Australian Government

Better fuel for cleaner air

Discussion paper

Ministerial Forum on Vehicle Emissions

December 2016

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Department of the Environment and Energy

The Department of the Environment and Energy acknowledges the traditional owners of country throughout Australia and their continuining connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

Contents

List of abbreviations

BITRE	Bureau of Infrastructure, Transport and Regional Economics
CBA	cost benefit analysis
CEA	cost effectiveness analysis
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
cSt or mm^2/s	centistokes or millimetres squared per second, unit of kinematic viscosity
Department	Department of the Environment and Energy
DCN	derived cetane number
DIPE	diisopropyl ether, also 2-propan-2-yloxypropane
DME	dimethyl ether, also methoxymethane
DVPE	dry vapour pressure equivalent
ETBE	ethyl tertiary-butyl ether (ETBE), also 2-ethoxy-2-methylpropane
EU	European Union
FAME	fatty acid methyl ester
FSCC	Fuel Standards Consultative Committee
Fuel Standards	Fuel Standard (Petrol) Determination 2001, Fuel Standard (Automotive Diesel) Determination 2001, Fuel Standard (Autogas) Determination 2003, Fuel Standard (Biodiesel) Determination 2003, Fuel Standard (Ethanol E85) Determination 2012.
GHG	greenhouse gases
GHG emissions	relate to emissions of carbon dioxide
g/L	grams per litre
Hart Report	Hart Energy, 2014: *International Fuel Quality Standards and Their Implications for Australian Standards*
HC	hydrocarbon
kPa	kilopascal, unit of pressure
KOH	potassium hydroxide
Legislation Act	*Legislation Act 2003* (Cth)
LPG	liquefied petroleum gas
mg/L or g/m^3	milligrams per litre, grams per cubic metre, units of density
mg/kg	milligrams per kilogram, same as parts per million
ML	megalitre
MMT	methycyclopentadienyl manganese tricarbonyl
molar	moles per litre
MON	motor octane number

MTBE	methyl tertiary butyl ether. Also 2-methoxy-2-methylpropane
m/m	mass by mass
NMA	N-methylaniline
NO2	nitrogen dioxide
NOx	nitrogen oxides
Noxious emissions	relate to emissions of carbon monoxide, volatile organic compounds, nitrogen oxides, particulate matter and sulfur oxides
OECD	Organisation for Economic Cooperation and Development
PAH	polycyclic aromatic hydrocarbons
PM	particulate matter
ppm	parts per million, equivalent to milligrams per kilogram
PULP	premium unleaded petrol (95 RON)
RIS	regulation impact statement
RON	research octane number, a measure of petrol's octane value
TBA	tertiary butyl alcohol. Also 2-methylpropan-2-ol
the Act	*Fuel Quality Standards Act 2000* (Cth)
the Regulations	Fuel Quality Standards Regulations 2001 (Cth)
ULP	unleaded petrol (regular, 91 RON))
USA	United States of America
VOCs	volatile organic compounds
vol	volume
v/v	volume by volume
wt	weight
WWFC	Worldwide Fuel Charter, 5th Edition September 2013

Executive summary

In 2016, an independent review of the *Fuel Quality Standards Act 2000* found that the regulation of the quality of fuel supplied in Australia had led to a quantifiable reduction in the level of pollutants and emissions arising from the use of fuel.

Following this review, the Australian Government committed to retaining and amending the *Fuel Quality Standards Act 2000* to maintain these environmental and health benefits. A review of the legislative instruments made under the *Fuel Quality Standards Act 2000*, which are due to sunset (cease to have effect) in 2019, formed part of this commitment.

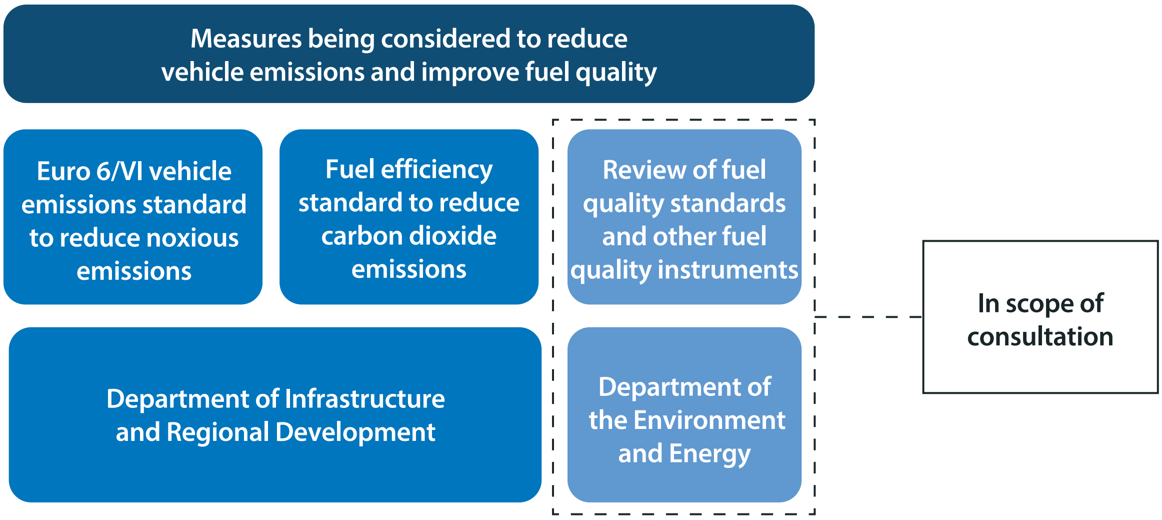
The Department of the Environment and Energy has released this discussion paper to seek stakeholder views on proposed policy alternatives in relation to legal instruments made under the *Fuel Quality Standards Act 2000*. Input provided from stakeholders will inform the final set of policy alternatives to be analysed and costed by the Department in 2017.

The fuel standards aim to reduce pollutants and emissions that contribute to health and environmental problems, ensure engine operability, and facilitate new technologies. The policy problem which is the subject of this discussion paper consists of a number of elements, and can be summarised as follows:

- Motor vehicle emissions can be split into two categories: noxious emissions which affect human health and the environment and contribute to respiratory illness, cardiovascular diseases and cancer, and greenhouse gas emissions which contribute to climate change.
- Petrol fuelled light vehicle emissions are one of the major causes of air pollution in urban Australia. Our expanding vehicle fleet, increasing urbanisation and aging population mean that further action is needed to improve air quality and reduce the health impacts of air pollution.
- Improving fuel quality can help reduce the level of noxious emissions, which improves air quality and health outcomes.
- Some advanced vehicle technologies (including advanced emissions control systems and certain fuel efficient engine technologies) require higher quality fuel to work effectively. The quality of fuel influences which engine and emission control technologies can be supplied to the Australian market.

The Australian Government established a Ministerial Forum in October 2015 to coordinate a whole-of-government approach to reduce motor vehicle emissions that harm human health and contribute to greenhouse gas emissions. This discussion paper forms part of this comprehensive package of measures. The Department of Infrastructure and Regional Development is considering the proposed introduction of Euro 6/VI vehicle emission standards for light and heavy vehicles to reduce noxious emissions, and fuel efficiency standards to reduce carbon dioxide emissions. These activities will be subject to their own regulation impact assessments and are out of scope for this discussion paper, as seen in Figure 1 on page 5.

