2. Ultra Low Sulfur Diesel Summary

2.1 Background

Ultra low sulfur diesel (ULSD) is diesel fuel that meets either the Euro4 fuel specifications for diesel fuel, or the fuel specifications proposed by the Commonwealth for implementation in 2006. To date, the only Euro4 fuel specification that has been established is for sulfur. Directive 98/70/EC of the European Communities in 1998 set the maximum sulfur level from 2005 as being 50 ppm. Euro3 specifications for other parameters such as the cetane number, cetane index, density, T95, and PAH levels, apply until replaced by revised specifications. These limits are shown in Table 2.1.

Table 2.1
Ultra low sulfur diesel fuel quality specifications (Environment Australia, 2000a, 2000b)

Fuel parameter	Euro 3 (applicable from 2000)	Euro 4 (applicable from 2005)	Commonwealth (1 January 2006)
Sulfur (ppm)	350 (max)	50	50 (max)
Cetane number	51 (min)	-	-
Cetane index	46 (min)	-	50 (min)
Density at 15^{o}C (kg/m^3)	845 (max)	-	820 to 850
Distillation T95 (^{o}C)	350 (max)	-	360 (max)
PAH (% by mass)	11 (max)	-	11 (max)

Diesel fuel is generally derived from light virgin gas oil that is produced from the distillation of crude oil. The distillation is conducted in Australian refineries. Low sulfur diesel is produced in refineries with a hydrodesulfurisation unit. ULSD requires either a hydrocracker, or the use of higher pressures in the hydrodesulfurisation unit (hydrofining). As at March 2001 Western Australia and Queensland had passed legislation mandating a diesel sulfur content of 500 ppm or less.

2.2 Results

Two modes of ULSD manufacture are examined. The first assumes that 50% of Australian ULSD production comes from hydrocracking, and the other 50% from hydrofining. The second (marked as 100% reprocessing) assumes that all ULSD comes from hydrofining.

2.2.1 Greenhouse gas emissions

Figure 2.1 depicts the greenhouse gas emissions estimated for diesel fuels. These are shown as emissions on an energy basis, as emissions on a per tonne-km basis for trucks, and on a per passenger basis for buses. We have used data from Apelbaum Consulting Group (1997) for the passenger task and the freight task in Australia and taken the mean energy intensity for the Australian freight task to be 1.2 MJ/tonne-km (Apelbaum Consulting Group, 1997: p.118), and the energy intensity of buses to be 1.06 MJ/passenger-km (Apelbaum Consulting Group, 1997: p.116).

