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NATIONAL FUEL QUALITY STANDARDS

comments by

Shell Australia

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Shell's Response to:-

Setting National Fuel Quality Standards:

Paper 2

Proposed Standards for FUEL PARAMETERS (Petrol and Diesel)

Issue & Reference	**Comments**
Comment Box, Page 8	Yes, there should only be ONE national fuel regulation. In addition, environmental, operability and quality issues all impact vehicle emissions, hence there is logic, as well as economy in this approach. As expressed by the AIP separately, we strongly recommend the implementation of an initial standard as soon as possible. This offers considerable environmental benefit (and political kudos) since current Australian Refinery qualities are considerably better than current allowable import quality. The introduction of tighter standards in some states raises the possibility of qualities in 'unregulated' states declining relative to qualities quoted by AIP for 1998 and referred to in EA discussion papers.
Comment Box, Page 13	We do not support the forced bringing forward of fuel quality changes to support "model cycles". The fact remains that significant refinery changes are required to meet the new qualities and they take time to implement. The MBE statement laid out the timetable for the introduction of clean fuels with clear consideration of construction times for refineries, this consideration appears to have been lost as the new ADRs were implemented. It has already been announced that the mandating of Euro 4 fuels will most likely mean the end of Clyde refinery. An earlier introduction of Euro 4 fuels has significant implications for our planning of the supply/ logisitic replacement in support of the Sydney market and earlier investment decisions being currently undertaken.. Our suggestion to resolve this issue:- 1. delay the implementation of the ADRs by one year 2. Then mandate the required quality changes in 2003 and 2006, one year before the ADR comes into effect. Thus achieving the goal of the vehicle suppliers to ensure the fuel availability.
Comment Box, Page 31	a) We would prefer to go straight from the 500 ppm standard to 50 ppm standard. The order of magnitude step requires major investment whereas an intermediate, incremental step to 350 ppm would impose considerable operational constraints for doubtful environmental benefits. b) See above comment relating to Page 13. c) CONCAWE report 99/62 implies a move to 30 ppm may not be necessary. d) Shell believes a Lubricity Specification must be added to the National regulations for diesel fuels with 500 ppm sulphur or less.
Comment Box, Page 68	On the one hand, pool averages clearly assist the fuel supplier, in that they allow for the variability that exists in the refining of crude oils which have constantly changing quality. On the other hand the averaging ensures the overall environmental targets are achieved.
Comment	Shell International's Fuel Laboratory advises:-

Box, Page 71	• DI is not the best parameter for hot climates • the current US DI is old relative to current engine technology • Good control of driveability can be achieved via limits to E100 or T50 • CONCAWE was successful in persuading European OEMs, on the basis of the above, to drop the request for DI in Europe • If a DI is still considered desirable there are better formulas available to the one offered in the EA document • Limits defined here are from the WWFC and are based on limits for US cars. A considerable amount of work would need to be done to determine a suitable Australian range
Comment Box, Page 77	Similar comment as for page 68.
Comment Box, Page 94	a) See above comment relating to Page 13. b) CONCAWE report 99/62 implies it is too early to fix a move to 30 ppm as technical advances may make it unnecessary.

DIESEL

Cetane

The Cetane Number is a measurement by a test engine, ASTM D613, of the combustion characteristics of a diesel fuel. It is a very old, cumbersome and expensive test with a relatively poor precision. Many empirical correlations have been developed to estimate the cetane number from other physical properties of the fuel with varying success. The most accurate of these have a standard error no greater than that of the ASTM D613 method itself but do have limitations on their range of applicability. The estimated value is referred to as the Cetane Index. Just recently, p22 of the June 2000 issue of Petroleum Review, the relationship between CN and CI was reviewed with the conclusions that the method is largely unbiased and estimates CN well but with possibly increasing scatter.

The simplicity of determining the Cetane Index has seen it dominate specifications and be routinely used for quality control. It has been so successful that there are now very few Cetane Number analysers available throughout the world and none within Australia.

A good summary of the available correlations is given in the paper "Equations for predicting the cetane number of diesel fuels from their physical properties" by Lodommatos and Goacher in Fuel 1995, vol 74, no.7.

The Cetane Number may be improved by the use of additives, so called Cetane Number Improvers(CNI), and there is widespread experience in Europe and the US with these improvers for increases of up to 8 units. The Cetane Index is not increased by the addition of CNI as the relevant physical properties, such as density and distillation, are not noticeably altered.. Engine testing by additive suppliers has demonstrated that there is negligible difference between fuels whose cetane number is improved by additives or through more severe refining, e.g. hydrogenation. A hydrogenated fuel will have a lower density (and lower aromatics) and so have a lower energy content. This together with the increased energy consumption for hydrogenation is most unlikely to lead to a net environmental gain.

It is presumed that the text which refers to a maximum CN:CI difference of 3 is attempting to indicate that there be a maximum increase in the CN achieved by additivation of 3. The unadditivated CN is estimated by the CI and the improvement is determined by established CNI response curves. There appears to be little information to support this limitation given the experiences in Europe and the US. In addition the CI method was developed for conventional hydrocarbons and it is known that some special blends and non-traditional components are outside the range of application. For this reason new test methods allowing the rapid determination of ignition quality are under development and appear very promising although it is likely they are still a few years away from commercialisation.