Figure 1: Package of Australian Government measures to reduce motor vehicle emissions



There are proven links between pollutants found in vehicle emissions and a range of human health problems (both short and long term). Air pollutants can have a significant impact on the cardio–-respiratory system. Individuals with pre-existing respiratory conditions, such as asthma and allergies, are especially vulnerable to air pollutants. The effects on human health can include reduced lung function, ischemic heart disease, stroke, respiratory illnesses, and lung cancer.[1] The cost of premature deaths due to outdoor air pollution in Australia in 2010 has been estimated to be up to $7.8 billion and in OECD countries, it is suggested that road transport accounts for approximately half of the cost of these preventable deaths.[2] With increasing vehicle numbers and use, these costs are likely to increase as the Australian population grows and ages. Between 2010 and 2015, the motor fleet in Australia grew at an average rate of 2.4 per cent making vehicles a growing source of air pollution.[3]

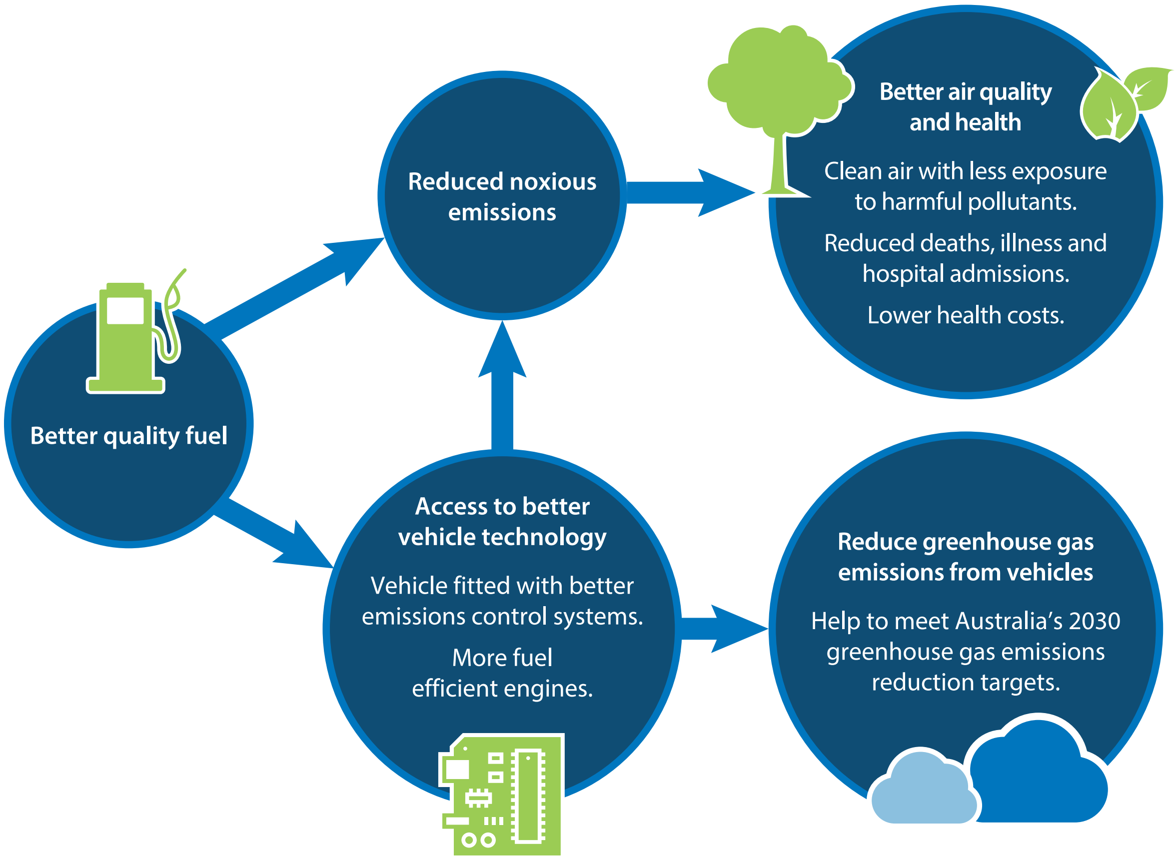
Good vehicle design and fuel standards work together to reduce vehicle emissions and improve air quality. Without appropriate fuel quality, the emission control technologies within vehicles do not operate as intended. Fuel quality may also influence which engine and emissions control technologies are incorporated into vehicles supplied to the Australian market. The quality of Australian fuel may limit the supply of some existing advanced technologies in use in other vehicle markets.

1 International Agency for Research on Cancer 2013. *Air pollution and cancer, IARC*, 161.

2 OECD 2014. *The Cost of Air Pollution: Health Impacts of Road Transport*, Brussels, 21 May 2014.

3 Australian Bureau of Statistics 2016. *Motor Vehicle Census*, ABS. Available from: http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/9309.0

Figure 2: Outcomes associated with better fuel quality and reduced noxious and greenhouse gas emissions



The human health impacts from exposure to noxious vehicle emissions are an external cost to society which is largely beyond the control of communities and individual businesses. A recent review of the *Fuel Quality Standards Act 2000* found that there is a strong case for continued government action in regulating fuel quality, based on the health risks associated with noxious emissions from vehicles and the benefits associated with international harmonisation of fuel standards.

Fuel standards are currently in place for a range of fuel types used in Australia, including petrol, diesel, autogas (LPG), biodiesel and ethanol (E85). Each fuel standard is made up of a list of parameters, which set an upper and/or lower limit on the substances permitted in that type of fuel. In addition to the fuel standards, there are information standards in place for petrol and E85 which set labelling requirements where these fuels are supplied.

There are two fuel parameters of particular concern: sulfur and octane in petrol. Catalytic converters in vehicles are designed to filter emissions and reduce noxious substances emitted from vehicles. Sulfur clogs the catalytic converters making them less effective. Higher octane fuels can be used in high compression engines petrol engines which are more fuel efficient and produce less greenhouse gas emissions.

This paper discusses five alternative policy approaches for updating existing fuel standards. There are two elements at the core of these proposed policy alternatives: changes to substance limits and other parameters for each fuel type (alternatives B, C, D and E), and a phase-out of regular unleaded petrol (91 RON) in alternatives B and D. The fuel standards specify many parameters. Although sulfur and octane in petrol are likely to be associated with greater benefits and costs this discussion paper proposes a number of further reforms, for example, changes to the parameters for cetane and polycyclic aromatic hydrocarbons in diesel.

The five alternative policy approaches for updating existing fuel standards are as follows:

A Australia's fuel standards remain in effect in their current form (business as usual). Petrol standards retained: unleaded petrol (91 RON) with a maximum sulfur limit of 150 ppm; premium unleaded petrol (95 RON) with a maximum sulfur limit of 50 ppm. Diesel standard continues to specify a maximum sulfur limit of 10 ppm and derived cetane number of 51 for diesel containing biodiesel only.

B Revisions to the fuel standards to align with the recommendations of the Hart Report[4] and to harmonise with European standards. Unleaded petrol (91 RON) would be phased out over a specified period of time (e.g. two to five years). Sulfur in premium unleaded petrol (95 RON) would be limited to 10 ppm and a new octane standard for premium unleaded petrol (98 RON) introduced. More stringent requirements would be introduced for cetane and polycyclic aromatic hydrocarbon levels in diesel.