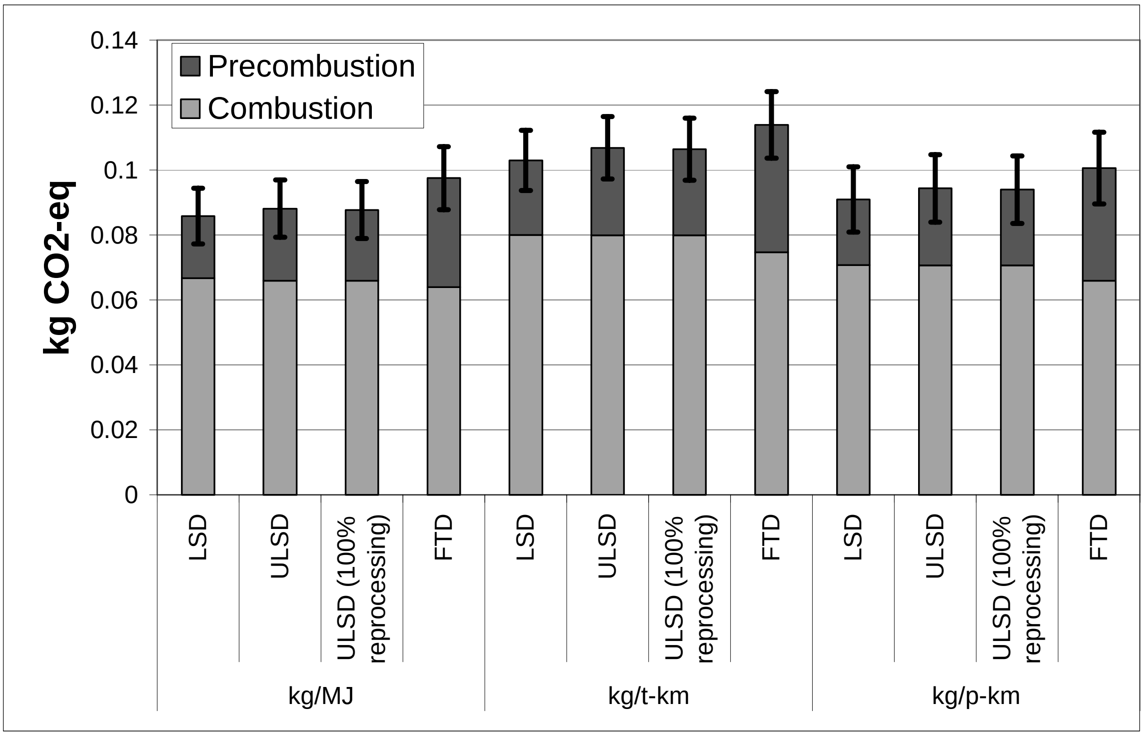

Figure 2.1
Exbodied emissions of greenhouse gases for diesel fuels, low sulfur diesel (LSD), ultra low sulfur diesel (ULSD) and Fischer-Tropsch diesel (FTD) per unit energy and per unit distance

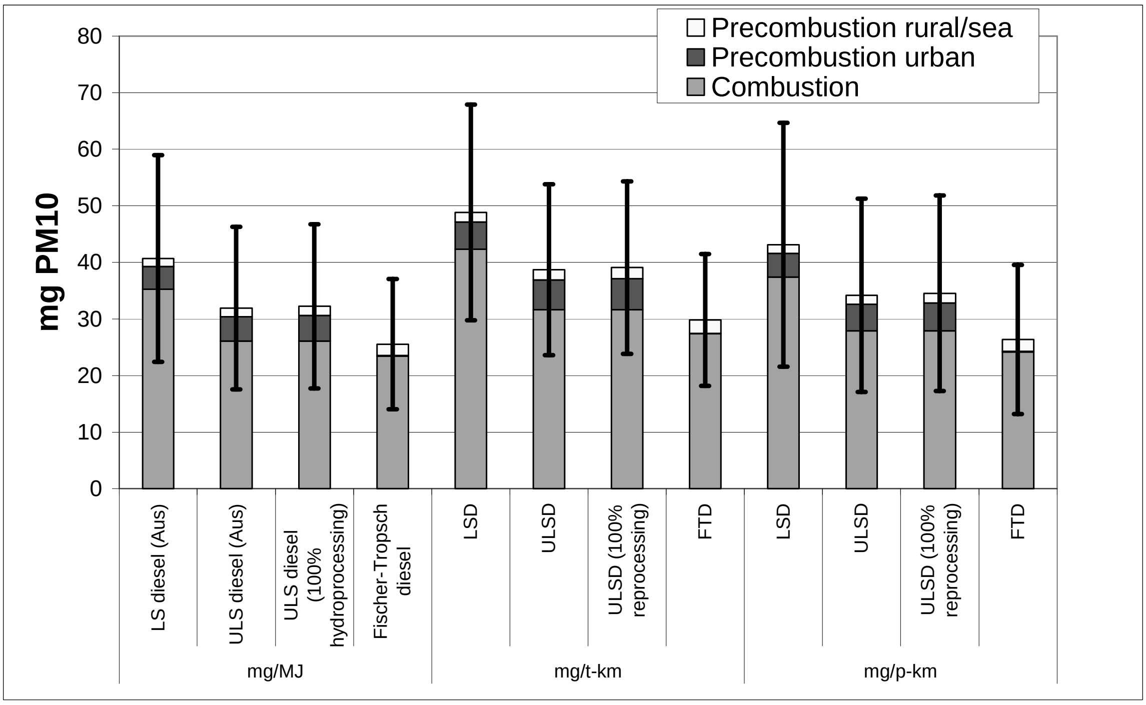

Figure 2.2
Exbodied emissions of particulate matter for diesel fuels, low sulfur diesel (LSD), ultra low sulfur diesel (ULSD) and Fischer-Tropsch diesel (FTD) per unit energy and per unit distance

2.2.2 Particulate matter emissions

Figure 2.2 depicts the particulate matter (PM10) emissions estimated for diesel fuels. These are shown as emissions on an energy basis, as emissions on a per tonne-km basis for trucks, and on a per passenger basis for buses using the same energy intensities previously noted.

2.2.3 Emissions of oxides of nitrogen

Figure 2.3 depicts the oxides of nitrogen (NOx) emissions estimated for diesel fuels. These are shown as emissions on an energy basis, as emissions on a per tonne-km basis for trucks, and on a per passenger basis for buses using the same energy intensities previously noted.