As FBP is reduced the CN is generally also reduced. The fact that 1998 average is one value does not mean the long term value will be the same - cutpoint changes in CCUs forced by gasoline S specifications may push more HCCG into LCO and so into diesel fuel and result in a lower cetane. Similarly the addition of kerosene components with a typical CN around 40 will lower the overall diesel pool cetane.

Density

The proposed density range is skewed with only the upper end being reduced. We would favour a narrowing of the range to something more like 825/830-850/855 kg/m3.
As the Paper points out, the average diesel fuel density in 1998 for the Australian market was 846 kg/m3. This means that more than half the fuel was at a density higher than the proposed limits. While we support the tightening of the density range so that improved engine performance can be achieved we believe the proposed approach is rather costly :-

1. To reduce sg will require several very costly changes involving either component disposal as low viscosity fuel oil, restricted crude selection and/or a much greater investment beyond the already large commitment required.
2. Cutpoint changes will mean either loss of Jet fuel (highest growing fuel) which has a low cetane or loss of high cetane HGO into CCU feeds (making more gasoline and/or low quality LCO into diesel) or will require hydrogenation units effectively doubling the capex for diesel.
3. Diesel fuel is a blend of desulphurised straight run components from the crude distillation unit, desulphurised components from a catalytic cracker where available, diesel from a hydro-cracker where available, and potentially kerosene. The highest density component is the cat-cracker diesel which is also the lowest cetane. Simply excluding this component from the pool as has been done in the UK is not practical in Australia due to the lack of a light fuel oil market and would short the diesel market by about 15-20%.
4. The density of the straight run components from crude range from 0.82 to over 0.90. About 50% of the world's crude oils will produce diesel with a density higher than that proposed, even most of Australia's own crude oils yield diesel fuels with a density above that proposed :

Cooper	819
Cossack	848
Gippsland	855
Thevenard	873
Barrow	897

Hence, as stated above, we favour a narrowing of the range to something more like 825/830-850/855 kg/m3.

Distillation

Reducing the heavy end components in diesel fuel by reducing the maximum T95% point to 350°C will also reduce production capacity. The extent to which this occurs can be estimated from the change in distillation at about 5% (possibly higher), partly due to overall cutpoint reductions and partly due to the restriction this will place on certain crude types (low wax content). More importantly however is the fact that once again the proposal is going to a level below the current average without demonstrated evidence that it has an advantage in the Australian car fleet.

As an aside :-The AIP average data is erroneous as it is a linear arithmetic average - FBP or 95% point does not blend linearly as the higher values are determining in a mixture! Shell has little data at 95% points, it is at 90% that testing is currently reported.

PAHs

The limited data we have available suggests that a value of 11% should not be a significant issue for refiners. It is assumed here that the analytical method is IP391 and PCAH refers to the tri+ aromatic molecules, i.e. excluding mono and di aromatics. Note that in the HDS process it is common to see an increase in the reported levels of total aromatics to about 110% of the feed level. Sulphur containing structures in the feed are often not identified as aromatic by the method however after the removal of sulphur and substitution by hydrogen these are often reported as aromatic structures in the product.

Ash

Properly refined products should not have difficulty in meeting the proposed ash limit of 100 ppm (0.01%) although this is at the limit of the test method (ASTM D482) at which point the repeatability is 300 ppm and reproducibilty is 500 ppm!

The timing of 1/1/2002 would place impossible pressure on waste oil business being at least 6 months before full recycling of lube oil is achievable. (Perhaps new Lube levy should support lube recycling in the meantime).

Viscosity

The proposed range would seem broader than is necessary given than it is greater than the extreme values reported in the 1998 fuel summary.

PETROL

Octane

Comment on the recently emerging idea for a wholesale change to 95 RON in 2002:-
This proposal must be subjected to a cost - benefit analysis. So far it seems the only drivers are :-

- mis-fueling if 95 is more expensive than 91
- FCAI say solving this by nozzle design is "too hard"

Sensitivity (RON-MON)

The proposal for a maximum gasoline sensitivity of 10 is not supported by recent engine developments. The sensitivity concept is a dated one and the following references may assist in a better understanding of the issue. MON and sensitivity appear to be redundant specifications for today's engines and we recommend that it be removed.

In principle the components that contribute to sensitivity are olefins, sensitivity about 15, aromatics, about 13, naphthenes 5-10, and lastly paraffins at about -1 to +5. As the fuels are largely composition constrained there seems little benefit to further curtail the formulation, especially where this now appears to be contrary to the desired engine performance. It should be noted that MON or sensitivity does not blend anywhere near linear, high sensitivity values have a much higher weighting in blends.

The industry is already often MON constrained and as octane levels increase the MON usually increases at only about two-thirds of the RON increase. If a maximum sensitivity of 10 is introduced it will quickly become impossible to produce acceptable fuels.