C Revisions to the fuel standards to align with the recommendations of the Hart report and to harmonise with European standards as per alternative B above, except that unleaded petrol (91 RON) is retained but with a lower sulfur level of 10 ppm.

D Revisions to the fuel standards as per alternative B above, except with even stricter parameters (including for cetane levels in diesel) to harmonise with the standards recommended by the Worldwide Fuel Charter (that recommends the fuel quality required by automobile companies to meet particular emission standards).

E Staged introduction of world standards from 2020, with a review in 2022 to determine next steps. Unleaded petrol (91 RON) would be retained. Sulfur would be reduced to 50 ppm for unleaded petrol (91 RON) and 25 ppm for premium unleaded petrol (95 RON) and a new octane standard for premium unleaded petrol (98 RON) introduced. Revisions to other parameters as per alternative B above.

Stakeholder views are sought on policy alternatives to amend the legislative instruments made under the *Fuel Quality Standards Act 2000*, including the fuel standards, to ensure the settings contained in these instruments remain up-to-date and effective. The input provided by stakeholders will contribute to the finalisation of a set of regulatory options for further analysis and costing by the Department in the coming months.

4 Hart Energy 2014. *International Fuel Quality Standards and Their Implications for Australian Standards*. The Department commissioned this report in 2014 to compare Australian fuel quality standards with comparable fuel standards in other countries, and to examine points of difference, 27 October 2014.

Introduction

In 2016, an independent review of the *Fuel Quality Standards Act 2000* found that the regulation of the quality of fuel supplied in Australia had led to a quantifiable reduction in the level of pollutants and emissions arising from the use of fuel.

Following this review, the Australian Government committed to retaining and amending the *Fuel Quality Standards Act 2000* to maintain these environmental and health benefits. A review of the legislative instruments made under the *Fuel Quality Standards Act 2000*, which are due to sunset (cease to have effect) in 2019 formed part of this commitment.

The Department of the Environment and Energy now seeks public comment on the legislative instruments made under the *Fuel Quality Standards Act 2000*, to ensure the settings contained in these instruments remain up-to-date and effective.

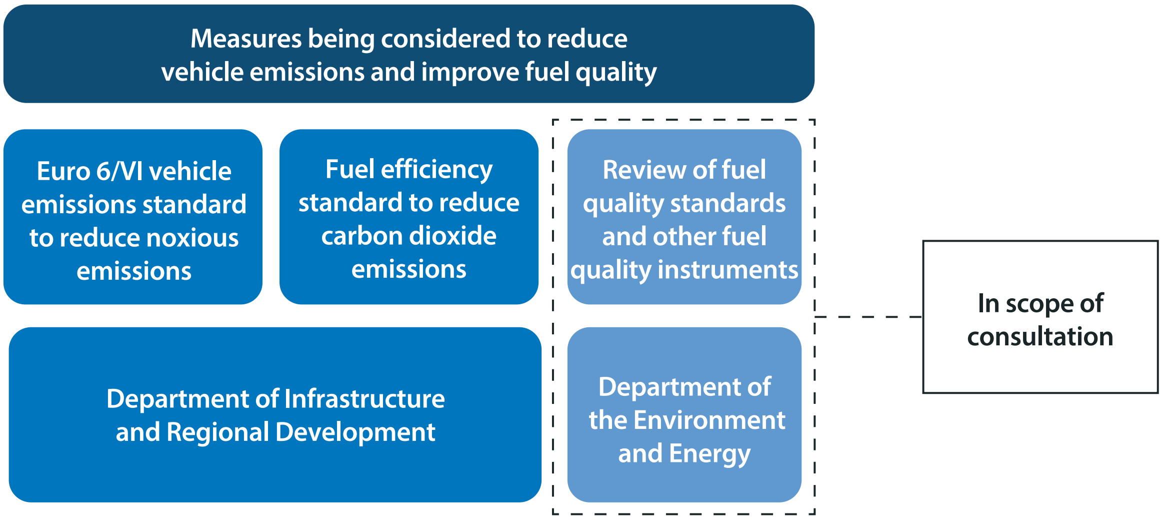
The objectives of the *Fuel Quality Standards Act 2000* are to regulate the quality of fuel supplied in Australia in order to:

- reduce the level of pollutants and emissions arising from fuel use that may cause health and environmental problems
- facilitate the adoption of better engine and emission control technology
- allow the more effective operation of engines
- ensure where appropriate that information about fuel is provided where fuel is supplied.

This discussion paper describes the current operation of fuel standards regulation in Australia, existing and emerging risks and opportunities, and policy alternatives for public consideration. The input provided by stakeholders will contribute to the finalisation of a set of regulatory options for further analysis and costing by the Department in 2017.

In October 2015, the Australian Government established a Ministerial Forum to coordinate a whole-of-government approach to reduce motor vehicle emissions that harm our health and contribute to our greenhouse gas emissions. This discussion paper forms part of this comprehensive package of measures. The Department of Infrastructure and Regional Development is considering the proposed introduction of Euro 6/VI vehicle emission standards for light and heavy vehicles to reduce noxious emissions, and fuel efficiency standards to reduce carbon dioxide emissions. These activities will be subject to their own regulation impact assessments and are out of scope for this discussion paper, as seen in Figure 1 on page 5.

Figure 1: Package of Australian Government measures to reduce motor vehicle emissions



Specific questions are posed throughout the paper for response by stakeholders. We would like your views and information on the benefits and costs for human and environmental health, industry and the Australian Government that may arise from any changes to the fuel standards. This information will assist us to assess the benefits and costs as well as regulatory impact of revised fuel standards to be considered in a regulation impact statement anticipated for release in 2017.

The technical annex at the end of this paper provides additional detail and questions on a range of chemical parameters being considered for each fuel standard. This information is provided should you wish to make comment or provide information on this additional detail.

The legislative instruments within the scope of this consultation, including the existing fuel standards, are listed in Table 1. A link is provided so you can access each standard online for ease of reference.

Table 1: Legislative instruments and location on the Federal Register of Legislation

Instrument	Available at
Fuel Quality Standards Regulations 2001	www.legislation.gov.au/Details/F2016C00131
Fuel Standard (Petrol) Determination 2001	www.legislation.gov.au/Details/F2008C00344
Fuel Standard (Automotive Diesel) Determination 2001	www.legislation.gov.au/Details/F2009C00145
Fuel Standard (Biodiesel) Determination 2003	www.legislation.gov.au/Details/F2009C00146
Fuel Standard (Autogas) Determination 2003	www.legislation.gov.au/Details/F2014C01226
Fuel Standard (Ethanol E85) Determination 2012	www.legislation.gov.au/Details/F2012L01770
Fuel Quality Information Standard (Ethanol) Determination 2003	www.legislation.gov.au/Details/F2006C00551
Fuel Quality Information Standard (Ethanol E85) Determination 2012	www.legislation.gov.au/Details/F2012L01771
Fuel Quality Standards (Register of Prohibited Fuel Additives) Guidelines 2003	www.legislation.gov.au/Details/F2007B01063

Call for submissions

Responses to the questions in this paper are requested by close of business (AEDT) 10 March 2017 and should be submitted electronically in Microsoft word .doc or .docx format to: fuel.policy@environment.gov.au.

Please ensure your submission is attached as a separate document when submitting your responses by email.

