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5. SCENARIO DEVELOPMENT

As outlined in Chapter 4, the objective of this study was to undertake a comprehensive review of possible new fuel specifications for Australia, designed to reduce emissions of greenhouse gases and air pollutants from Australian road transport. The stakeholder liaison process summarised in Section 4, together with consideration of the information presented in Sections 2 and 3 relating to the interaction between motor vehicle technology, fuel quality and motor vehicle emissions lead to the formulation of six fuel quality specification scenarios. This chapter of the report includes:

- The background to the development of these scenarios in Section 5.1;
- The rationale behind the scenarios in Section 5.2;
- Other factors taken into consideration in the development of the scenarios in Section 5.3; and
- Presentation of the six scenarios in detail in Section 5.4.

5.1 BACKGROUND TO SCENARIO DEVELOPMENT

During April and May 1999, the Review Team consulted with a broad range of stakeholders including many within government, the automotive industry and the petroleum industry, to solicit views on future fuel quality scenario development.

During that same period, MVEC finalised its *'Review of Motor Vehicle Emission Standards, Recommendations to NRTC and NEPC'*, which was circulated to the Review Team on 26 May. MVEC anticipates that necessary Government decisions will be made to allow amendments to the ADRs before the end of 1999.

On 28 May 1999, the Government and the Democrats reached agreement on a range of issues within the Government's taxation proposals, *'A New Tax System (ANTS)'*. This *'Tax Package Agreement'* involves a number of amendments to ANTS that will have impact on future vehicle emissions and fuel standards.

MVEC has subsequently revised its recommendations to NRTC and NEPC, and circulated a paper *'Revised Emissions and Fuel Standards Package'* to the Review Team. This paper presents a revision of MVEC's 'Preferred Option' to incorporate the Prime Minister's commitments under the *'Measures for a Better Environment'* element of the *'Tax Package Agreement'*.

The ANTS legislation, incorporating the *'Tax Package Agreement'*, was passed by the Parliament in late June 1999.

Environment Australia directed the Review Team to take account of the Government's *'Measures for a Better Environment'* and MVEC's *'Revised Emissions and Fuel Standards Package'*, in developing scenarios for evaluation in this Review.

Also, Environment Australia emphasised that scenarios must be relevant to the issues, and credible to the Government and all stakeholders. In particular, at least

one scenario should be targeted to indicate the effects of possible future cooperative arrangements, or rationalisation, within the refining industry. Environment Australia asked the Review Team to consult with the AIP on the development of such a scenario for the Project Steering Committee's approval.

This paper presents proposed scenarios that reflect the bulk of views put to the Review Team by Stakeholders. These scenarios take account of –

- MVEC's *'Revised Emissions and Fuel Standards Package'*.
- Other relevant provisions of the Government's *'Measures for a Better Environment'*.
- Concerns expressed by Environment Australia with respect to future cooperative arrangements or rationalisation within the refining industry.

During the study, the Review Team examined the scope for increased co-operative efforts between pairs of refineries on Australia's eastern seaboard:

- a) In Queensland: BP Bulwer Island and Caltex Lytton;
- b) In NSW: Caltex Kurnell and Shell Clyde; and
- c) In Victoria: Mobil Altona and Shell Geelong.

Senior managers from each of the above oil companies indicated that rationalisation had been considered and rejected for various economic, technical or political reasons.

5.2 Rationale for the Scenarios

'Base Case' – Scenario 1

It is considered that the base case should encompass the continuation of current policy settings but should include a number of other assumptions outlined below.

The Commonwealth Government's Environmental Strategy for the Motor Vehicle Industry (November 1997) notes that the phase out of leaded fuel will 'be brought forward'. Based on the trend in declining market share, and for the purpose of this modelling exercise, it has been assumed that the phase out of leaded petrol will be completed during 2002.

- It should be noted that, in relation to Western Australia, BP has recently agreed to phase out leaded petrol, and reduce levels of MTBE and benzene in petrol from 1 January 2000. In relation to Victoria, Shell has announced that it plans to phase out leaded petrol in 'late 2000'.
- Reductions in petrol volatility are in train or planned, following negotiations with State authorities.
- MVEC's proposal to allow ECE (Euro) certification from 2000 implies increasing volumes of 95 RON ULP (PULP) to meet increasing demand from imported (and some locally produced) vehicles.

- The AIP advises that the import parity price differential for 95 RON PULP vs 91 RON ULP is approximately 2 c/litre. This is relevant for evaluation of the Base Case and all other scenarios, for which a similar 2 c/litre differential retail price is assumed to be in effect from 1/2/2002. Clearly, this will drive growth in the use of PULP in all scenarios. Given this assumption, it is proposed to seek information from the FCAI on the likely future demand for PULP vs ULP to supply new vehicles entering the market through the period to 2010.
- The Base Case will take account of the auto industry NAFC target of a 10% reduction to 2010 as a base.
- The Base Case will include reductions in sulfur in train or planned, *as agreed by individual companies*. For BP, this will include road transport diesel at –
 - 500 ppm urban / 2000 ppm country in WA from 1/1/2000;
 - 500 ppm urban in Brisbane from 1/7/2000 / position on country level to be clarified by BP.For other refiners this will include road transport diesel at –
 - 1000 ppm pool average urban / 2000 ppm pool average country, with +500 ppm caps, from 1/1/2000.
- For off-road diesel fuel, it is assumed there will be no change from current standards.

The 1997 average pool qualities of petrol and diesel at Australian refineries in 1997 are summarised in Table 5-1.

