

How Do New Zealand's Fuels Stack Up?

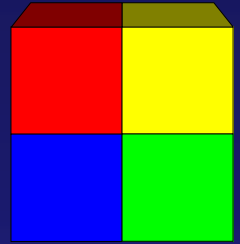
Barry Blackett

BP Oil NZ Ltd

June 2001

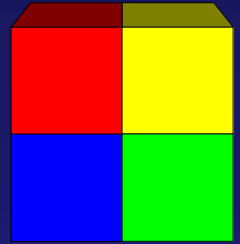


The New Zealand Road to Cleaner Air



How NZ's Fuels have Evolved

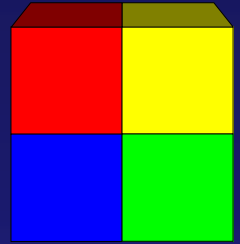
- ❑ **Refinery expansion 1986**
 - Able to process a wide range of crudes
 - Focus on middle distillates – Hydrocracker
 - Reformer upgrade but no other gasoline capability
 - Refinery-to-Auckland pipeline and Wiri terminal
- ❑ **Synfuels plant**
 - 92 octane, low benzene base gasoline
- ❑ **Deregulation 1988**
 - National Fuels Specifications – ESS Test Programme
- ❑ **Unleaded transition 1996**
 - Imported blend components used to balance out aromatics



Specifications

- ❑ Performance
- ❑ Safety
- ❑ Health and Environment
- ❑ No-harm

Combination of above – sometimes in conflict

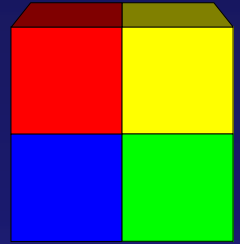


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New Zealand's fuel specifications have evolved from the British Standard and early European specifications

