Australian Institute of Petroleum

Submission to the Department of Infrastructure, Transport, Regional Development and Local Government

on the

Discussion Paper

for Light vehicle CO_2 emission standards for Australia

9 December 2011

ABOUT AIP

The Australian Institute of Petroleum (AIP) was established in 1976 as a non-profit making industry association. AIP's mission is to promote and assist in the development of a sustainable, internationally competitive petroleum products industry, operating efficiently, economically and safely, and in harmony with the environment and community standards.

AIP member companies play various roles in the fuel supply chain. They operate all of the petroleum refineries in Australia and handle a large proportion of the wholesale fuel market. However, AIP member companies directly operate and control only a relatively limited part of the retail market.

AIP is pleased to present this submission on behalf of the AIP's four core member companies:

BP Australia Pty Ltd
Caltex Australia Limited
Mobil Oil Australia Pty Ltd
The Shell Company of Australia Limited

Contact Details

Should you have any questions in relation to this submission, or require additional information from AIP, the relevant contact details are outlined below.

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Introduction

AIP is pleased to have the opportunity to comment on the Discussion Paper for light vehicle emission standards for Australia. The Australian refining industry seeks to closely cooperate with regulators and the motor vehicle industry to ensure that fuels of an appropriate standard are introduced when vehicles requiring a particular quality of fuel arrive in the market. The refining industry has generally ensured that fuels meeting progressively tighter standards are available to the Australian market on the timeframe agreed with regulators and has made a strong and positive contribution to the implementation of the Commonwealth Government's cleaner fuels program.

AIP and its member companies accept the community imperatives for improving urban air quality and addressing the risks of climate change and support the development of policy based on sound science, thorough economic analysis, affordability for industry and acceptability to the community.

While the Discussion Paper does not contain any discussion regarding fuel standards we consider that it is important that the consultation is informed by our perception of the emerging vehicle technologies and the implications for the development of future fuel standards. Based on very clear evidence, we consider that prospective conventional engine technologies can readily operate on the fuels that are currently in the Australian market and therefore we consider that any proposals for mandatory vehicle CO_2 emission standards will not require any further tightening of Australian fuel quality specifications.

Australian diesel standards already require 10ppm sulfur and are comparable to the most stringent international standards and are not an impediment to the operation of light duty vehicles in Australia.

The Discussion Paper does mention (quoting the UK King Review) that one available vehicle efficiency strategy is lean burn gasoline direct injection (GDI). AIP acknowledges that to achieve the efficiency gains from lean burn GDI the required fuel is 10ppm sulfur petrol. However, we present clear evidence in this paper that lean burn technologies have achieved very low penetration rates in the global vehicle market and have been or are being phased out in Europe and Japan where 10 ppm sulfur fuel has been available for some time. Therefore, the only potential driver for fuel standards changes (being lean burn GDI) is not a strategy being deployed by vehicle manufacturers.

The production of 10ppm sulfur petrol is a complex and expensive investment for Australian refineries that was last estimated in 2005 at a total of around $1.3 billion but could be expected to have increased substantially since that time. Requiring supply of 10ppm sulfur petrol has the unintended consequence of reducing the octane of the cracked gasoline component of the fuel and also substantially increases the degree of interdependency between units in the refinery, increasing the risk that unplanned shut downs will result in fuel supply disruptions. At a time when there is expected to be a global over-capacity in refinery production for some years into the future, the significant investment requirements and potentially adverse impacts on refinery and fuel supply reliability will challenge the viability of the Australian refinery sector.

If there were further refinery closures, it would negatively affect Australia's liquid fuel supply security and represent a loss to the Australian community of a high technology, value added manufacturing industry that is a significant industry in its own right and underpins the competitiveness of a range of other Australian industries.

However, given that appropriate fuel standards apply to liquid fuels in Australia and further changes in fuel standards are not required to facilitate the likely engine technologies to be used in petrol driven vehicles, we do not consider that there are any implications for fuel standards from the introduction of light vehicle CO_2 emission standards in Australia.

Engine Technology and Carbon Emissions

In conventional petrol engines, fuel is generally supplied through injection into the intake ports. Direct injection systems supply the fuel directly into the cylinder enabling precise control over the amount of fuel and injection timings that are varied according to load conditions. It is also possible to inject more than once during a single cycle. After the first fuel charge has been ignited, it is possible to add fuel as the piston descends. The benefits are more power and fuel economy. Gasoline Direct Injection (GDI) can potentially deliver improvements in fuel economy of up to 15% depending on the drive and load characteristics. These benefits were identified in the Discussion Paper.