Table 5-1: Australian Refineries: 1997 Average Pool Qualities of Petrol and Diesel¹

| Company | All | Caltex | | BP | | Mobil | | Shell | |
|---------------------------|-----------|-----------|----------|----------|---------|------------|----------|----------|-----------|
| Refinery Location | Aust Avg. | Lytn. QLD | Kurn NSW | Bulw QLD | Kwin WA | Altona VIC | S'vac SA | Geel VIC | Clyde NSW |
| Petrol : | | | | | | | | | |
| Production | 13.1 | 1.9 | 2.3 | 1.1 | 1.6 | 1.8 | 1.0 | 1.7 | 1.6 |
| RON-0 | 92.3 | 92.1 | 92.0 | 92.0 | 93.0 | 92.3 | 92.0 | 92.8 | 93.4 |
| MON-0 | 82.6 | 82.6 | 82.4 | 82.3 | 82.9 | 83.1 | 83.7 | 82.4 | 82.3 |
| Benzene % | 2.9 | 2.4 | 2.4 | 2.9 | 2.1 | 4.3 | 3.4 | 2.9 | 2.7 |
| Aromatics % vol | 31 | 30.6 | 34.1 | 30.6 | 33.3 | 31.6 | 30.9 | 25.8 | 28.4 |
| Olefins % | 13 | 12.6 | 16.5 | 10.5 | 8.9 | 12.6 | 1.0 | 12.6 | 17.0 |
| Sulfur ppm | 193 | 70 | 181 | 350 | 292 | 216 | 22 | 90 | 224 |
| RVP, Nov to Feb kPa | 73 | 75.5 | 72.7 | 73.3 | 71.1 | 70.5 | 66.9 | 72.9 | 77.8 |
| Density kg/m ³ | 734 | 736 | 734 | 732 | 729 | 737 | 740 | 729 | 740 |
| FBP °C | 192 | 186 | 201 | 191 | 184 | 187 | 193 | 176 | 217 |
| On-road Diesel : | | | | | | | | | |
| Production | 10.2 | 1.4 | 1.2 | 0.9 | 2.1 | 1.2 | 0.8 | 1.6 | 1.1 |
| Sulfur ppm | 1500 | 380 | 1400 | 2100 | 2100 | 1000 | 900 | 1600 | 2200 |
| Cetane Index | 51.1 | 50.2 | 50.0 | 50.4 | 49.5 | 51.9 | 58.8 | 48.6 | 51.0 |
| PAH % m | 3.5 | n/a | n/a | 2.2 | 4.0 | n/a | n/a | n/a | n/a |
| T-95 | 349 | 339 | 343 | n/a | n/a | 357 | 366 | n/a | n/a |
| Viscosity, 40 °C, | 3.2 | 3.1 | 3.2 | n/a | 1.9 | 3.2 | 3.2 | 2.9 | 3.5 |
| Density | 847 | 843 | 852 | 842 | 845 | 847 | 835 | 850 | 855 |

1: AIP (1997).

Aust avg: Australian average
Lytn: Lytton
Kurn: Kurnell
Bulw: Bulwer
Kwin: Kwinana
S'vac: Port Stanvac
Geel: Geelong

Table 5-2: 1998 Baseline Petrol Capacity for 8 Refineries - Details by Petrol Grade