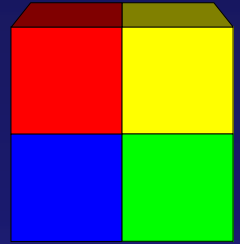


Petrol - Octane Quality

- Premium Grade
 - Regulated 95/85
 - Voluntary 96/86

- Regular Grade
 - Regulated and voluntary 91/82

- High Octane Grades
 - 'Boutique' grades beginning to appear in some locations

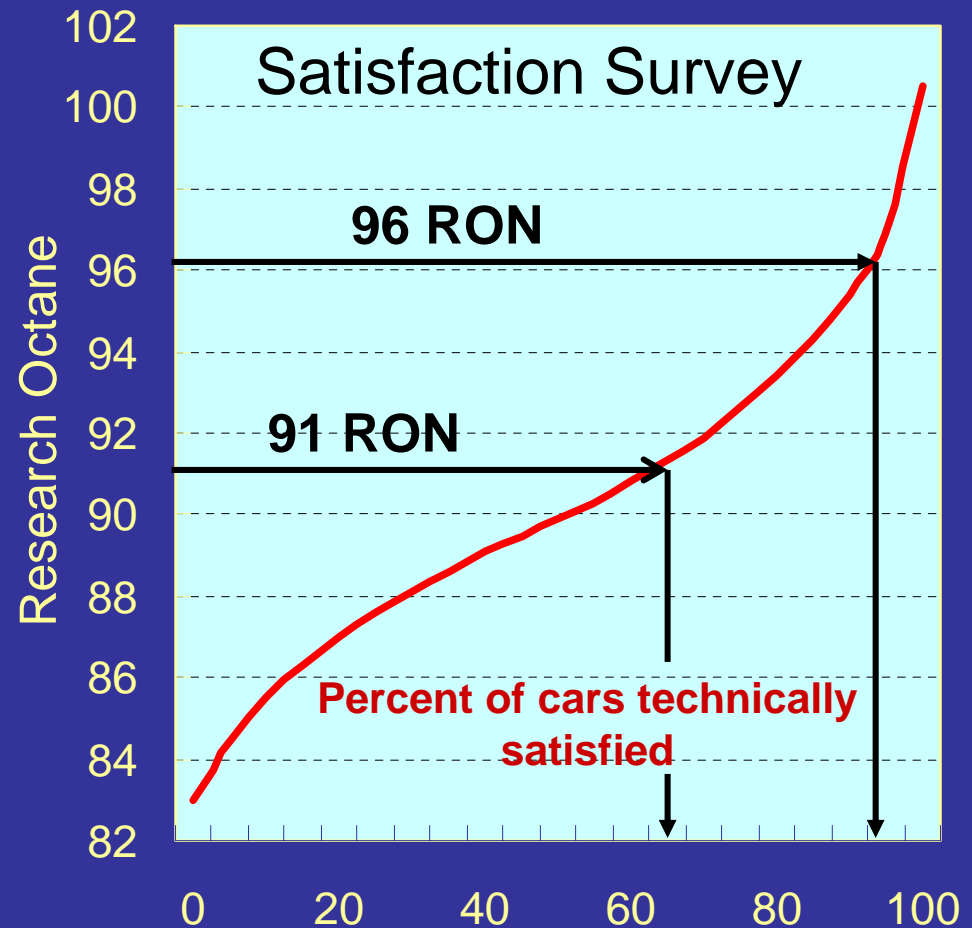


Petrol - Octane Quality

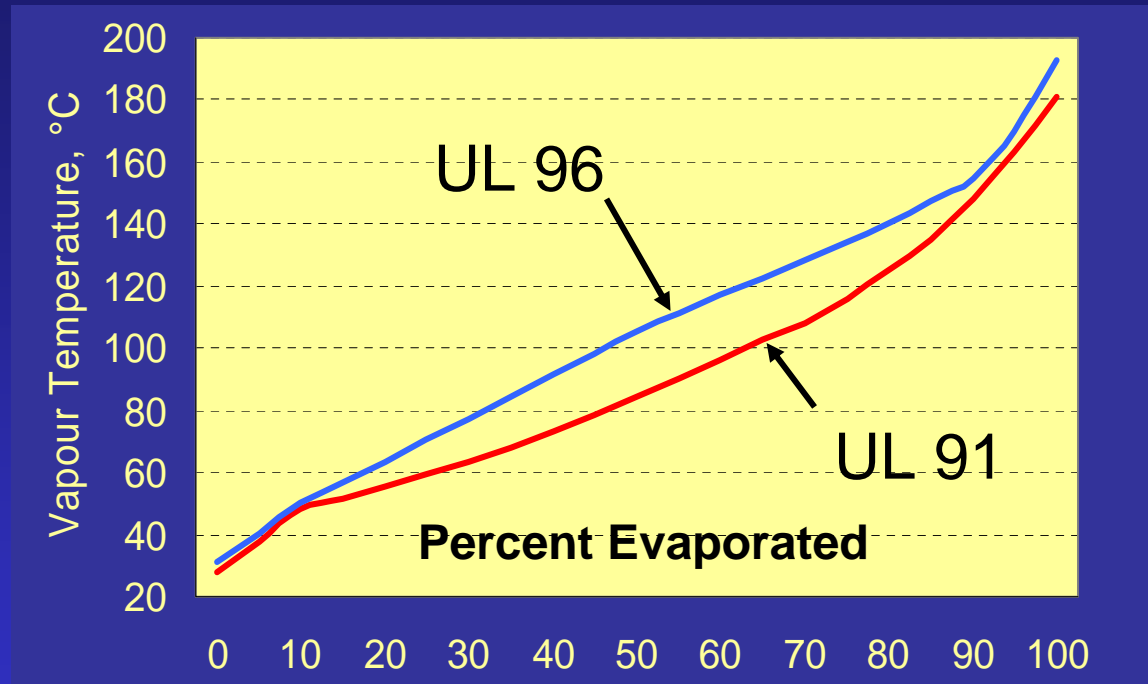
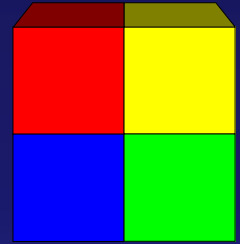
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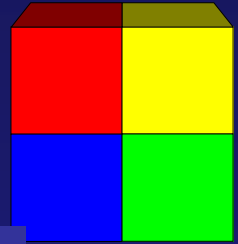