2.2.4 Hydrocarbons

Figure 2.3 depicts the oxides of non-methanic hydrocarbon (HC) emissions estimated for diesel fuels. These are shown as emissions on an energy basis, as emissions on a per tonne-km basis for trucks, and on a per passenger basis for buses using the same energy intensities previously noted.

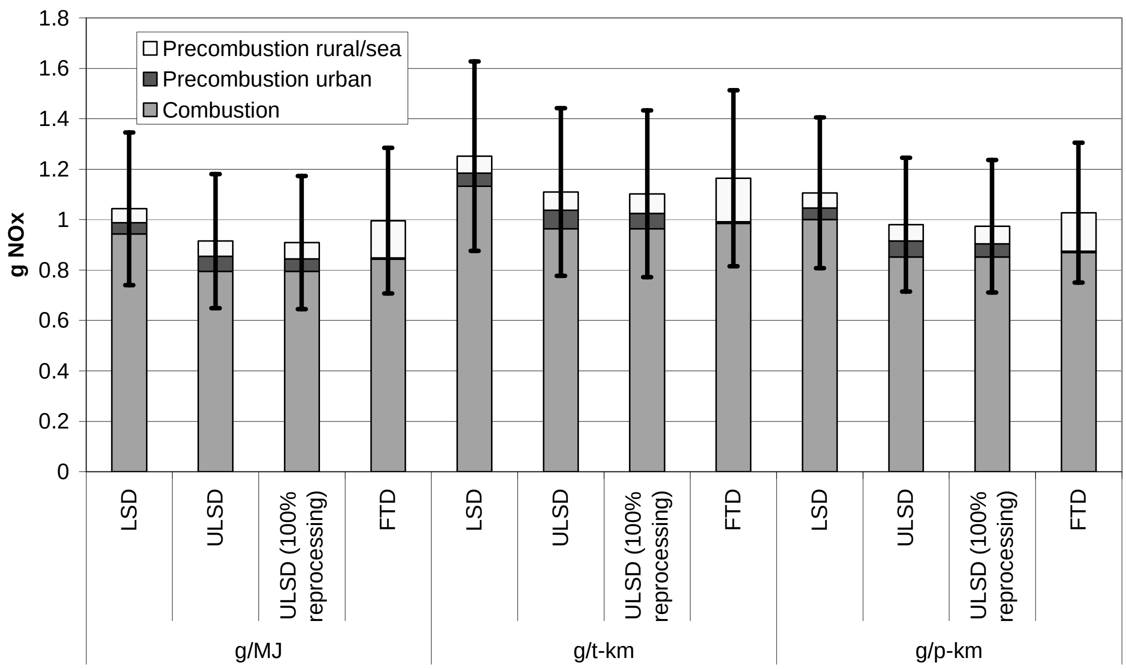

Figure 2.3
Exbodied emissions of oxides of nitrogen for diesel fuels, low sulfur diesel (LSD), ultra low sulfur diesel (ULSD) and Fischer-Tropsch diesel (FTD) per unit energy and per unit distance