| Location | Grade | Prod'n ML pa | RON-0 | MON-0 | Benzene % vol | Aromat's % vol | Olefins % vol | Sulphur ppm wt | RVP kPa Nov~Feb | Density kg/m3 | FBP deg.C |
|------------------|-------------|-----------------|-------------|-------------|------------------|-------------------|------------------|-------------------|--------------------|------------------|--------------|
| 8 Refin's | Leaded | 4965 | 93.8 | 82.5 | 2.88 | 30.5 | 20 | 210 | 71.9 | 739 | 199 |
| | ULP | 12218 | 91.6 | 82.5 | 2.58 | 27.3 | 17.1 | 150 | 72.2 | 735 | 197 |
| | PULP | 640 | 96.1 | 85.5 | 3.29 | 35.7 | 17 | 120 | 75.7 | 748 | 198 |
| | Pool | 17823 | 92.4 | 82.6 | 2.7 | 28.5 | 17.9 | 166 | 72.2 | 737 | 198 |
| Lytton | Leaded | 722 | 93.0 | 82.5 | 2.6 | | | 20 | 73.8 | 741 | 195 |
| | ULP | 1596 | 91.5 | 82.8 | 2.3 | | | 100 | 74.7 | 737 | 193 |
| | PULP | 72 | 96.5 | 86 | 3.6 | | | 100 | 76.3 | 756 | 197 |
| | Pool | 2390 | 92.1 | 82.8 | 2.4 | 28.5 | 17.9 | 76 | 74.5 | 739 | 194 |
| Kurnell | Leaded | 769 | 93.1 | 82.5 | 2.1 | 30.5 | 20 | 100 | 69.3 | 740 | 203 |
| | ULP | 2178 | 91.4 | 82.1 | 2.2 | 25.6 | 16.4 | 100 | 71.4 | 735 | 204 |
| | PULP | 117 | 95.6 | 84.5 | 2.4 | 32 | 18.9 | 100 | 74.9 | 746 | 205 |
| | Pool | 3064 | 92.0 | 82.3 | 2.2 | 27.1 | 17.4 | 100 | 71.0 | 737 | 204 |
| Bulwer Is | Leaded | 473 | 93.4 | 82.5 | 3.5 | 29.4 | 17.6 | 210 | 73.9 | 737 | 199 |
| | ULP | 1094 | 91.3 | 82.2 | 3.2 | 27.6 | 15.1 | 230 | 73 | 727 | 194 |
| | PULP | 46 | 95.6 | 85.5 | 3.3 | 35.4 | 18.6 | 190 | 76.4 | 747 | 192 |
| | Pool | 1613 | 92.0 | 82.4 | 3.3 | 28.4 | 15.9 | 350 | 73.4 | 731 | 195 |
| Kwinana | Leaded | 544 | 93.5 | 82.5 | 1.5 | 32.5 | 23.2 | 190 | 71.0 | 739 | 201 |
| | ULP | 1554 | 92 | 82.6 | 2.0 | 29.2 | 20.9 | 280 | 70.5 | 730 | 200 |
| | PULP | 110 | 96.6 | 86.5 | 3.1 | 42.7 | 17.0 | 190 | 78.2 | 751 | 191 |
| | Pool | 2208 | 92.6 | 82.8 | 1.9 | 30.7 | 21.3 | 253 | 71.0 | 733 | 200 |
| Altona | Leaded | 889 | 94.3 | 82.5 | 4.3 | | | 500 | 71.2 | 740 | 197 |
| | ULP | 1872 | 91.5 | 82.6 | 3.8 | | | 200 | 70.3 | 733 | 188 |
| | PULP | 68 | 95.8 | 85.3 | 4.0 | | | 200 | 82.6 | 735 | 193 |
| | Pool | 2829 | 92.5 | 82.6 | 4.0 | 28.5 | 17.9 | 294 | 70.9 | 735 | 191 |
| P.Stanvac | Leaded | 400 | 93.3 | 82.5 | 2.9 | | | 6 | | 738 | 193 |
| | ULP | 633 | 91.3 | 83.9 | 2.7 | | | 1 | | 737 | 195 |
| | PULP | 9 | 96.2 | 85.8 | 3.9 | | | 100 | | 729 | 197 |
| | Pool | 1042 | 92.1 | 83.4 | 2.8 | 28.5 | 1.0 | 4 | 72.2 | 737 | 194 |
| Geelong | Leaded | 689 | 94.4 | 82.5 | 2.9 | 29.3 | | 60 | 75.8 | 734 | 187 |
| | ULP | 1659 | 91.4 | 82.1 | 2.3 | 21.9 | | 60 | 75.0 | 743 | 187 |
| | PULP | 100 | 96.3 | 85.9 | 3.6 | 32.4 | | 30 | 69.5 | 746 | 188 |
| | Pool | 2448 | 92.4 | 82.4 | 2.5 | 28.5 | 17.9 | 59 | 75.0 | 741 | 187 |
| Clyde | Leaded | 478 | 94.4 | 82.5 | 2.9 | 30.9 | 18.8 | 500 | 74.1 | 746 | 218 |
| | ULP | 1632 | 92.5 | 82.1 | 2.3 | 29.5 | 15.6 | 220 | 73.6 | 736 | 213 |
| | PULP | 118 | 96.3 | 85.9 | 3.6 | 35.8 | 14.6 | 100 | 75.4 | 752 | 215 |
| | Pool | 2228 | 93.1 | 82.4 | 2.5 | 30.1 | 16.2 | 274 | 73.8 | 739 | 214 |

Data Source: AIP "Australian Refinery Product Characteristics - 1998"

'MVEC/MBE (Explicit) Option' – Scenario 2

It is proposed that Scenario 2 will be as the 'Base Case', with the following additions:

- A further 15% reduction in NAFC through the period 2000 to 2010, taking account of the Government's commitment in its *'Environmental Strategy for the Motor Vehicle Industry', 1997*.
- MVEC (in its original proposal) indicated its *'Preferred Option'* as one of the scenarios to be modelled in this Review. MVEC's *'Revised Preferred Option'* and relevant provisions of the Government's *'Measures for a Better Environment'* are incorporated.
 - Only the fuel parameters and timelines explicitly set out in the MVEC/MBE package will be considered, that is:
 - the sulfur content of diesel fuel; and
 - assumptions in relation to petrol as for the base case.
 - Euro 3 sulfur levels (150 ppm) for petrol introduced in 2005, to coincide with MVEC's proposed Euro 3 emission standard for petrol vehicles in 2005/6.
 - Subsection 4(3) of the *Diesel and Alternative Fuels Grants Scheme Act 1999* states:

In the case of diesel fuel, the Commonwealth intends to restrict entitlements available under the Energy Grants (Credits) Scheme to ultra low sulfur diesel from 1 January 2006, when a mandatory standard to 50 ppm sulfur will come into effect.

This will apply in relation to both on-road and off-road uses of diesel, as the Energy Grants (Credits) Scheme will replace the current Diesel Fuel Rebate Scheme (applying to off-road uses) as well as introducing certain grants to on-road uses of diesel. Therefore, 50 ppm sulfur diesel will be assumed from 1 January 2006.

- Existing off-road diesel standards will be assumed to continue prior to 2006.
- It is assumed, for the purposes of modelling, that the excise advantages for 50 ppm sulfur diesel during the period 2002/5 are intended to flow on to consumers.

'Best Endeavours - MVEC/MBE (Implicit) Option' – Scenario 3

It is proposed that Scenario 3 will be as Scenario 2, with the following additions –

- The introduction of Euro 3 petrol in 2005, with parameters other than sulfur concentration, RON and RVP set on a refinery best endeavours basis. The Euro 3 specifications for petrol are outlined in Section 10.4.
- The introduction of Euro 4 petrol in 2008, with parameters other than sulfur concentration and RVP set on a refinery best endeavours basis.
- The introduction of Euro 4 diesel in 2006, with specific requirements for 50 ppm sulfur.