Alternatively, responses can be mailed to:

Fuel Quality Standards Section
Department of the Environment and Energy
GPO Box 787
CANBERRA ACT 2601

Unless marked as confidential, all submissions will be treated as public documents and posted on the Department's website (www.environment.gov.au). The Department will not post any personal details (such as the names of individuals or email addresses) on the Department's website.

1 What is the policy problem?

Key messages:

- Noxious emissions from vehicles are one of the major causes of air pollution in urban Australia. Our expanding vehicle fleet, increasing urbanisation and aging population mean that further action is needed to improve air quality and reduce the health impacts of air pollution.
- Improving fuel quality can help reduce the level of noxious emissions which improves air quality and health outcomes.
- Some advanced vehicle technologies (including advanced emissions control systems and certain fuel efficient engine technologies) require high quality fuel to work effectively. The quality of our fuel influences which engine and emission control technologies can be supplied to the Australian market.

Australia has relatively clean air by world standards, but further action is needed to improve air quality and reduce the health impacts of air pollution. Strategies to manage air pollution in Australia have contributed to reducing the levels of pollutants in our air. This is important as airborne pollutants can have detrimental impacts on environmental and human health. Increasing demands for transportation and energy consumption, urbanisation and population growth are ongoing challenges that impact on our air quality.

One of the mechanisms used by governments to address these factors is the regulation of fuel quality. The fuel quality standards aim to reduce pollutants and emissions that contribute to health and environmental problems, ensure engine operability, and facilitate new technologies. Better fuel quality can help reduce the level of noxious emissions by enabling the use of better noxious emission control technology. Fuel quality also directly affects the level of harmful emissions produced by motor vehicles, for example, lower limits for benzene (a known carcinogen) result in fewer benzene emissions.

1.1 Better fuel reduces noxious emissions which improves air quality and health outcomes

The pattern and scale of urban development in parts of Australia, and the associated increase in vehicle use, will place more pressure on urban air quality. With increasing vehicle numbers and use, these costs are likely to rise as the Australian population grows and ages. Between 2010 and 2015, the motor fleet in Australia grew at an average rate of 2.4 per cent per year.[5]

As Australia's population and economy grows, so will its light vehicle fleet, which will increase fuel usage and emissions. ABS data indicates that between 2010 and 2014 fuel consumption by Australian passenger vehicles increased by 460 million litres[5] (or 2.5 per cent). Automotive fuel is a significant source of noxious emissions. Unless further action is taken to improve the management of vehicle emissions, air quality is likely to decline in the medium to long term. This will adversely impact on the health of Australians.

5 Australian Bureau of Statistics (2016) 9309.0–*Motor Vehicle Census, Australia, 31 Jan 2016*, available at http://www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0

Noxious emissions from motor vehicles are particularly harmful for human health, as the general population is exposed to more motor vehicle exhaust emissions (while driving, walking, using public places, etc) than most other pollutant sources.[6] Air pollutants can have a significant impact on the cardio–respiratory system. Individuals with pre-existing respiratory conditions, such as asthma and allergies, are especially vulnerable to air pollutants. The effects on human health can include reduced lung function, ischemic heart disease, stroke, respiratory illnesses, and lung cancer.[7] A description of the health impacts associated with a range of common pollutants are summarised in Table 2 below.

Emissions of particulate matter (PM) are of increasing concern amongst health researchers, with linkages between adverse health effects and particulate exposure being demonstrated at increasingly lower levels of particulates in the atmosphere. These associations are observed even when air pollutant concentrations are below national standards. Research suggests the risks of cardiovascular effects may be particularly great for exposure to fine (less than 2.5 micrometres) and ultrafine (less than 0.1 micrometres) exhaust particles.[8] A 2013 study into the public risk of exposure to air pollutants found that long term population exposure to particulate matter alone is attributable to nine per cent of all deaths due to ischemic heart disease in Australia's four largest cities.[9] An OECD report from 2014 estimated that Australia experienced a 68 per cent increase in deaths attributable to ambient particulate matter and ozone between 2005 and 2010.[10] The current consensus is that there is no safe level of exposure to particulates and that any reduction in particle concentrations would improve population health outcomes.[11, 12]

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6 Department of the Environment and Energy 2016. *National Pollutant Inventory*. Available from: http://www.npi.gov.au/data/search.html [accessed 13 July 2016].

7 International Agency for Research on Cancer 2013. *Air pollution and cancer*, IARC, 161.

8 Yue W; Schneider A; Stolzel M; Ruckerl R; Cyrys J; Pan X; Zareba W; Koenig W; Wichmann HE; Peters A (2007*), Ambient source-specific particles are associated with prolonged repolarization and increased levels of inflammation in male coronary artery disease patients*, Journal Mutation Research: Fundamental and Molecular Mechanisms of Mutagenesis, 621:50-60.

9 Golder Associates 2013. *Exposure Assessment and Risk Characterisation to Inform Recommendations for Updating Ambient Air Quality Standards for PM2.5, PM10, O3, NO2 SO.* Available from: http://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/exposure-assessment-risk-characterisation.pdf

10 OECD 2014. *The Cost of Air Pollution: Health Impacts of Road Transport*, Brussels, 21 May 2014.

11 Daniels MJ, Dominici F, Zeger SL, Samet JM, 2004. *The national morbidity, mortality, and air pollution study Part III: PM10 concentration-response curves and thresholds for the 20 largest US cities*, prepared for the Health Effects Institute, 94, May 2004.

12 Schwartz J, Coull B, Laden F, Ryan L, 2008. The effect of dose and timing of dose on the association between airborne particles and survival. *Journal Environmental Health Perspectives*, 116:64-69.

Table 2: Summary of pollutants of concern, and their health impacts

Pollutant	Description
carbon monoxide (CO)	Carbon monoxide is a colourless, odourless and tasteless gas that is poisonous to humans in high concentrations. In sufficiently high concentrations and long exposures, CO interferes with the blood's capacity to carry oxygen. Exposure, even at lower levels, can have adverse effects on individuals with cardiovascular disease.
volatile organic compounds (VOCs)	Volatile organic compounds (VOCs) are emitted from burning fuel. One example of a VOC found in stored fuels and exhaust from cars that is a known human carcinogen is benzene. VOCs can enter the body by inhalation. General effects of exposure to VOCs include: irritation of the eyes, nose and throat; headaches; loss of coordination; nausea; damage to the liver, kidney and central nervous system, and cancer.
nitrogen dioxide (NO_2)	Nitrogen dioxide in the atmosphere may irritate respiratory systems, worsen asthma in susceptible individuals, increase susceptibility to cardiovascular disease symptoms and respiratory infections, and reduce lung function. As a precursor to smog, it also contributes to effects associated with ozone.
ozone (O_3)	Health effects attributed to ozone include irritation of the eyes and airways, exacerbation of asthma symptoms in susceptible people, increased susceptibility to infection, and acute respiratory symptoms such as coughing. Ozone also has adverse effects on vegetation and other materials. Some members of the population are sensitive even at very low concentrations.[13]
fine particles (also referred to as particulate matter or PM)	Small particles with a diameter of less than 10 micrometres (PM_{10}) are a particular health concern because they are easily inhaled and retained in the lungs. Studies in the USA and elsewhere consistently show a relationship between particulate matter and a range of respiratory, cardiovascular and cancer related illnesses. Smaller particles, identified as $PM_{2.5}$ can be more lethal than PM_{10}.
sulfur oxides	Exposure to sulfur can cause throat irritation, exacerbation of cardiovascular diseases, and exacerbation of asthma symptoms.