- SAE 962105 (Bradley, Kalghatgi and Golombok) shows that higher sensitivity fuels give better combustion characteristics.
- 26th symposium on combustion 1996 pp 2653-2660 (Bradley, Kalghatgi, Golombok and Yeo) shows that higher sensitivity aromatic fuels tend to give benign autoignition whereas low sensitivity paraffinic fuels lead to damaging detonation.
- Combustion Science and Technology 1995 vols 110-111 pp 209-228 (Kalghatgi, Golombok and Snowdon) indicates that knock is not just related to octane number, but also to fuel composition with high sensitivity aromatic type components giving less knock intensity than low sensitivity paraffinic fuels.

Volatility

Levels below 60-62 may impose drivability problems.

Disposal of 300,000 tpa butane: if to LPG market would require substantial infrastructure for distribution. This also highlights the need for a similar quality regulation for LPG to be developed.

Use of pool averaging supported

Distillation

As for diesel the use of an arithmetic linear average is inappropriate. The more likely true average is around 220°C ! Text gives no justification for significant tightening. The higher the octane required the higher the FBP will tend to be due to heavier reformate. Higher cetane diesel will push Cat Cracker Light Cycle Oil front end into Heavy Cat Cracker Gasoline and raise FBP.

Olefins

Accept 16% olefins but 14% is not achievable without octane penalty.

Benzene

We support the position in the discussion paper on the basis that Australian data and research on ambient benzene demonstrates that levels in Australian cities are remarkably low:

"Investigation of a cluster of leukaemia in the Illawarra region of New South Wales, 1989-1996" Westley-Wise, VJ et al. Medical Journal of Australia Vol 171 16 August 1999 p.178. This paper states that the average benzene level around Wollongong in 1996 was 1 ppb, with a range from eight monitoring sites of <0.01 to 3.8 ppb. The authors say that "since 1970, ambient air concentrations of benzene were estimated to have averaged up to 3 ppb, about one-thousandth of the level at which leukaemia risk has been identified in occupational epidemiological studies". They also conclude that the current environmental benzene exposure and the reconstructed past environmental exposure are too low to explain the local leukaemia excess.

The Queensland EPA monthly air quality bulletins are published on the web and as an example the July 1999 issue gives an annual average for the Brisbane CBD of 0.7 ppb with the highest 24 hour maximum reading in the previous year being 1.7 ppb.

NSW EPA Technical Report of the Pilot Air Toxics Project (May 1998) reports data from 1995-96, with an average of 1.2 ppb benzene across Sydney with an average of 2.5 ppb in the CBD. Data from near a busy arterial road, and a freeway were 1.1 and 1.2 ppb respectively, no different from other locations. This report also shows (appendix D) that interlaboratory variability is around 1ppb.

Volatile Organic Compounds Monitoring in Perth Western Australian DEP January 2000. This monitoring project concluded that the benzene average in Perth is 1.44 ppb with the different site averages being 0.15 to 2.17 ppb. The authors state that the Perth results are not expected to contribute significantly to health effects.

Sulphur

Mandatory 50 ppm sulphur in 2005.

It is important to note that the common route to sulphur reduction in gasoline is via conversion of diesel HDTs to gasoline. In this context it is logical for the gasoline sulphur to be reduced 6-12 months AFTER the diesel specifications are reduced to 50 ppm. The regret expenditure were gasoline reductions to come earlier would be of the order 30-40 MAUD.

Proposed 30 ppm sulphur limit

There are no units operating to produce 30ppm at this time. The point at which the reaction kinetics and equilibrium becomes limiting is not well known. It is hoped that new units can be designed to achieve 30 ppm even though some catalyst advances may be required. The timetable for 30 ppm seems premature given we are trying to anticipate catalyst and technology developments in refining and engine design some 8 years out. We would propose that this be an area to be revisited at a later date.

Japanese auto technology works at much higher levels(doesn't need 30 ppm) compared to best US.
Note: the lower the S the more HDS and more octane loss.

Oxygenates

Due to the problems with ground water contamination in the USA, we would not be disappointed by an early ban on the ethers to protect the Australian environment.

Any encouragement of ethanol use will need to be accompanied by a slackening of the proposed Volatility constraint.

Setting National Fuel Quality Standards:
Paper 3

A View on the Complex Model

The focus of the complex model is emissions per se, rather than delivering fuel quality which enables the technology which ensures the emissions meet the targets.

It would be illogical to argue that certain qualities enable certain engine technologies as Discussion Paper 2 points out and then to introduce "flexibility" in the fuel quality requirements via a "complex model" such as currently proposed for SA.

Averaging and Flat Limits.

Since any averaging regime should include appropriate bounds, it will not be a simple case of either "flat limits" or "averaging".
Flat limits, or bounds, need , if possible, to be set so that technology can continue to deliver its design intent without unnecessary or unwarranted imposition on the refiners. An

example would be say a flat limit of 550 ppm sulphur diesel, together with the average target of 500 ppm.

On the other hand, where a quality relates directly to an environmental effect then pool averaging, within bounds of course, will ensure the environmental benefit is achieved for less cost.