- Only the sulfur and specifications for petrol and diesel (50 ppm) and the aromatics for petrol (35% vol) have been set for Euro 4. Where Euro 4 specifications for other identified components are not yet available, it has been agreed that the specifications shown in Tables 5-3 and 5-4 (Euro 4 Fuel Specification) will be used for the purposes of modelling.
- Other important parameters (For petrol: benzene, distillation, aromatics, olefins; for diesel: cetane, density, aromatics, PAH, T90) will be discussed with each refiner to determine the approximate cost/benefit break points (which may be different for each refinery). Specifications will be set for each refinery taking account of these breakpoints.
- The cost of dosing with a lubricity additive will also be explicitly developed for this scenario.
- Many stakeholders (particularly in Government) expressed concerns about the GHG emission consequences of projected growth in transportation. Therefore, it is proposed to conduct sensitivity analyses on this scenario to indicate the relative fuel costs and emission benefits of lower growth. Here, it is assumed that overall average GHG commitments set in the Kyoto Protocol would be met (i.e. by scaling back fuel production/demand to give total projected CO₂-equivalent emissions equal to 108% of 1990 emission levels by 2010).

‘Mandatory - MVEC/MBE (Implicit) Option’ – Scenario 4

It is proposed Scenario 4 will be as Scenario 3, except with all the Euro fuel parameters to be mandatory and not on a best endeavours basis.

- The incremental cost of meeting each of the Euro fuel specifications will be identified.
- The AIP considers that 50 ppm sulfur diesel will require a lubricity additive, which will add to the cost. 500 ppm sulfur diesel may not, but would need to be tested to be certain. Otherwise the additive may be needed on conservative grounds, also adding to cost.) Indicative industry cost for 50 ppm sulfur dosing is likely to be of the order of \$10M.
- In order to take account of concerns expressed by Environment Australia and others, it was proposed that as an addition to this scenario the Review Team will make estimates of the benefits that could be obtained by cooperation and linkage of the three East Coast pairs of refineries. Each refining company has agreed to assist by nominating an individual who will separately meet with the Review Team to provide a ‘reality check’ of assumptions made. As this is only a cost issue, and not one of quality or volume, it does not need a separate scenario. As noted in Section 5.1, senior managers from the relevant oil companies indicated that rationalization had been considered and rejected for various economic, technical or political reasons.

‘Euro 4 Transport Fuels By 2006’ – Scenario 5

It is proposed that Scenario 5 will be as Scenario 4 except as follows.

- All parameters for petrol and transport diesel will be set to Euro 4 specifications from 1/1/2006.
- Where specifications for the other identified components are not available, the specifications tabulated in Tables 5-3 and 5.4 of this report will be used for the purposes of modelling.
- Assume 98 RON fuel use by new vehicles produced from 2008.

'Most Stringent Case' – Scenario 6

It is proposed that Scenario 6 will be as Scenario 5, with the following additions –

- a requirement for 30 ppm sulfur in petrol and diesel (as suggested in the Auto Industry's *'World-Wide Fuel Charter'*) is assumed to be applied from 2008.

5.3 Other Considerations

Octane Enhancement Additives

The AIP has advised that some refiners at least, would chose to use MMT and/or MTBE for petrol octane enhancement, given the necessary approval from Government to do so. The use of these additives is permitted within the Euro fuel specifications, and would be particularly important in those scenarios where Euro 4 petrol (with <1% benzene) is included. It is noted that MMT is also an effective lead replacement additive for older engines. The AIP considers debate on issues in respect of both additives should be opened.

The FCAI strongly advise against the use of MMT additives because of Canadian experience where MMT was shown to adversely affect catalyst performance, spark plug durability and sensors for on board diagnostics. The FCAI also considers MBTE should be avoided on the basis of degradation of fuel efficiency performance, adverse emissions impacts and the potential for environmental problems due to the high solubility of MBTE.

It is proposed to develop costs both with and without these additives, at each refinery where their use may be a consideration. Other strategies for achieving desired octane levels will be discussed in the final report.

Euro 4 Fuel Specifications

Euro 4 fuel specifications are not yet finalised by the EU Council and Parliament. The specifications to be used for modelling purposes are shown in Tables 5-3 and 5-4.

Table 5-3: Euro 4 Petrol Specifications and Agreed Levels (for Modelling Purposes) of Components Not Yet Specified for Euro 4

| Parameter | Specification |
|---------------------|---------------|
| Sulfur, %mass max | 0.005* |
| RON min | 95 |
| MON min | 85 |
| Benzene, %vol max | 1 |
| Aromatics, %vol max | 35* |
| Olefins, % vol max | 14 |
| FBP, °C, max | 205 |

*: Specification has been set for Euro 4.
FBP: Final Boiling Point

Table 5-4: Euro 4 Diesel Specifications and Agreed Levels (for Modelling Purposes) of Components Not Yet Specified for Euro 4

| Parameter | Specification |
|--------------------|---------------|
| Sulfur, %mass max | 0.005* |
| Density, kg/L max | 0.845 |
| Cetane Number, min | 55 |
| Cetane Index, min | 52 |
| T95, °C, max | 350 |
| PAH, %mass, max | 4 |

*: Specification has been set for Euro 4.
T95: Distillation temperature at which 95% of the fuel has evaporated
PAH: Polycyclic Aromatic Hydrocarbons

Pool Averaging

EU has adopted maximum limits for relevant parameters in its specifications for fuel quality, whereas the US has adopted a 'pool' system. The AIP indicates a strong preference for 'pool' specifications on an airshed basis.

- The principle of setting an average with a reasonable cap has been agreed in the volatility reduction MOU in NSW.
- For the Base Case and Scenarios 2 and 3, it was proposed to adopt a 'pool' system for those scenarios with specifications that are a relaxation from the Euro standards, except for sulfur levels. This would include a cap and an industry (pool) annual average within the airshed. (The only seasonal specification is volatility, where monthly averaging is appropriate.) In practice, a related specification was adopted for Scenarios 2 and 3, and applied as a cap.
- Sulfur levels are maximum limits and are not amenable to a pool approach.
- The 'pool' system will not be used for Scenarios 4, 5 and 6, where all parameters are mandated.