In economic terms, health costs associated with noxious emissions are hard to quantify, but studies suggest they may be substantial.[14] Studies on the impacts of noxious motor vehicle emissions in Australia estimated that:

- The combined economic cost of motor vehicle-related mortality (deaths) and morbidity (illness) was between $1.6 billion and $3.8 billion in 2000.[15]
- In 2010, 1493 deaths were attributable to outdoor air pollution.[16]
- The economic cost of premature deaths due to outdoor air pollution in Australia increased between 2005 and 2010 from $4.6 billion to $7.8 billion per annum and in OECD countries, it is suggested that road transport accounts for approximately half of the cost of these preventable deaths.[17]

13 United States Environmental Protection Agency 2006. *Air quality criteria for ozone and related photochemical oxidants*, Washington, 28 February 2006.

14 The NSW Department of Environment and Conservation 2005. *Air Pollution Economics. Health Costs of Air Pollution in the Greater Sydney Metropolitan Region*, Sydney.

15 Bureau of Transport and Regional Economics 2005. *Health impacts of transport emissions in Australia: Economic costs*, Canberra.

16 OECD, 2014. *The Cost of Air Pollution: Health Impacts of Road Transport*, OECD, Brussels .

17 OECD, 2014. *The Cost of Air Pollution: Health Impacts of Road Transport*, OECD, Brussels.

1.2 The quality of our fuel influences which technologies can be supplied to the Australian market

The *Fuel Quality Standards Act 2000* was established to achieve certain objectives, including facilitating the adoption of better engine and emission control technology. This recognises the role fuel quality plays as an enabler of technology. Some advanced vehicle technologies, including advanced emissions control systems and certain fuel efficient engine technologies, require high quality fuel to work effectively.

A number of the major fuel quality parameters in the current fuel standards, such as limits on sulfur in petrol, were determined between 2000 and 2005. One of the main considerations in setting the levels of these parameters was ensuring Australia's fuel was of an appropriate quality to support the move to the Euro 3 standard for petrol vehicles by 2006 and Euro 4 for diesel vehicles by 2007.

Since that time, Australia has adopted the Euro 5 standard for new light vehicles and is now considering moving to Euro 6. Euro 6 standards commenced in the European Union from September 2014 and similar standards now apply in most developed countries. The United States implemented equivalent standards from 2004 to 2009 and will move to more stringent standards from 2017.

Globally, vehicle manufacturers are also looking for ways to reduce vehicle fuel consumption and greenhouse gas emissions. This is being driven by consumer demand for better fuel efficiency, as well as countries and regions implementing fuel efficiency standards–including the United States, European Union, China, Japan and others. According to the United States Environment Protection Agency, 'lower sulfur gasoline also facilitates the development of some lower-cost technologies to improve fuel economy and reduce greenhouse gas emissions, which reduces gasoline consumption and saves consumers money'.[18]

To facilitate the adoption of better noxious emission standards and in some cases more fuel efficient engine technologies, major overseas markets have strengthened their fuel quality standards. If Australia's fuel standards do not align with the latest international standards, Australia may potentially forego the benefits of some vehicle technologies available, or more widely used, in other countries. An example is lean burn gasoline direct injection (lean burn GDI) engines. While lean burn GDI remains a niche technology, its use may increase as fuel efficiency standards become more stringent over time.

The Department commissioned the Hart Report[19] in 2014 to compare Australian fuel standards with those in other countries, and to examine points of difference. The report found that there are a number of parameters in Australian petrol, diesel, biodiesel and E85 that may require changes to bring Australian fuel standards into line with global practice. The report noted that further study would be needed to assess the impacts of any changes to the fuel standards, for example, expected air quality improvements, enabling of advanced emission control technologies, the impacts on the refining industry, and impacts on fuel supply.

Views on acceptable levels of sulfur in fuel vary across stakeholder groups. For example, the Australian Institute of Petroleum stated in their submission to the Ministerial Forum on Vehicle Emissions discussion paper that the Australian Institute of Petroleum does not consider that 10 ppm sulfur petrol is required to implement Euro 6 light vehicle emissions standards because there are no operability benefits and very few environmental benefits of changing the fuel standards.[20]

Alternatively, in their submission to the Ministerial Forum on Vehicle Emissions discussion paper, the Federal Chamber of Automotive Industries, who represent the major vehicle suppliers in Australia, has commented that the high sulfur content in petrol currently supplied to the Australian market limits the supply of some existing petrol engines that meet Euro 6 standards.

18 United States Environmental Protection Agency 2014. *Control of air pollution from motor vehicles: Tier 3 motor vehicle emission and fuel standards final rule. Regulatory Impact Analysis. March 2014*.

19 Hart Energy 2014. *International Fuel Quality Standards and Their Implications for Australian Standards*. The Department commissioned this report in 2014 to compare Australian fuel quality standards with comparable fuel standards in other countries, and to examine points of difference, 27 October 2014.

20 Australian Institute of Petroleum 2016. *Submission to the Vehicle Emissions Working Group on the Vehicle Emissions Discussion Paper*, AIP, 8 April 2016.

The situation will continue until such time that 10 ppm sulfur petrol is widely available in the Australian market.[21] Mercedes-Benz Australia spokesman says his company isn't in a position to introduce more efficient engines for its cars until Australia adopted low sulfur fuel standards.[22]

1.3 Fuel parameters of concern

This discussion paper provides an opportunity for stakeholders to provide feedback on whether current fuel standards are helping to meet the key objectives of the *Fuel Quality Standards Act 2000* which are to:

- reduce the level of noxious emissions arising from fuel use that may cause health and environmental problems
- drive the adoption of better engine technology and emission control technology
- allow motor vehicle engines to operate cleanly and efficiently
- ensure that appropriate information is provided to consumers where fuel is supplied.

This section provides an overview of common fuel components, additives and by-products. The presence of these substances in fuel at specific concentrations can cause a number of negative environmental and health impacts and can influence which technologies are made available to the Australian vehicle market. Revised limits for these substances are referred to in the policy alternatives described in Section 3.1 of this discussion paper.

Sulfur in petrol

Sulfur is a natural component of crude oil. In addition to the health impacts discussed in Section 1.2, sulfur is present in fuel (petrol and diesel) and can clog the catalytic converters of motor vehicles,[23] limiting its ability to process noxious emissions before they are released as part of the vehicle's exhaust.

Reducing sulfur in fuel makes catalytic converters more effective, and so fewer noxious substances are emitted. Reducing sulfur in petrol would facilitate uptake of more stringent noxious emission standards in the future. It would also allow lean burn GDI engine technologies that reduce carbon dioxide emissions.

Figure 3 below depicts current and future-state global limits for sulfur content in gasoline (petrol). The majority of Australia's trading partners are significantly reducing permitted sulfur limits in fuel over the next four years in order to meet Euro 6 emission standards. Currently, Australia is ranked 66 in the 'Top 100' world ranking of petrol quality (based on sulfur content[24]) and is the lowest ranked of the 35 OECD member countries.