Vapour Pressure and Distillation

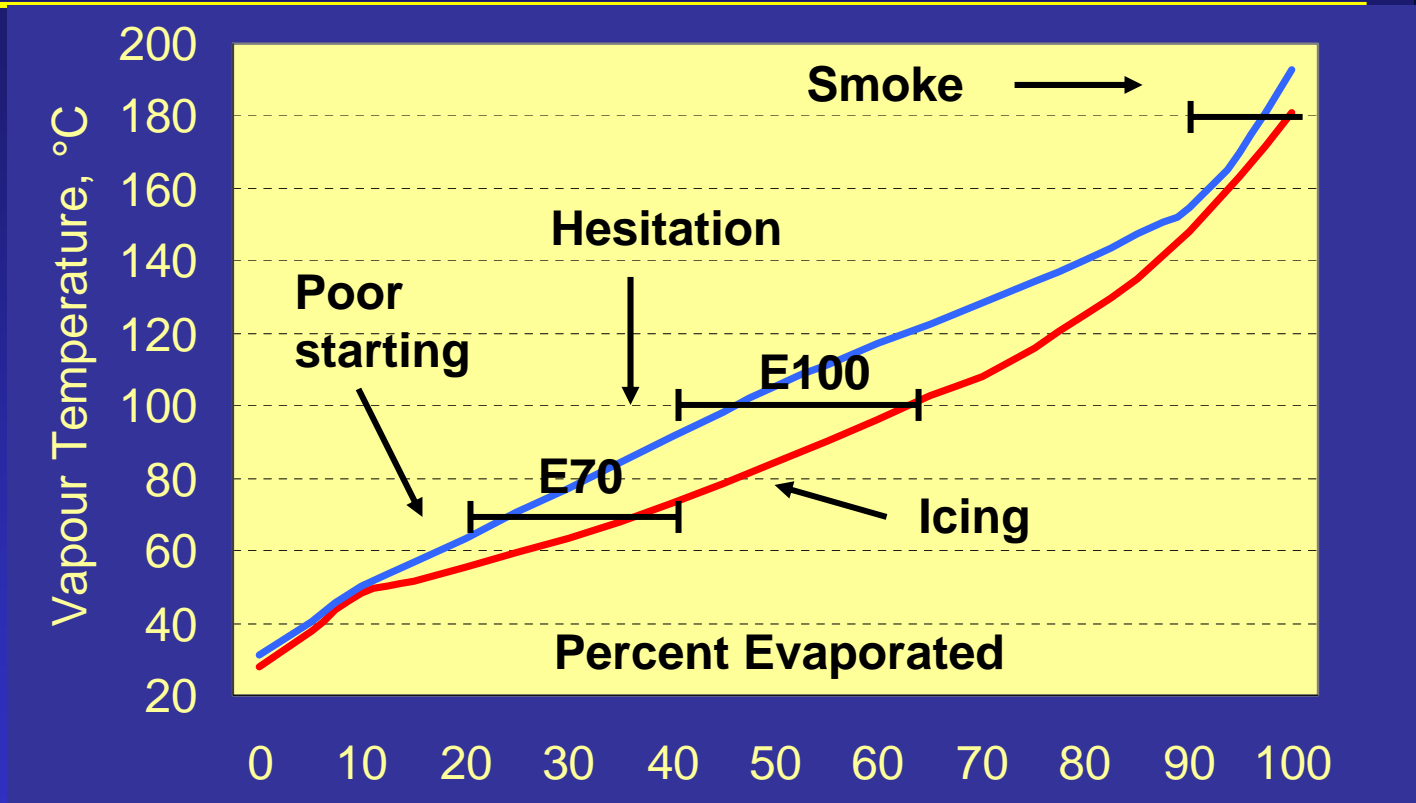


Good starting and good driveability requires -

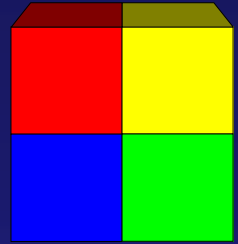
- Adequate vapour pressure (RVP)
- Good but not excessive volatility throughout the distillation range
- However, high vapour pressure leads to high evaporative emissions



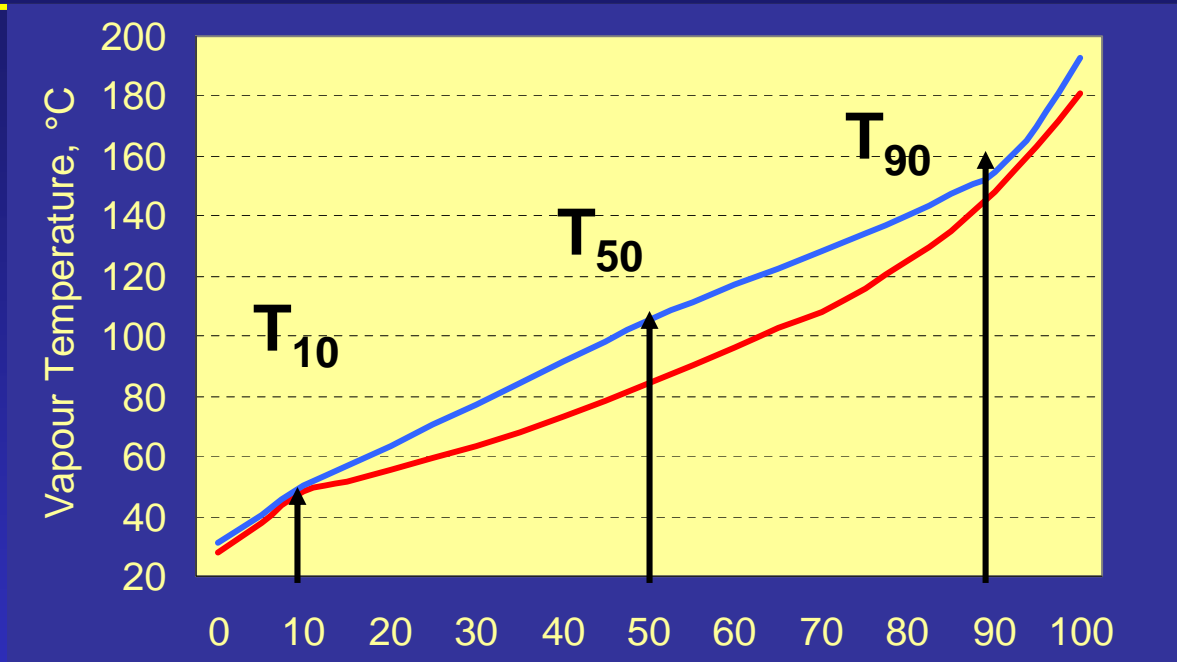
Distillation – Driveability



Distillation properties are controlled by forcing the curve through gates – E70, E100 and E150 (or E180)