Projecting Demand Growth In 95 RON PULP

Growth in demand for 95 RON PULP will largely be driven by the assumption of a 2 c/L PULP/ULP differential in all scenarios, based on import price parities. In order to model PULP/ULP demand volumes, it will be necessary to make assumptions on the proportions of new vehicles (together with their likely model average fuel consumption) that will be optimised for PULP and ULP. The FCAI have indicated that between 2000 and 2002 vehicle owners would be expected to continue to use 91 RON unless incentives are provided to encourage the use of 95 RON.

RON fuel usage for all new imported vehicles from 2005/6 was adopted for Scenarios 2 to 6.

98 RON ULP

The FCAI believes that 98 RON is essential to assist in achieving NAFC reductions and Euro 4 fuel specifications. AIP members are not in favour of a move to 98 RON, believing it to be beyond the optimal RON for overall greenhouse performance.

98 RON for all new vehicles from 2008/9 for was adopted Scenarios 5 and 6.

Dual Grade Diesel Distribution

MVEC's proposal covers road transport fuels only (i.e. registered vehicles), which leaves open the possibility of a dual grade (on-road/off-road) distribution for diesel. As part of the scenario evaluation, each refiner will provide commentary and cost estimates for on-road/off-road and city/country options prior to mandatory dates, and options for delivering off-road diesel at on-road quality as a trade off against infrastructure costs.

It is proposed to seek advice from diesel engine suppliers on what if any limitations should be applied for off-road diesel quality, in particular for mining and agricultural plant and equipment.

Likely Capital Cost Estimates

AIP advised that the capital costs likely to be derived through this Review, will be lower than were estimated by members in earlier studies. This is because of the rapid change in technological development and resultant cost reduction. Concawe 99/56 study, just released, states "Concawe's view of the cost of diesel fuel sulfur reduction up until recently were somewhat overstated because not enough allowance was made for emerging new advances of gas oil hydrodesulfurisation technology (new catalysts etc)."

5.4 Adopted Scenarios in Detail

Scenario 1 - Base Case

- Vehicle assumptions –
 - ADR 37.01 and ADR 70 ongoing.
 - Allowance of Euro 2 and 3 as alternates to ADR 37.01, from 2000.
 - 10% NAFC reduction 1990 to 2000 for cars.
 - Additional 10% NAFC reduction (1% per year) 2000 to 2010 for cars.
 - Continuation of current trends in fuel mix (petrol/diesel/LPG/CNG).
 - Business as usual growth scenario for VKT.
 - Petrol quality assumptions: current standards ongoing except –
 - Leaded petrol phased out by 1/1/2002.
 - Increase in PULP demand for imported (and some locally produced) Euro 2/3 vehicles during 2000/2002.
 - Further increase in PULP demand from 2002, in response to a reduction in the PULP/ULP retail price differential to 2 c/litre.
 - Reductions in petrol volatility/sulfur in train or planned, following agreements with the States.
 - Road transport diesel quality assumptions: current standards ongoing except reductions in sulfur in train or planned, *as agreed by individual companies*. For BP, this will include –
 - 500 ppm urban / 2000 ppm country in WA from 1/1/2000;
 - 500 ppm urban in Brisbane from 1/7/2000, position on country level to be clarified by BP.
- For other refiners this will include –
- 1000 ppm pool average urban / 2000 ppm pool average country, with +500 ppm caps, from 1/1/2000.
- Off-road diesel quality assumptions –
 - no changes from current standards.

Scenario 2 - MVEC/MBE (Explicit) Option

- Vehicle assumptions –
 - ECE compliance allowed as an alternative to ADR 37.01 from 2000 (= base case).
 - Euro 2 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2003/4.
 - Euro 3 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2005/6.
 - View to adopt Euro 4 for petrol vehicles at a later date (after review in 2000/2001). For the purposes of analysis of this scenario it is assumed that Euro 4 standards for petrol vehicle are not adopted prior to 2010.
 - 10% NAFC reduction 1990 to 2000 for cars (= base case).
 - Additional 10% NAFC reduction 2000 to 2010 for cars (= base case).
 - Additional 15% NAFC reduction 2000 to 2010 for cars, 4WDs and LCVs >3.5 tonnes.
 - Euro 3 for all medium and heavy diesel trucks (>3.5 tonnes)(with US 98 as alternate) from 2002/3.
 - Euro 2 for diesel passenger cars, light trucks and buses (<3.5 tonnes) from 2002/3.
 - Euro 4 for all diesel vehicles (with US 2004 as alternate) from 2006/7.
 - Increasing conversions to CNG/LPG in response to Government subsidies for vehicles >3.5 tonnes. (Up to 800 buses, 4000 commercial vehicles per year over the first four years).
 - Business as usual growth scenario for VKT (= base case).
- Petrol quality assumptions –
 - Leaded petrol phased out by 1/1/2002 (= base case).
 - Increase in PULP demand for imported (and some locally produced) Euro 2/3 vehicles during 2000/2002 (= base case).
 - Further increase in PULP demand from 2002, in response to a reduction in the PULP/ULP retail price differential to 2 c/litre (= base case).
 - 95 RON for all new vehicles from 2005/6.
 - Reductions in petrol volatility in train or planned, following agreements with the States (= base case).
 - Euro 3 sulfur level (50 ppm) to be introduced in 2005, coinciding with MVEC's proposed Euro 3 emission standards for petrol vehicles in 2005/6.