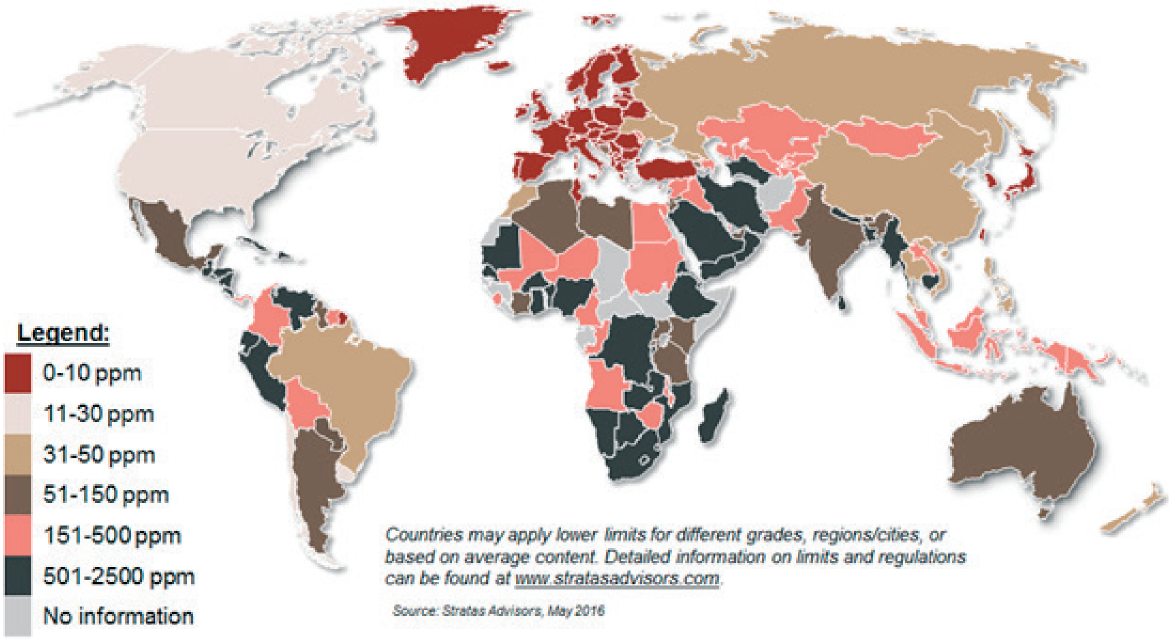
21 Federal Chamber of Automotive Industries 2016. *FCAI response to the Vehicle Emissions Discussion Paper*, FCAI, 8 April 2016.

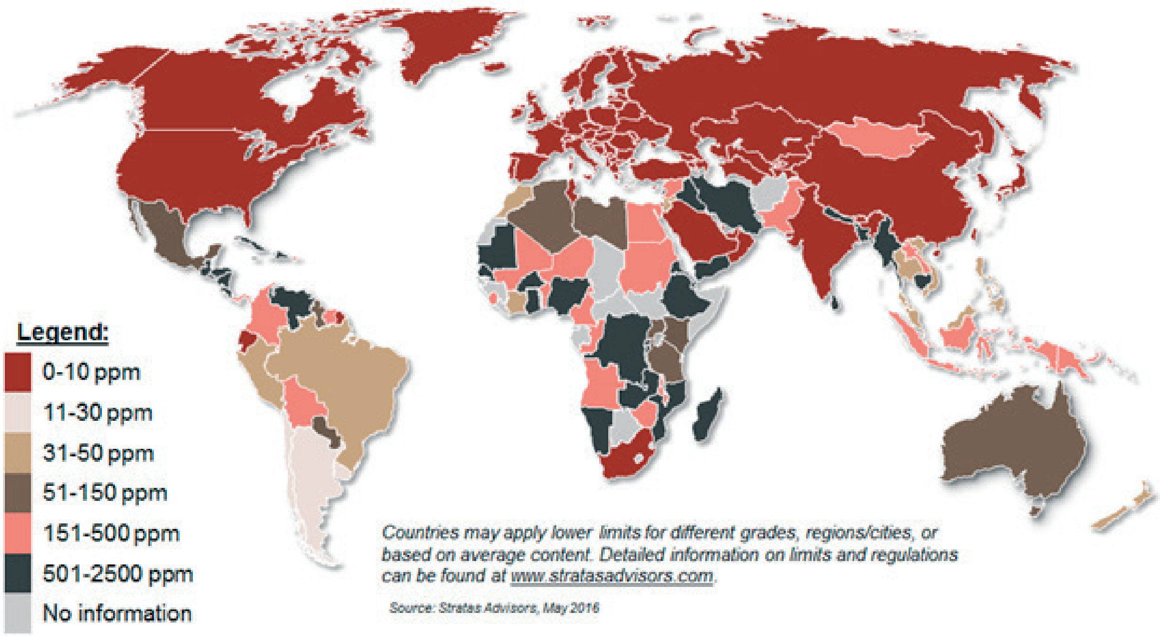
22 Dowling N 2012. Bad petrol denies us good engines, Cars Guide. Available from http://www.carsguide.com.au/car-news/bad-petrol-denies-us-good-engines-19814, 12 March 2012

23 A catalyst, or catalytic converter, is part of a vehicle's emission system that converts noxious emissions to less harmful forms before they are released as part of the exhaust.

24 Stratas Advisors 2016. *Nine Countries Move Up in Top 100 Ranking on Gasoline Sulfur Limits*, Hart Energy. Available from: https://stratasadvisors.com/Insights/Top-100-Sulfur-Gasoline.

Figure 3: Maximum global sulfur limits in gasoline, 2016 (top) and 2020 (bottom)





Source: Stratas Advisors, May 2016

Australia's unleaded petrol is low octane (91 RON) with a maximum sulfur limit of 150 ppm and premium unleaded petrol is high octane (minimum 95 RON) with a maximum sulfur limit of 50 ppm. The maximum sulfur limit in Europe is 10 ppm; the minimum octane level is 95 RON. The maximum sulfur level in the US will be 10 ppm from 2017, the minimum octane level ranges from 92–96 RON. The Hart report suggests alignment of sulfur levels in petrol with the European Union, Japan and South Korea by reducing the limit from the current 150 ppm for all grades and 50 ppm for premium unleaded petrol to 10 ppm to enable advanced emission controls on the vehicles that are being produced and driven in the Australian market.[25]

Octane levels in petrol

The Research Octane Number, often referred to just as 'octane', is a measure of the compression that the air/fuel mixture can withstand in an engine before igniting. Examples include unleaded petrol with 91 RON (low octane) and premium unleaded petrol with 95 RON (high octane).

High octane fuels can be used in high compression petrol engines which are more energy efficient so use less fuel and produce fewer noxious and greenhouse gas emissions. Base-grade petrol used in Europe has both higher octane and lower sulfur levels than current base-grade petrol in Australia. Other countries such as Japan and South Korea specify octane levels similar to Australia.

Too low an octane fuel for an engine can cause 'knocking', which can be harmful to engines. To avoid engine knocking in countries that have low octane fuel (including Australia), some vehicle manufacturers do not offer the higher compression models supplied to other markets.

Derived cetane number (diesel fuel)

Diesel fuels can be used in compression ignition or diesel engines. A key parameter of diesel fuel is the 'derived cetane number'–the higher the number, the higher the combustion speed of a fuel. Diesel fuels with a higher cetane number run more smoothly, and may be more efficient. Generally, high cetane number fuels in light vehicles produce more energy, less carbon monoxide and fewer volatile organic compounds, but may also increase particulate matter (which is then collected by diesel particulate filters).

