios 3-6

Vehicle Category	Fuel	Methodology/Assumptions
Passenger	Petrol	Reference exhaust emission rates and deterioration rates for ADR 37 and ADR 27 vehicles established using vehicle testing data from EPANSW (1995) and FORS (1996). For post catalyst vehicles, deterioration according to vehicle travel capped at pre catalyst vehicle emissions (150,000 km travel). Euro 2, 3 and 4 emission limits adopted as reference rates for these vehicles. Deterioration rates based on Euro specification of 20% deterioration from 0 to 80 000 km. Reference emission rates modified to account for fuel specifications proposed for each Scenario.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	Petrol emission factors scaled according to FORS data as reported by Parsons (1998): Pre catalyst – scale petrol emission factors by 0.5 HC, 0.7 NO _x , 1.0 CO Post catalyst - scale petrol emission factors by 1.2 HC, 1.1 NO _x , 1.9 CO
Light Commercial	Petrol	As for passenger vehicles for HC and CO, NO _x scaled by 1.15 (EPANSW, 1995)
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	As for passenger vehicles
Rigid and Non-Freight Trucks	Petrol	Pre 2003 and 2003-2007 emission rates equal to USEPA Heavy Duty Vehicles, 1985 and 1996 vintage respectively. Post 2007 emission rates equal to Euro 4 limits. Deterioration as for USEPA heavy duty vehicles, 1985 vintage.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	As for buses (shown below)
Articulated Trucks	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
Buses	Petrol	Pre Euro : emission rates as for rigid/non-freight trucks scaled by 0.7. Factor based on ratio of petrol fuel consumption of buses to that of rigid/non-freight trucks from current SMVU. Post Euro : as for rigid/non-freight trucks.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	As for petrol fuelled buses, scaled by 0.4 HC, 1.7 NO _x , 0.2 CO. Factors scaled according to data for 1990 vintage vehicles as reported by Parsons (1998).
Motor Cycles	Petrol	Assume equal to USEPA motor cycles, HC 1988+, NO _x 1980+ and CO 1982+.

Table A4.3 Methodology Used to Estimate Evaporative Emissions from Petrol Fuelled Passenger Vehicles, Scenarios 1-6

Evaporative Component	Estimation Method
Diurnal	Calculation of uncontrolled fuel tank vapour generation using equation developed by Reddy (1989). Reduce uncontrolled vapour generation estimates according to evaporative control systems in later passenger vehicle models (ADR 27 and ADR 37/01)
Hot soak	Based on relative magnitudes of diurnal and hot soak losses for different vehicle vintages as reported in the international literature
Running	Given lack of data on these losses for Australian vehicles, running loss assumed to be 0.5 g/km for summer, 0.25 g/km for winter (Coffey, 1995)
Resting	Given lack of data on these losses for Australian vehicles, resting loss assumed to be 0.5 g/km for summer, 0.25 g/km for winter (Coffey, 1995)

Table A4.4 Methodology and Assumptions for Estimating Particulate Emission Factors, Scenario 1

Vehicle Category	Fuel	Methodology/Assumptions
Passenger	Petrol	Emission rates assumed equal to that of US 1986-90 catalyst equipped vehicles (Maricq et al., 1999) and US 1970-74 non-catalyst vehicles (USEPA, 1995).
	Diesel	Emission rates adopted from Cox and Apelbaum (1999), Scenario 1. Reference rates adjusted for sulphur content.
	LPG/CNG	Emission rate assumed equal to that of recent model catalyst equipped European vehicle (Rijkeboer et al., 1994).
Light Commercial	Petrol	As for passenger vehicles
	Diesel	Emission rates adopted from Cox and Apelbaum (1999), Scenario 1. Reference rates adjusted for sulphur content.
	LPG/CNG	As for passenger vehicles
Rigid and Non-Freight Trucks	Petrol	Assume equal to USEPA emission rates for heavy duty vehicles, pre 1987 vintage, no catalyst.
	Diesel	Emission rates adopted from Cox and Apelbaum (1999), Scenario 1. Reference rates adjusted for sulphur content.
	LPG/CNG	As for passenger vehicles
Articulated Trucks	Diesel	As for Rigid and Non-Freight trucks
Buses	Petrol	As for Rigid and Non-Freight trucks
	Diesel	Emission rates adopted from Cox and Apelbaum (1999), Scenario 1. Reference rates adjusted for sulphur content.
	LPG/CNG	As for Rigid and Non-Freight trucks
Motor Cycles	Petrol	Assume equal to emission rates for early model US motor cycles, weighted for 80% 4-stroke and 20% 2-stroke engines

Table A4.5 Methodology and Assumptions for Estimating Particulate Emission Factors, Scenarios 2-6

Vehicle Category	Fuel	Methodology/Assumptions
Passenger	Petrol	Emission rates assumed equal to that of US 1986-90 catalyst equipped vehicles (Maricq et al., 1999) and US 1970-74 non-catalyst vehicles (USEPA, 1995).
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	Emission rate assumed equal to that of recent model catalyst equipped European vehicle (Rijkeboer et al., 1994).
Light Commercial	Petrol	As for passenger vehicles
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	As for passenger vehicles
Rigid and Non-Freight Trucks	Petrol	Assume equal to USEPA emission rates for heavy duty vehicles, pre 1987 vintage, no catalyst.
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	As for passenger vehicles
Articulated Trucks	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
Buses	Petrol	As for Rigid and Non-Freight trucks
	Diesel	Adopted from Cox and Apelbaum (1999), Scenario 3 Reference emission rates adjusted according to fuel quality changes for each Scenario.
	LPG/CNG	As for Rigid and Non-Freight trucks
Motor Cycles	Petrol	Assume equal to emission rates for early model US motor cycles, weighted for 80% 4-stroke and 20% 2-stroke engines

As for Scenario 1, it is assumed for the purposes of this study that all particulate matter from motor vehicles is smaller than 10 micron and that 90% of this is smaller than 2.5 micron.