- Road transport diesel quality assumptions –
 - Voluntary reduction of sulfur in urban areas to 500 ppm through 2000/2, on a best endeavours basis.
 - Sulfur set at 500 ppm (= Euro 2 sulfur level) from 1/12/2002.
 - 1 c/L excise advantage for 50 ppm sulfur diesel during 2003.
 - 2 c/L excise advantage for 50 ppm sulfur diesel during 2004/5.
 - Sulfur set at 50 ppm (= Euro 4 sulfur level) from 2006.

- Off-road diesel quality assumptions –
 - 50 ppm sulfur from 2006. Current specifications continuing prior to 2006.

Scenario 3 – Best Endeavours - MVEC/MBE (Implicit) Option

- Vehicle assumptions -
 - ECE compliance allowed as an alternative to ADR 37.01 from 2000 (= base case).
 - Euro 2 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2003/4 (= Scenario 2).
 - Euro 3 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2005/6 (= Scenario 2).
 - Euro 4 for all petrol vehicles from 2008/9.
 - 10% NAFC reduction 1990 to 2000 for cars (= base case).
 - Additional 10% NAFC reduction 2000 to 2010 for cars (= base case).
 - Additional 15% NAFC reduction 2000 to 2010 for cars, 4WDs and LCVs >3.5 tonnes (= Scenario 2).
 - Euro 3 for all medium and heavy diesel trucks (>3.5 tonnes)(with US 98 as alternate) from 2002/3 (= Scenario 2).
 - Euro 2 for diesel passenger cars, light trucks and buses (<3.5 tonnes) from 2002/3 (= Scenario 2).
 - Euro 4 for all diesel vehicles (with US 2004 as alternate) from 2006/7 (= Scenario 2).
 - Increasing conversions to CNG/LPG in response to Government subsidies for vehicles >3.5 tonnes. (Up to 800 buses, 4000 commercial vehicles per year over the first four years) (= Scenario 2).
 - Business as usual growth scenario for VKT (= base case).

- Petrol quality assumptions -
 - Leaded petrol phased out by 1/1/2002 (= base case).
 - Sulfur 500 ppm (= Euro 2 sulfur level) from 2002
 - Euro 3 petrol from 2005. Specifications for parameters other than sulfur concentration, RON and RVP to be set on a refinery best endeavours basis (based on best cost/benefits breakpoints for each refinery). Euro 3 specifications for petrol are outlined in Section Table 5-5.
 - 95 RON for all new vehicles from 2005/6.
 - Euro 4 petrol from 2008 on best endeavours basis, as for 2005 adoption of Euro 3. The Euro 4 specifications for petrol to be adopted for modelling purposes are outlined in Table 5-3.
 - Increase in PULP demand for imported (and some locally produced) Euro 2/3 vehicles during 2000/2002 (= base case).
 - Further increase in PULP demand from 2002, in response to a reduction in the PULP/ULP retail price differential to 2 c/litre (= base case).
 - Reductions in petrol volatility in train or planned, following agreements with the States (= base case).
- Road transport diesel quality assumptions –
 - Voluntary reduction of sulfur in urban areas to 500 ppm through 2000/2, on a best endeavours basis (= Scenario 2).
 - Sulfur set at 500 ppm from 1/12/2002 (= Scenario 2).
 - 1 c/L excise advantage for 50 ppm sulfur diesel during 2003 (= Scenario 2).
 - 2 c/L excise advantage for 50 ppm sulfur diesel during 2004/5 (= Scenario 2).
 - Euro 4 diesel from 2006, with specific requirement for 50 ppm sulfur. Specifications for parameters other than sulfur to be based on best cost/benefit breakpoints for each refinery. The Euro 4 specifications for diesel to be adopted for modelling purposes are outlined in Section 9.2.
- Off-road diesel quality assumptions –
 - 50 ppm sulfur from 2006. Current specifications continuing prior to 2006.

Scenario 4 – Mandatory - MVEC/MBE (Implicit) Option

- Vehicle assumptions -
 - ECE compliance allowed as an alternative to ADR 37.01 from 2000 (= base case).
 - Euro 2 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2003/4 (= Scenario 2).
 - Euro 3 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2005/6 (= Scenario 2).
 - 10% NAFC reduction 1990 to 2000 for cars (= base case).
 - Additional 10% NAFC reduction 2000 to 2010 for cars (= base case).
 - Additional 15% NAFC reduction 2000 to 2010 for cars, 4WDs and LCVs >3.5 tonnes (= Scenario 2)
 - Euro 3 for all medium and heavy diesel trucks (>3.5 tonnes)(with US 98 as alternate) from 2002/3 (= Scenario 2).
 - Euro 2 for diesel cars, light trucks and buses (<3.5 tonnes) from 2002/3 (= Scenario 2).
 - Euro 4 for all diesel vehicles (with US 2004 as alternate) from 2006/7 (= Scenario 2).
 - Increasing conversions to CNG/LPG in response to Government subsidies for vehicles >3.5 tonnes. (Up to 800 buses, 4000 commercial vehicles per year over the first four years) (= Scenario 2).
 - Business as usual growth scenario for VKT (= base case).
- Petrol quality assumptions –
 - Leaded petrol phased out by 1/1/2002 (= base case).
 - Sulfur 500 ppm (= Euro 2 sulfur level) from 2002
 - Euro 3 petrol from 2005. Specific, mandatory, requirements to be set for RVP, benzene, sulfur, aromatics and olefins, as outlined in Table 5-5.