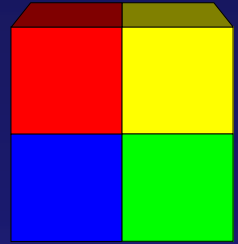
Driveability Index



For carburetted cars in temperate climates

$$DI = 1.5 \times T_{10} + 3 \times T_{50} + T_{90}$$

Both grades have good DI values – Avg 495 and 540 respectively



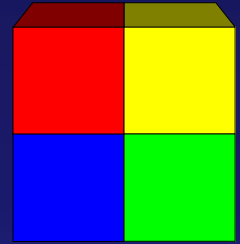
Petrol – Health Properties

□ Lead

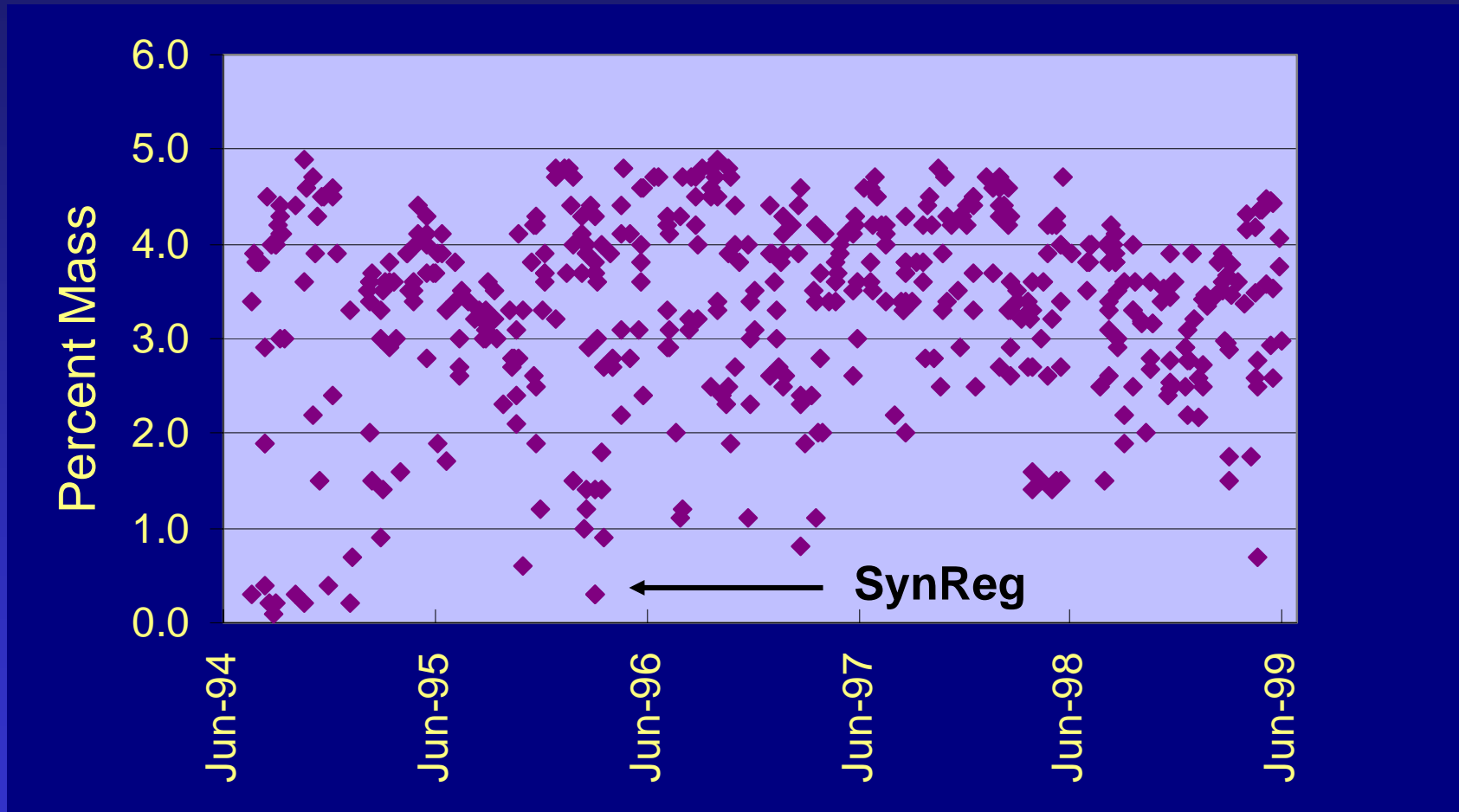
- Nerve poison - behavioural problems and child mental development
- Leaded petrol - greatest contribution to the lead burden in the environment but severe cases of poisoning related mainly to lead in paint, food cans and water pipes

□ Benzene

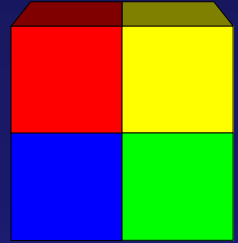
- A known carcinogen
- Associated with AML but only with prolonged exposures at quite high levels
- Effect uncertain at low levels - is a risk factor. Aim is to reduce risk from '*very low*' to '*exceedingly low*'
- Current OECD trend is to bring levels in gasoline down from 5% to 1% max