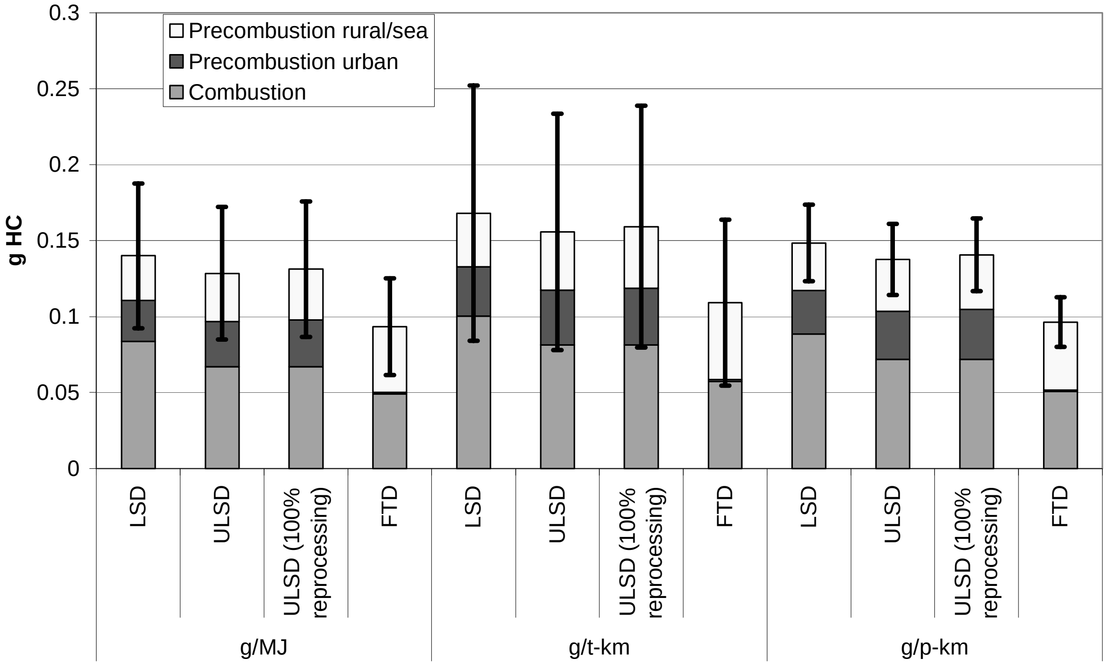

Figure 2.4
Exbodied emissions of hydrocarbons for diesel fuels, low sulfur diesel (LSD), ultra low sulfur diesel (ULSD) and Fischer-Tropsch diesel (FTD) per unit energy and per unit distance

2.3 Viability and Functionality

There is a need to match the fuel with the appropriate vehicle technology. The major benefits of the move to ULSD are provided by the ability to use advanced technology in the engine and the catalyst. These components are often sensitive to sulfur. We expect vehicle emissions to be lower than those presented in the results section when ULSD is used with the appropriate Euro4 fuelled engines. Using ULSD in a Euro2 vehicle provides only marginal improvement in tailpipe emissions over low sulfur diesel. However, the emissions from a Euro4 vehicle with advanced on-board diagnostics and a particulate trap will be dramatically better.

2.4 Health Effects

Epidemiological evidence indicates that decreasing particle emissions reduces morbidity and reduces hospital admissions as a result of respiratory illness. At present, diesel engines are a major source of fine particles – diesel exhaust releases particles at a rate about 20 times greater than that from petrol-fuelled vehicles. Thus the combination of ULSD and particulate traps on vehicles using ULSD will have the beneficial effect of reducing the emissions of particles. ULSD upstream particulate and HC emissions are similar to LSD. ULSD tailpipe HC emissions are similar to LSD and have little effect on emissions of VOCs and aldehydes. ULSD reduces particulate emissions compared to LSD.

OH&S issues associated with ULSD are the same as those associated with LSD (the reference fuel).

2.5 Environmental Issues

The fuel quality review (Environment Australia, 2000a, 2000b) lists the impact on the environment arising from the introduction of low sulfur diesel and ULSD. The combination of ULSD and oxygenating catalysts or "de-NOx" catalysts will enable emissions of smog precursors to diminish, thus improving urban air quality. The upstream environmental issues associated with ULSD are the same as low sulfur diesel and are dealt with in the section on low sulfur diesel.

ESD issues

The modern western economy is based on petroleum products, of which diesel is one. The current concern over climate change highlights the burning of fossil fuels as one of the main causes. Examined from the ESD perspective of equity, efficiency and ecological integrity, even if one argues that the fossil fuel economy is economically efficient, it is more difficult to argue that it encourages equity or ecological integrity. Climate change, and global warming in particular, pose threats to inter-generational equity.

Sustainability

Crude oil supplies are sustainable in the medium term (to at least 2020), though Australian imports will need to rise as the Victorian oil fields start to decline in production. The key sustainability issues for diesel fuel depend on global oil supply.

Groundwater contamination

Diesel is refined from crude oil. Spills of crude oil, especially during transport in oil tankers at sea, pose an environmental hazard that contaminates marine life and bird life. Environmental damage from diesel itself can also occur, especially from leaks at service stations and refuelling depots that have been known to contaminate groundwater supplies.

2.6 ADR Compliance

Ultra low sulfur fuel is being introduced specifically to enable the introduction of technology to meet Euro4 fuel specifications. The ADR have been based on this fuel so that, by definition, there should be no potential to compromise vehicles' compliance with gazetted ADR standards.

2.7 Summary

The advantages of ultra-low sulfur diesel are:

- ULSD contains little sulfur and few aromatics. In a properly tuned engine this is expected to lead to lower particle exhaust emissions.
- The low sulfur content means that oxidation catalysts will be more efficient.
- The existing diesel infrastructure can be used, unchanged, for ultra-low sulfur diesel.
- Low-sulfur diesel can be used in existing diesel engines.
- Diesel is one of the safest of the automotive fuels.

The disadvantages of ultra-low sulfur diesel are:

- Diesel exhaust (including ULSD exhaust) is treated by the US EPA as an air toxic.
- Because of the extra processing energy, ULSD produces more exbodied greenhouse gases than LSD.

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