Table 5-5: Euro 3 Specifications for Petrol

| Parameter | Specification |
|------------------------------------------------------------------|-----------------|
| RON, min | 95 |
| MON, min | 85 |
| Sulfur (ppm) | 150 |
| Distillation - evaporated at 100 ⁰ C, min (%vol) | 46 |
| Distillation - evaporated at 150 ⁰ C, min (%vol) | 75 |
| Oxygen content, max (%mass) | |
| RVP, summer period (max, kPa) | 60 |
| Benzene, max (%vol) | 1 |
| Aromatics, max (% vol) | 42 |
| Olefins, max (% vol) | 18 ¹ |
| Oxygenates, max: | |
| Methanol (%vol) | 3 |
| Ethanol (%vol) | 5 |
| Iso-propyl alcohol (%vol) | 10 |
| Tert-butyl alcohol (% vol) | 7 |
| Iso-butyl alcohol (% vol) | 10 |
| Ethers containing five or more carbon atoms per molecule (% vol) | 15 |
| Other oxygenates (% vol) | 10 |
| Lead content (g/L) | 0.005 |

1: Except for ULP with minimum MON of 81 and RON of 91, for which the maximum olefin content shall be 21% vol.

max: maximum

%vol: Percentage by volume

%mass: Percentage by mass

- 95 RON for all new vehicles from 2005/6.
- Euro 4 petrol from 2008 (all specifications mandatory). The Euro 4 specifications for petrol to be used for modelling purposes are outlined in Table 5-3.
- Increase in PULP demand for imported (and some locally produced) Euro 2/3 vehicles during 2000/2002 (= base case).
- Further increase in PULP demand from 2002, in response to a reduction in the PULP/ULP retail price differential to 2 c/litre (= base case).
- Reductions in petrol volatility in train or planned, following agreements with the States (= base case).
- Road transport diesel quality assumptions –
 - Voluntary reduction of sulfur in urban areas to 500 ppm through 2000/2, on a best endeavours basis (= Scenario 2)
 - Sulfur set at 500 ppm from 1/12/2002 (= Scenario 2).
 - 1 c/L excise advantage for 50 ppm sulfur diesel during 2003 (= Scenario 2).

- 2 c/L excise advantage for 50 ppm sulfur diesel during 2004/5 (= Scenario 2).
- Euro 4 diesel from 2006 (all specifications mandatory). The Euro 4 specifications for diesel to be used for modelling purposes are outlined in Table 5-4.
- Off-road diesel quality assumptions –
 - 50 ppm sulfur from 2006. Current specifications continuing prior to 2006.

This scenario will also include estimates of the benefits that might be obtained by cooperation and linkage of the three East Coast pairs of refineries.

Scenario 5 – Euro 4 Transport Fuels By 2006

- Vehicle assumptions -
 - ECE compliance allowed as an alternative to ADR 37.01 from 2000 (= base case).
 - Euro 2 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2003/4 (= Scenario 2).
 - Euro 3 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2005/6 (= Scenario 2).
 - Euro 4 for all petrol vehicles 2008/9 (= Scenario 3).
 - 10% NAFC reduction 1990 to 2000 for cars (= base case).
 - Additional 10% NAFC reduction 2000 to 2010 for cars (= base case).
 - Additional 15% NAFC reduction 2000 to 2010 for cars, 4WDs and LCVs >3.5 tonnes (= Scenario 2).
 - Euro 3 for all medium and heavy diesel trucks (>3.5 tonnes)(with US 98 as alternate) from 2002/3 (= Scenario 2).
 - Euro 2 for diesel cars, light trucks and buses (<3.5 tonnes) from 2002/3(= Scenario 2).
 - Euro 4 for all diesel vehicles (with US 2004 as alternate) from 2006/7 (= Scenario 2).
 - Increasing conversions to CNG/LPG in response to Government subsidies for vehicles >3.5 tonnes. (Up to 800 buses, 4000 commercial vehicles per year) (= Scenario 2).
 - Business as usual growth scenario (= base case).
- Petrol quality assumptions –
 - Leaded petrol phased out by 1/1/2002 (= base case).
 - Sulfur 500 ppm (= Euro 2 sulfur level) from 2002 (= Scenario 2).

- Euro 3 petrol from 2005. Specific, mandatory, requirements to be set for RVP, benzene, sulfur, aromatics and olefins, as outlined in Table 5-6.
- 95 RON for all new vehicles from 2005/6
- 98 RON for all new vehicles from 2008/9
- Euro 4 quality from 2006. The Euro 4 specifications for petrol to be used for modelling purposes are outlined in Table 5-3.
- Increase in PULP demand for imported (and some locally produced) Euro 2/3 vehicles during 2000/2002 (= base case).
- Further increase in PULP demand from 2002, in response to a reduction in the PULP/ULP retail price differential to 2 c/litre (= base case).
- Reductions in petrol volatility in train or planned, following agreements with the States (= base case).
- Road transport diesel quality assumptions –
 - Voluntary reduction of sulfur in urban areas to 500 ppm through 2000/2, on a best endeavours basis (= Scenario 2)
 - Sulfur set at 500 ppm from 1/12/2002 (= Scenario 2).
 - 1 c/L excise advantage for 50 ppm sulfur diesel during 2003 (= Scenario 2).
 - 2 c/L excise advantage for 50 ppm sulfur diesel during 2004/5 (= Scenario 2).
 - Euro 4 diesel from 2006 (all specifications mandatory). The Euro 4 specifications for diesel to be used for modelling purposes are outlined in Table 5-4.
- Off-road diesel quality assumptions –
 - 50 ppm sulfur from 2006. Current specifications continuing prior to 2006.