Benzene in Unleaded 91



Health and Environmental Properties 2



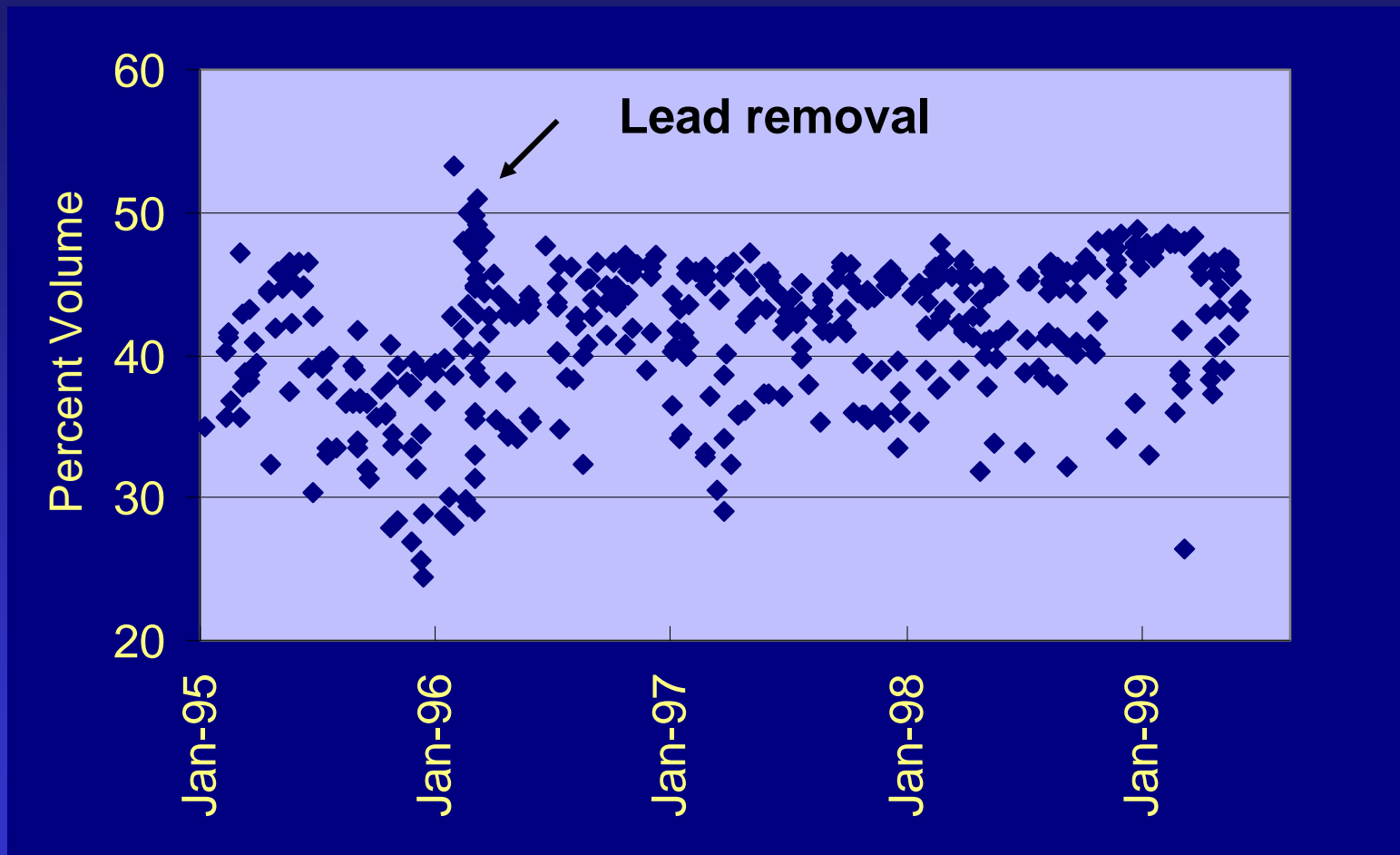
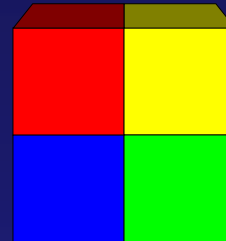
□ Aromatics

- Guarantees on fuel system elastomers require aromatics levels to remain below 50%
- Generate benzene on combustion but effect is small compared to effect of benzene itself in the fuel
- Are photochemically active → Ground level ozone
- Effects on exhaust emissions - NO_x, CO etc are equivocal

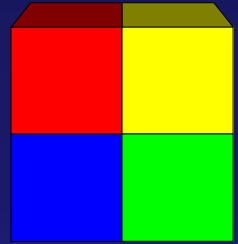
□ Olefins

- Arise from presence of cracked spirit in gasoline
- Generate butadiene – a carcinogen
- Are photochemically very active

Aromatics in Premium Unleaded



Health and Environmental Properties 2



□ Aromatics

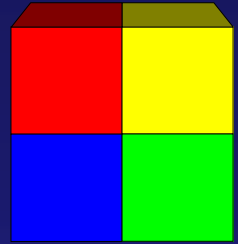
- Loose fuel system elastomer guarantees if above 50%
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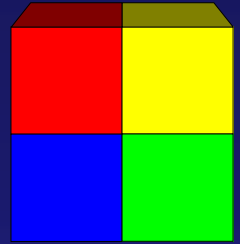
□ MTBE (and other Octane Enhancers)

- Health effects uncertain – nauseous odour in still air
- Poor biodegradability – contamination of underground aquifers