Ethers

Some ethers are persistent and mobile in water and can easily contaminate groundwater, making it unsuitable for drinking. Some areas of Australia rely heavily on groundwater for agricultural purposes and human consumption. In Australia, groundwater is highly susceptible to contaminants due to porous soil and a shallow water table. The fuel quality standards permit a maximum of 1 per cent methyl tertiary butyl ether (MTBE). There are different arrangements overseas. MTBE is banned in some parts of the United States due to concerns about groundwater contamination, but its use is, nonetheless, permitted in other countries because it is an effective octane enhancer.

Ethanol

Ethanol burns cleanly and is a popular octane enhancer used in Australia. Petrol blended with ethanol is high in octane and can be used in higher compression engines, but has lower energy density than petrol which means a vehicle using fuel blended with ethanol will need to refuel more regularly.

It should be noted that ethanol is high performance fuel that when added to petrol increases its RON or octane value, meaning that it can be used in higher compression engines. E10 fuel is almost of premium quality now (based on RON), and many E10 samples do have a RON greater than 95. E10 fuel is currently cheaper than regular ULP (91 RON), and with appropriate management of petrol before it is blended with ethanol, or

25 Hart Energy 2014. *International Fuel Quality Standards and Their Implications for Australian Standards*. The Department commissioned this report in 2014 to compare Australian fuel quality standards with comparable fuel standards in other countries, and to examine points of difference, 27 October 2014.

addition of a high octane oxygenate, ethanol blended fuels could provide premium quality petrol at substantially reduced cost to that available now. Ethanol does have a lower energy density than petrol, which means a vehicle using E10 fuel will need to refuel more regularly.

We are interested in stakeholder views on whether higher levels of ethanol could be used in Australian vehicles, and what petrol management options could be used or what octane enhancers could be added to E10 achieve premium quality (95 RON) fuels at lower prices.

Other compounds

Other substances found in fuel which are of interest include:

- benzene, which is carcinogenic
- olefins–types of hydrocarbons that can contribute to ozone formation
- phosphorus because it can clog vehicle catalytic converter systems which remove other pollutants (such as carbon dioxide, hydrocarbons and nitrogen oxides) from vehicle exhaust.

2 Why is government action needed?

Key messages:

- There have been significant efforts by governments over a number of years to improve air quality in Australia through the reduction of noxious emissions from vehicles, including through the regulation of fuel quality under the *Fuel Quality Standards Act 2000*.
- Government action to revise fuel standards addresses the negative externality of noxious and greenhouse gas emissions from vehicles, and addresses information issues and transaction costs.
- Moving towards international harmonisation of fuel standards is another factor driving regulation of fuel quality in Australia.
- The recent review of the *Fuel Quality Standards Act 2000* and successful activities in other countries to reduce the impact of vehicle emissions on health and the environment provide evidence that the policy problem can be addressed by government action.

The human health impacts from exposure to noxious and greenhouse gas emissions from vehicles are an external cost to society which is largely beyond the control of communities and individual businesses. The links between exposure to noxious emissions from vehicles, human health and the health of the environment make this issue a priority for joint action by governments, businesses and the community.[26]

Fuel standards have made a positive contribution to reducing noxious emissions and their health impacts over the past 16 years. Ongoing review of Australian fuel standards is necessary to determine whether further action is required to improve air quality and emission standards over time, particularly in light of population growth and increasing urbanisation. The ongoing review of fuel quality information standards is also important, as it enables consumers to make informed choices about the fuel they use in their vehicles.

As air pollution is not contained within state and territory boundaries, a national approach is required to implement effective policies which reduce environmental and health risks. In 2015, the National Clean Air Agreement was established by Australia's environment ministers to address the impacts of air pollution on human and environmental health.[26] Strategic approaches under the National Clean Air Agreement include stronger reporting standards for particulate matter, sulfur dioxide, nitrogen dioxide and ozone, and a review of the *Fuel Quality Standards Act 2000*.

The review of the *Fuel Quality Standards Act 2000* completed in 2016 found that regulating the quality of fuel supplied in Australia has led to a quantifiable reduction in the amount of pollutants arising from the use of fuel in major capital cities, and related improvement in health outcomes.[27] The review noted that the health risks associated with air pollution and the emission of greenhouse gases associated with fuel use in vehicles suggest that a strong case remains for the continued regulation of fuel quality in Australia–by setting fuel standards and requiring the disclosure of information to consumers about fuel in a readily accessible form.

26 Department of the Environment and Energy 2015. *National Clean Air Agreement*. Available from: https://www.environment.gov.au/protection/air-quality/national-clean-air-agreement.

27 Marsden Jacob 2016. *Review of the Fuel Quality Standards Act 2000*, piii, 28 April 2016.

Two key objectives of the *Fuel Quality Standards Act 2000* relating to the adoption of better engine and emission control technology and allowing effective operation of engines are linked to the harmonisation of Australian standards with international standards, and the availability of fuels to adopt new technologies. This is another factor influencing government action. In the review it was noted that emission standards around the world are becoming more stringent and higher quality fuel is needed to meet these standards. Australia is operating in an increasingly global automotive industry and is heavily reliant on imported vehicles which adds to pressure for emission and fuel standards to be more closely harmonised with international standards.

In considering whether non–regulatory approaches could achieve the objectives of the *Fuel Quality Standards Act 2000*, the review found that a regulatory framework for fuel quality in Australia should remain in place for the foreseeable future. The review also considered co–regulation and self-regulation options and determined that these options would be poorly suited to the achievement of positive fuel quality outcomes.[28] There was broad public support for the ongoing need for the *Fuel Quality Standards Act 2000* in managing the health risks posed by exposure to noxious vehicle emissions. The Australian Government has established a Vehicle Emissions Ministerial Forum to help reduce the health and environmental impacts from motor vehicle emissions through a whole of government approach. The Ministerial forum will examine a range of issues including the implementation of Euro 6 or equivalent standards for new vehicles and fuel quality standards.

Emission standards for vehicles are regulated as Australian Design Rules (ADRs). The ADRs are national standards for vehicle safety, anti-theft and emissions. The ADRs are generally performance based and cover issues such as occupant protection, structures, lighting, noise, engine exhaust emissions, braking and a range of miscellaneous items.[29] In developing the ADRs, the Australian Government has committed to adopting United Nations (UN) standards where possible, as this approach provides the desired environmental outcome and facilitates international trade in motor vehicles.

Globalisation of the motor vehicle industry, the relatively small size of the vehicle market in Australia and the higher costs involved, make the development of unique Australian standards undesirable from both a government and manufacturing perspective. The adoption of international standards can reduce duplication of regulatory approvals, reduce delays, increase competition and improve business competitiveness in Australia. Where a product has been approved under a trusted international standard, the Australian Government should not impose any additional requirements for approval in Australia, unless it can be demonstrated that there is a good reason to do so.[30]

28 Marsden Jacob 2016. *Review of the Fuel Quality Standards Act 2000*, piv, 28 April 2016.

29 Department of Infrastructure and Regional Development 2015. *Australian Design Rules*. Available from: https://infrastructure.gov.au/roads/motor/design/ [Accessed 5 October 2016].