There are 2 types of GDI: lean burn and stoichiometric. Initially, lean burn was the technology being advanced into production, however, its application was limited because lean burn combustion and emission control systems are not cost effective compared to other technologies and the negligible fuel efficiency benefits experienced in real world driving conditions. Significant advances in stoichiometric GDI technology in recent years have provided the majority of the benefits of lean burn GDI without the need for ultra low sulfur fuels. Stoichiometric GDI is the dominant GDI technology being favoured by vehicle manufacturers because of its simplicity and ability to utilise conventional pollution control equipment, i.e. a three way catalyst. Stoichiometric GDI can readily operate on 150ppm sulfur level fuel and, depending on the engine management system, may be able to operate on 91 RON. However, the general trends in stoichiometric GDI deployment suggest that downsizing and turbo charging will most probably require at least 95 RON fuels in the future, but this will depend on the individual engine technology. AIP notes that the new Holden Spark Injection Direct Ignition (SIDI) engine is capable of operating satisfactorily on 91 RON ULP.

However, the lean burn GDI mode which is used for light-load running conditions, at constant or reducing road speeds or where no acceleration is required, operates at substantially higher air/fuel ratio and consequently substantially increases the emissions of NO_x, requiring after treatment with lean NO_x catalysts. Lean burn GDI is sensitive to sulfur levels and is recommended to operate on 10ppm sulfur levels because of the need to regenerate the catalyst more frequently at higher sulfur levels which significantly reduces the fuel economy gains. For these reasons, market penetration of lean burn GDI has been limited and largely confined to high performance and luxury segments of the market. Significant advances in stoichiometric GDI means that it delivers the same benefits under most load conditions and delivers the majority of the fuel economy benefits without the increased NO_x emissions.

Stoichiometric GDI is expected to make a fairly rapid penetration into the new car market. In 2005, the proportion of new vehicles that were using both stoichiometric and lean burn GDI was around 1% in the US and 5% in Europe. This proportion is expected to grow to 26% in the US and 30% in Europe[1]. Slow fleet turnover will mean that these vehicles will be a relatively small, but growing proportion of the on-road fleet over time and it seems likely that stoichiometric GDI will become the main technology in petrol markets subject to any further developments in technology.

Martec Group undertook a major study in 2010 into the likely penetration of different vehicle technologies and specifically examined the penetration of lean burn GDI and stoichiometric GDI in the major global markets. The results of the study were published in SAE International, the journal of the Society of Automotive Engineers[2]. The study was supported by extensive interviews with vehicle manufacturers and is considered to be a comprehensive assessment of likely vehicle technologies and fuel requirements.

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[1] Beecham M (2009) *Global market review of fuel injection systems – forecasts to 2016* Just-Auto.

[2] McMahon KB, Selecman C, Botsem F, Stablein B (2011) *Lean GDI Technology Cost and Adoption Forecast: The Impact of Ultra-Low Sulfur Gasoline Standards* SAE International 2001-01-1226

The main findings of the Martec study were:

- One of the main reasons for the adoption of 10ppm sulfur PULP in Europe and Japan was to facilitate expanded introduction of lean burn gasoline engines.
- The study defined the cost/benefit of lean combustion and emission control systems compared to other CO_2 emissions reducing technologies that are in commercial development in the global market.
- The market penetration of lean burn GDI engines peaked at 2% in 2010 in Europe, the same maximum penetration level the technology reached in Japan 10 years ago.
- After peaking at 2% in both regions, lean burn engines have been (Japan) and will be (Europe) withdrawn from the market due to unfavourable variable cost economics compared to other solutions.
- Japanese and European vehicle manufacturers and suppliers reported poor consumer receptivity to lean burn engines due to negligible fuel efficiency benefits experienced in real world driving conditions, notwithstanding the availability of 10 ppm sulfur fuel in those markets.
- In the US, the opportunity for lean burn GDI will be limited to a narrow range of naturally aspirated engines that cannot accommodate variable valve timing. These vehicles are generally large capacity (e.g. 6.0l V8) SUVs and sports cars.
- The potential share of US vehicles utilising lean burn GDI is expected to peak at 3% between 2015 and 2020 and then decline as observed in Japan and Europe.

The next round of improved vehicle technologies is likely to be Homogenous Charge Compression Ignition (HCCI) or Controlled Auto Ignition (CAI) that combines features of both spark ignition and compression ignition. In test conditions[3] these engines have shown further improvements in fuel economy with the added benefit of lower PM and NO_x emissions. In bench testing these engines have been shown to run successfully on a variety of fuels, including under part-load and full-load operating conditions. The further implication for fuel standards is that these engines may be optimised with very different fuels than currently available, such as kerosene. A further implication is that the octane requirements when operating on petrol are significantly lower as are the cetane requirements when operating on diesel.

Given the likely developments in engine technologies, AIP considers that the technology facilitation benefits have already been achieved by the introduction of the current Australian PULP standard.