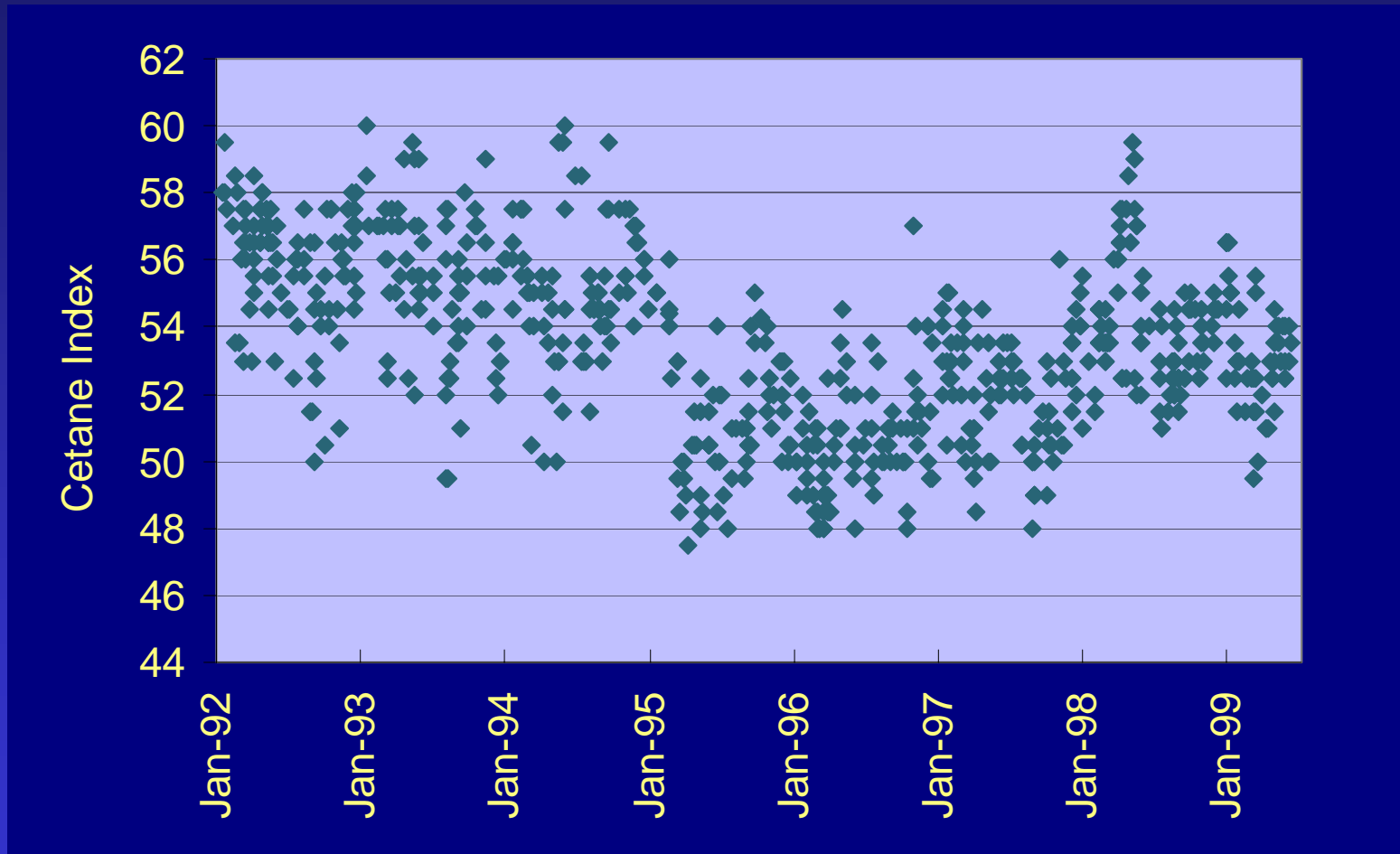


Diesel – Burning Properties

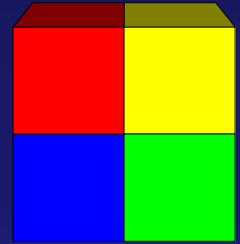
- **Cetane quality (CN / CI)**
 - Faster burning -> easier starting, less unburnt hydrocarbon and CO emissions, lower aldehydes (odour) and smoke
 - Hydroprocessing and effect of low sulphur
- **Distillation**
 - Heavy ends is main concern
 - Controlled using maximum distillation temperature limits - T85 and/or T95
- **Aromatics**
 - Concern is di- and tri-aromatics -> PAH and black smoke
- **Density**
 - Correlates with above properties, hence good indicator



Diesel – Cetane Index

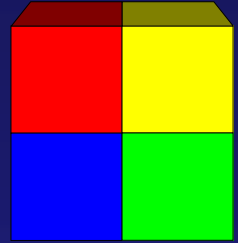


Total Sulphur



- Above 5000 ppm
 - **Power station and bunker fuels**
 - Main concern – Acid rain
 - Not a problem in New Zealand
- 500 to 5000 ppm
 - **Conventional automotive diesel**
 - Fine particulates
 - Particulates made up of sulphates and carbonaceous material
 - Oxidation catalysts can increase particulate count
- 50 to 500 ppm
 - **Low sulphur diesel**
 - Still high enough to impair performance of emission control devices
- Below 50 ppm
 - **Ultra-low sulphur diesel.** 2005 European target