Scenario 6 – Most Stringent Case

- Vehicle assumptions -
 - ECE compliance allowed as an alternative to ADR 37.01 from 2000 (= base case).
 - Euro 2 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2003/4 (= Scenario 2).
 - Euro 3 for all petrol vehicles < 3.5 tonnes (US 1996 HDV for >3.5 tonnes) from 2005/6 (= Scenario 2).
 - Euro 4 for all petrol vehicles 2008/9 (= Scenario 3).
 - 10% NAFC reduction 1990 to 2000 for cars (= base case).
 - Additional 10% NAFC reduction 2000 to 2010 for cars (= base case).
 - Additional 15% NAFC reduction 2000 to 2010 for cars, 4WDs and LCVs >3.5 tonnes (= Scenario 2).
 - Euro 3 for all medium and heavy diesel trucks (>3.5 tonnes)(with US 98 as alternate) from 2002/3 (= Scenario 2).

- Euro 2 for diesel passenger cars, light trucks and buses (<3.5 tonnes) from 2002/3(= Scenario 2).
- Euro 4 for all diesel vehicles (with US 2004 as alternate) from 2006/7 (= Scenario 2).
- Increasing conversions to CNG/LPG in response to Government subsidies for vehicles >3.5 tonnes. (Up to 800 buses, 4000 commercial vehicles per year) (= Scenario 2).
- Business as usual growth scenario (= base case).

- Petrol quality assumptions –
 - Leaded petrol phased out by 1/1/2002 (= base case).
 - Sulfur 500 ppm (= Euro 2 sulfur level) from 2002 (= Scenario 2).
 - Euro 4 quality (all parameters including volatility) from 2005. The Euro 4 specifications for petrol to be used for modelling purposes are outlined in Table 5-3.
 - Long term goal – 30 ppm sulfur by 2008.
 - Increase in PULP demand for imported (and some locally produced) Euro 2/3 vehicles during 2000/2002 (= base case).
 - Further increase in PULP demand from 2002, in response to a reduction in the PULP/ULP retail price differential to 2 c/litre (= base case).
 - 95 RON for all new vehicles from 2005/6 (= Scenario 2).
 - 98 RON for all new vehicles from 2008/9 (= Scenario 5).
 - Reductions in petrol volatility in train or planned, following agreements with the States (= base case).

- Diesel quality assumptions (road and off-road) –
 - Voluntary reduction of sulfur in urban areas to 500 ppm through 2000/2, on a best endeavours basis (= Scenario 2).
 - Sulfur set at 500 ppm from end 2002 (= Scenario 2).
 - 1 c/L excise advantage for 50 ppm sulfur diesel during 2003 (= Scenario 2).
 - 2 c/L excise advantage for 50 ppm sulfur diesel during 2004/5 (= Scenario 2).
 - Euro 4 quality from 2005. The Euro 4 specifications for diesel to be used for modelling purposes are outlined in Table 5-4.
 - Long term goal - 30 ppm sulfur by 2008.

The six scenarios for fuel quality are summarised in Table 5-6.

Table 5-6: Adopted Fuel Scenarios in Summary

| Scenario | Description | 2002 | 2005 | 2006 | 2008 |
|----------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1 | Base case | Business as usual: 2 c/L PULP/ULP differential from 2002; LP out in 2002; RVP reduced as per State agreements. On road diesel: BP at 500ppm urban / 2000 ppm country in WA from 1/1/00; 500 ppm urban in Brisbane from 1/7/00, country Qld 2000. Other members: 1000 ppm av urban / 2000 ppm av country with +500 caps, from 1/1/00. Off road diesel: no change from present position. | Petrol: 150 ppm S 95 RON for all new vehicles. On road diesel: excise reductions on 50 ppm S: 1 c/L in 2003; 2 c/L in 2004/5 Off road diesel: no change from present | On road diesel: 50 ppm S Off road diesel: 50 ppm S | Euro 4 petrol specifications other than sulfur based on best cost/benefit breakpoint for each refinery. |
| 2 | MVEC/MBE (Explicit) Option | Petrol: 500 ppm S On road diesel: best endeavours to achieve metro diesel 500 ppm ahead of 1/12/02; 500 ppm for all on road from 1/12/02. Off road diesel: no change from present | As for Scenario 2 but also: Petrol: Euro 3 with specific requirements for RVP, benzene, sulfur, aromatics and olefins. Specifications for parameters other than S based on best cost/benefit breakpoints for each refinery. | On road diesel with specific requirement for 50 ppm sulfur. Specifications for parameters other than S based on best cost/benefit breakpoints for each refinery. Off road diesel: 50 ppm S. | Euro 4 petrol specifications other than sulfur based on best cost/benefit breakpoint for each refinery. |
| 3 | Best Endeavours MVEC/MBE (Implicit) Option | Petrol - 500 ppm sulfur On road diesel - 500 ppm sulfur Off road diesel: no change from present | As for Scenario 2 but also: Petrol: Euro 3 with specific requirements for RVP, benzene, sulfur, aromatics and olefins. Specifications for parameters other than S based on best cost/benefit breakpoints for each refinery. | On road diesel with specific requirement for 50 ppm sulfur. Specifications for parameters other than S based on best cost/benefit breakpoints for each refinery. Off road diesel: 50 ppm S. | Euro 4 petrol specifications other than sulfur based on best cost/benefit breakpoint for each refinery. |
| 4 | Mandatory MVEC/MBE (Implicit) Option | As for Scenario 3 | As for Scenario 3 but set specifications for all parameters to be mandatory | As for Scenario 3 but set specifications for all parameters to be mandatory | Euro 4 petrol specifications mandated. |
| 5 | Euro 4 Transport Fuels by 2005 | As for Scenario 3 | As for Scenario 3 | As for Scenario 3 but also: Petrol: Euro 4 | 98 RON for all new vehicles |
| 6 | Most stringent | As for Scenario 3 | Petrol: Euro 4 complete RVP=60 kPa All diesel: Euro 4 complete | | 98 RON for all new vehicles. Petrol: 30 ppm S All diesel: 30 ppm S |