Technical Implications for Australian refineries

To produce 10ppm sulfur PULP, Australian refineries would need to install additional desulfurisation capacity for the petrol streams. In addition, since the desulfurisation process destroys octane there will be a further requirement to produce additional high octane streams such as alkylate or isomerate. These operating units will also require the augmentation of electricity and water supplies and since the desulfurisation process requires hydrogen, the augmentation of hydrogen production at refineries. All these processes are energy intensive and will lead to a significant increase in refinery energy consumption and therefore an increase in greenhouse gas emissions.

[3] Cracknell RF, Rickeard DJ, Ariztegui J, Rose KD, Meuther M, Lamping M, Kolbeck A (2008) *Advanced Combustion for Low Emissions and High Efficiency Part 2: Impact of Fuel Properties on HCCI Combustion*
SAE International 2008-01-2404

These issues were examined in detail in the 2005 report by MMA[4] that found Australian refineries would need to invest $1.3 billion in capital equipment to enable the production of the 10ppm sulfur PULP. It is probable that these costs would have increased since 2005 but this would need to be the subject of further detailed consideration by the Australian refineries. The report also found that under a range of plausible scenarios the introduction of 10ppm sulfur PULP would lead to net community costs. A central assumption made by MMA was that PULP would grow to 50% of the petrol pool and that lean burn GDI vehicles would become reasonably common. This has not proven to be the case and from the foregoing analysis on engine technologies it is unlikely to occur. The developments since 2005 for both engine technologies and vehicle penetration suggests that there would be a significant net community cost for the implementation of 10ppm sulfur PULP.

While the technology choice to produce 10ppm sulfur PULP is similar to that required for 50ppm ULP, the impacts on the refineries would need to be considered in detail, cognisant of the potential impacts on the petrol market and the availability of product of such quality in the Asian region. On balance, it is probable that the cost estimate for 50ppm ULP could be higher than the result from the MMA study given that the volumes required to be processed would be considerably higher. One Australian refiner indicated in the MMA study that it was not technically or economically viable for it to implement these technology solutions and any change to the standard would lead to refinery closure. Therefore, given the potentially large implications for Australian refiners of any change to petrol standards, AIP considers that a detailed investigation of the costs and benefits of any such changes in the fuel standards should be undertaken. We believe that there will be greater community costs than identified in the 2005 MMA study.

In summary, any changes to the sulfur level in petrol will be expensive, complicated and difficult for refiners to implement, may potentially lead to stranded technology (if HCCI or CAI engine options develop as hoped), and will result in greater greenhouse gas emissions from the Australian refineries.

Other costs to the Australian community

Given international markets demonstrate premiums for higher quality fuels and Australian refiners will be incurring substantially greater costs there may be an impact on consumers. Any change in fuel prices is a real cost to the Australian community that should be included in any assessment of proposed fuel standards changes. The vast majority of the Australian car fleet will not be able to utilise the higher quality fuels and will therefore be paying additional expense for a fuel that will deliver no benefit to the consumer. These impacts were not adequately addressed in the 2005 MMA study and represented a major flaw.

In 2008, the Australian downstream petroleum industry reported a net loss of $500 million. The loss was driven by the sharp fall in the Australian dollar but also by a significant easing in global refiner margins. The trend in refiner margins was evident before the advent of the Global Financial Crisis (GFC) and was caused by rapid increases in refining capacity largely in India, China and the Middle East. The Asian region, which had a deficit of refining capacity from 2003 until 2007, moved back into surplus in 2008 and this contributed to the sharp deterioration in refiner margins. The general expectation is that the surplus in Asian refining capacity will continue for some years with the more pessimistic views suggesting that the surplus will persist until at least 2020. These developments emphasise the cyclical nature of the refining industry where long periods of economic under performance can be experienced.

The general outlook for the regional refining industry is extremely uncertain but it is certain that the Australian refining industry will be facing an extended period of significant competitive pressure. In order to remain viable the industry will be making major efforts to contain costs and cannot afford unnecessary new capital expenditure. Consequently, we consider that great care and significant

[4] McLennan, Magasanik and Associates Pty Ltd (MMA) (2005) *Assessing the Costs and Benefits of Introducing 10ppm sulfur in Premium Unleaded Petrol* Australian Greenhouse Office

examination should be undertaken before contemplating any proposals which will substantially change operating requirements for refineries.

The closure of Australian refineries has broader policy implications for the Australian Government than just a shift to greater imports of finished petroleum products. The Australian refining industry is a significant economic activity in its own right contributing $6.2 billion to national GDP and underpinning the competitiveness of major export industries. Recent government reports (National Energy Security Assessment and Liquid Fuel Vulnerability Assessment) have found that Australian refining contributes to Australia's security of liquid fuels supply by diversifying the sources of supply. The Australian refining industry is a high technology, high valued adding industry that generates many external benefits. These benefits would need to be carefully considered in light of potential regulatory actions which are likely to undermine the viability of the industry, such as the introduction of 10ppm sulfur PULP.