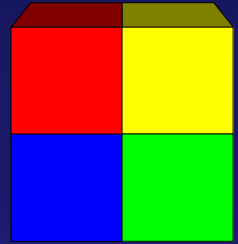
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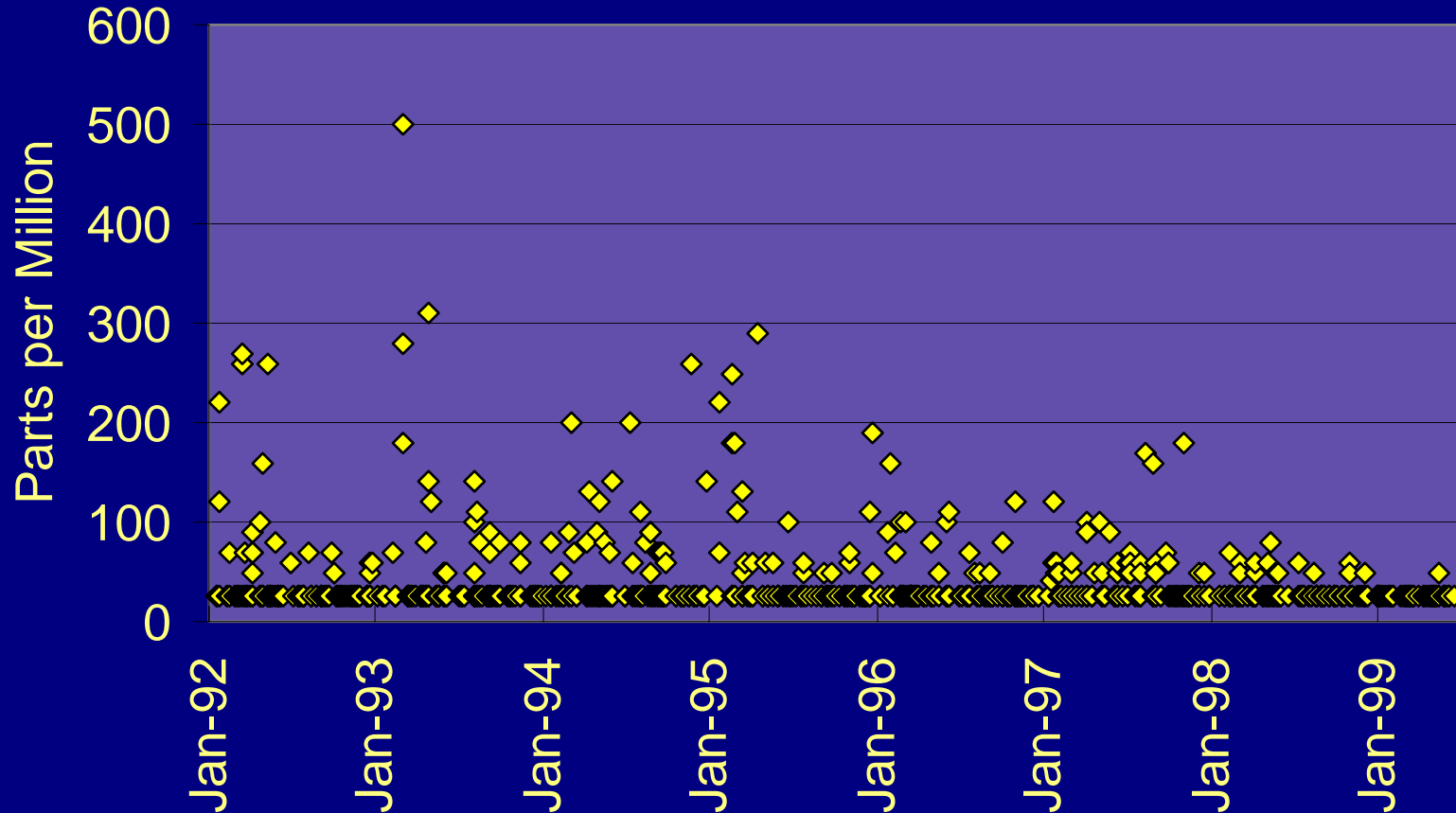
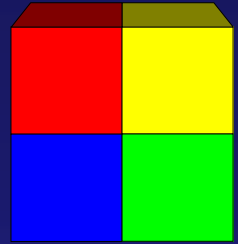
NZRC (60%)

- 10 – 50 ppm
- Euro 4 2005 standard

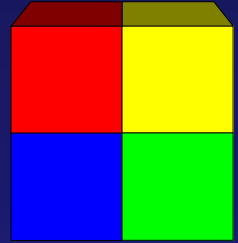
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Sulphur in Premium Unleaded



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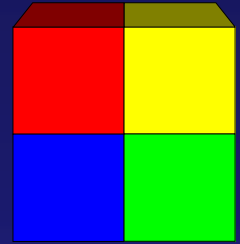
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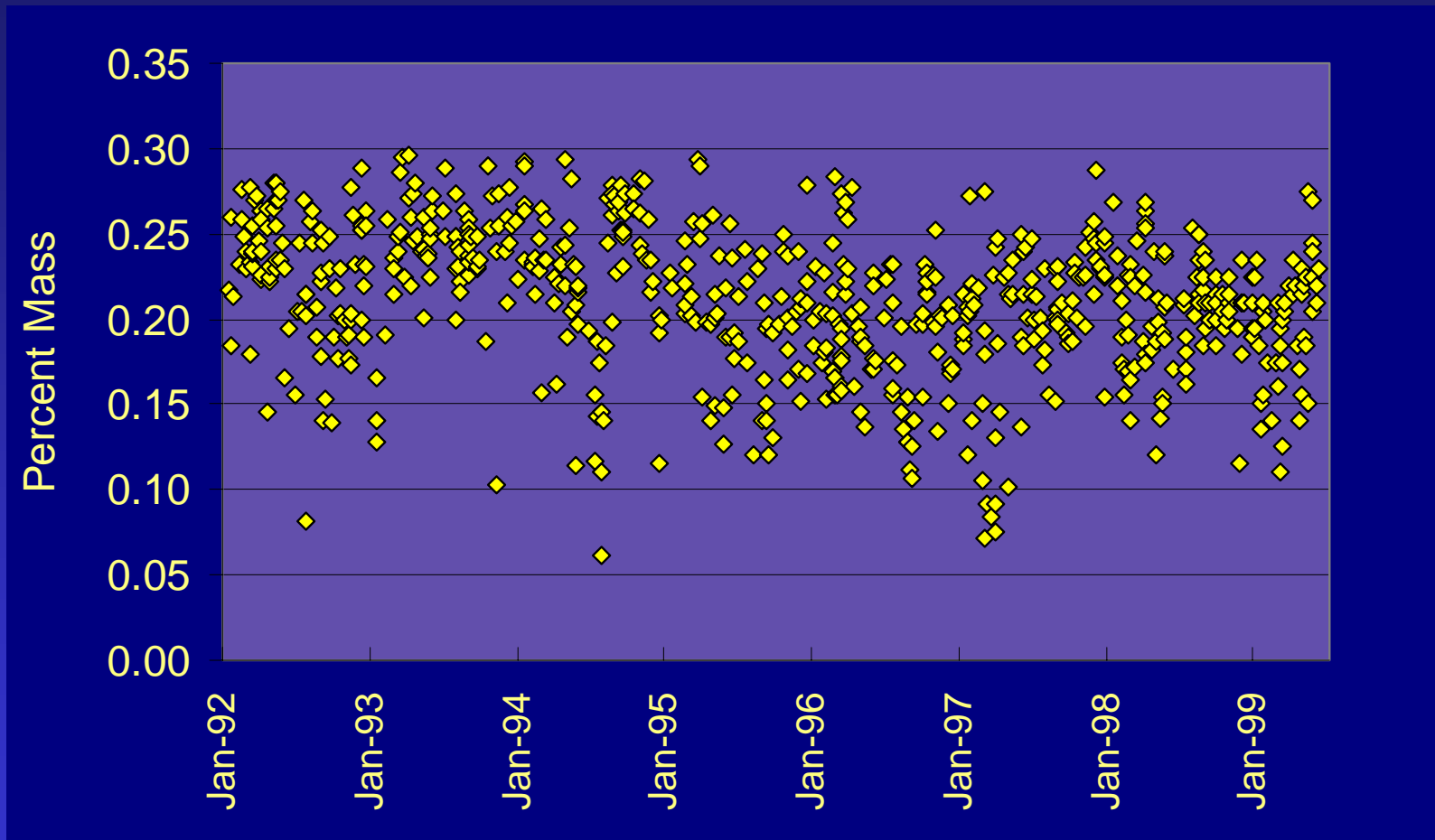
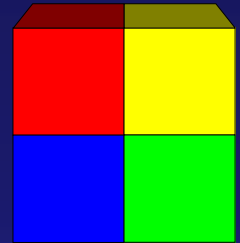
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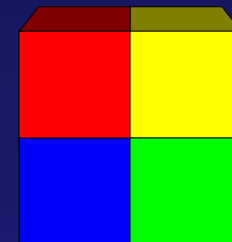
NZRC (90%)

- 1000 – 3000 ppm depending on crude diet, averaging 2200 ppm
- Pre Euro 2 standard

Total Sulphur in Diesel



Scorecard



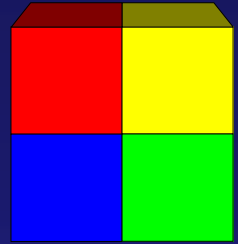
- 5 Euro 2005 standard
- 3 Good current standard
- 1 Mid-1990's pre-Euro 2 level

Petrol

- Vapour pressure 2
- Distillation 4
- Lead 5
- Benzene and Aromatics 1
- Olefins 5
- MTBE etc 4
- Sulphur 4

Diesel

- Cetane 4
- Distillation – Heavy Ends 3
- Polyaromatics 3
- Density 3
- Sulphur 1



Conclusion

- **MED Fuel Specifications Review**
 - New Zealand, like Australia, is likely to follow path set by the Euro standards but with some variations
- **Biggest issues for fuel quality:**
 - Sulphur in Diesel
 - Benzene in Petrol
 - Timing of Reductions

Petroleum Fuel Quality in New Zealand 1992-99

Energy Safety Services