30 Australian Government 2015. International Standards and Risk Assessments. Available from: https://www.cuttingredtape.gov.au/resources/guidance/international-standards-and-risk-assessments

3 Policy alternatives

Key messages:

- Fuel standards are currently in place for petrol, diesel, autogas, biodiesel and ethanol (E85).
- Fuel standards set limits on substances and parameters in each fuel.
- Five policy alternatives are proposed for amending the fuel standards.
- Fuel parameters of particular concern include sulfur and octane in petrol; and cetane and polycyclic aromatic hydrocarbons in diesel.
- Stakeholder views are also invited on the fuel quality information standards, guidelines and regulations.

This paper discusses five policy alternatives for changing the fuel standards. Each existing fuel standard is made up of a list of parameters, which set the upper and/or lower limit on the substances allowed in that type of fuel.

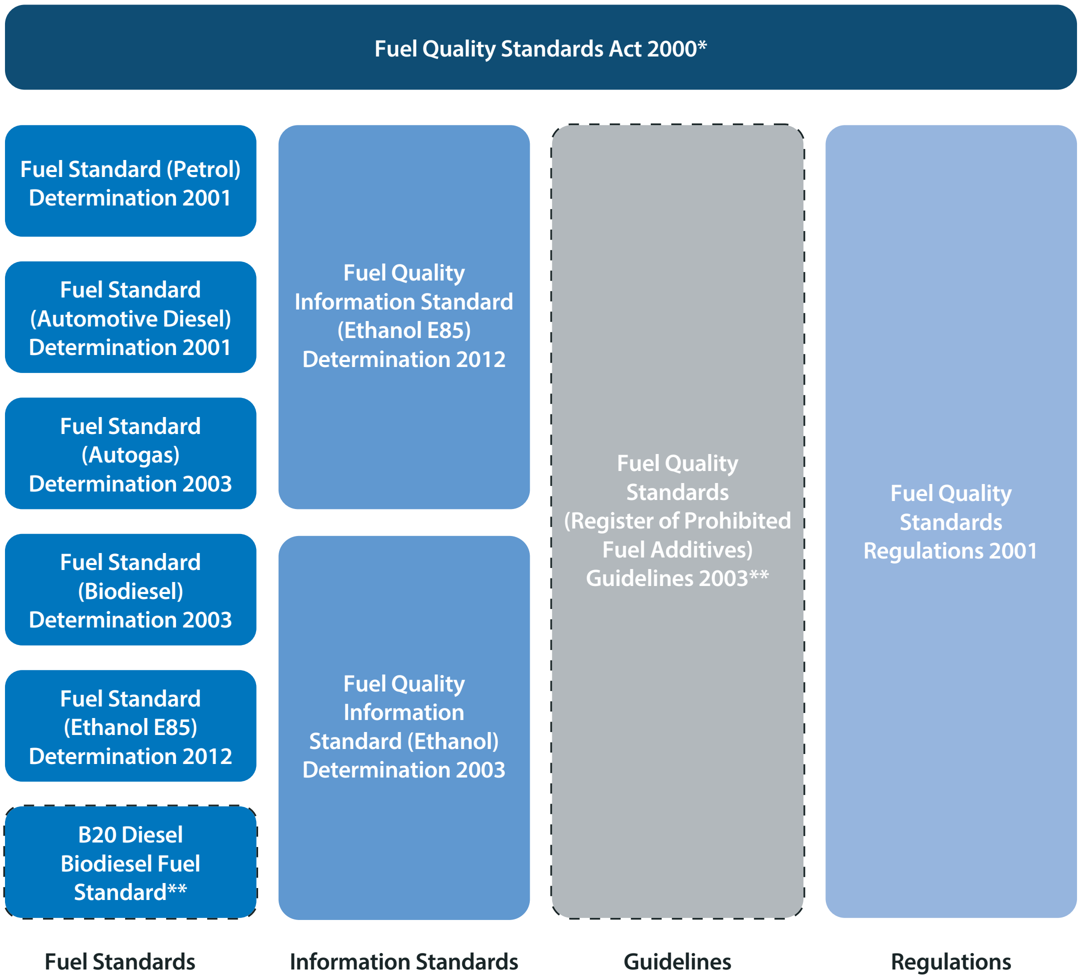
The alternatives below offer a range of proposed changes to those limits, or the addition or removal of particular substances found in fuel. This list is not exhaustive and you may suggest other possibilities for the Government to consider.

A Technical Annex is provided for each policy alternative where changes to substance limits are described, along with a comparison against existing international fuel standards.

In addition to the alternatives for changing the fuel standards, feedback is also sought on proposed changes to other legislative instruments which have been made under the *Fuel Quality Standards Act 2000*. Options related to these instruments are covered in sections 3.2 to 3.5.

The instruments which form part of this consultation are set out in Figure 4. Any proposed changes to the fuel standards or other legislative instruments requiring legislative amendments would be carried out in accordance with the requirements of the Office of Best Practice Regulation.

Figure 4: Categories of legislative instruments made under the Fuel Quality Standards Act 2000 which form part of this consultation



*The operation of the *Fuel Quality Standards Act 2000* is beyond the scope of this consultation.
** The development of a fuel standard for B20 fuel and a register of prohibited fuel additives are proposed as part of this consultation.

3.1 Policy alternatives for changing the fuel standards

There are two elements at the core of these proposed policy alternatives: changes to substance limits and other parameters for each fuel type (alternatives B, C, D and E), and a phase-out of regular unleaded petrol (ULP) in alternatives B and D.

The five policy alternatives are outlined below and summarised in Table 3. Further detail is available in the Technical Annex.

A Australia's fuel standards remain in effect in their current form (business as usual). Petrol standards retained: unleaded petrol (91 RON) with a maximum sulfur limit of 150 ppm; premium unleaded petrol (95 RON) with a maximum sulfur limit of 50 ppm. Diesel standard continues to specify a maximum sulfur limit of 10 ppm and derived cetane number of 51 for diesel containing biodiesel only.

B Revisions to the fuel standards to align with the recommendations of the Hart Report[31] and to harmonise with European standards.

The key changes proposed under alternative B are:

- In petrol, phasing out unleaded petrol (91 RON) over a specified period of time (e.g. two to five years). Sulfur in premium unleaded petrol (95 RON) would be limited to 10 ppm and a new octane standard for premium unleaded petrol (98 RON) introduced, aromatics limited to 35 per cent and in the ethanol used to blend E10, sulfur is limited to 10 ppm and inorganic chloride to 1 ppm.
- In diesel, the derived cetane number of 51 applies also to diesel not containing biodiesel, and polycyclic aromatic hydrocarbons are limited to 8 per cent.
- In ethanol E85, sulfur is limited to 10 ppm.
- A new fuel standard for B20 diesel biodiesel blend is proposed, which would streamline administration and costs for fuel suppliers and for the Department. B20 fuel is primarily used by mining and transport operators.

Changes proposed to the biodiesel standard are minimal, and are described fully in the Technical Annex.

C Revisions to the fuel standards to align with the recommendations of the Hart report and to harmonise with European standards as per alternative B, except that unleaded petrol (91 RON) is retained but with a lower sulfur limit of 10 ppm.

D Revisions to the fuel standards as per alternative B above, except with stricter parameters (including for cetane levels in diesel) to harmonise with standards recommended by the Worldwide Fuel Charter (that specifies the fuel quality required by automobile companies to meet particular emission standards).

This alternative includes all the changes to fuel standards detailed under alternative B, with some stricter limits and additional changes for improved engine performance:

- in petrol, olefins are limited to 10 per cent, the induction period (which is a measure of the age and eventual degradation of fuel in storage) is increased to 480 minutes and a trace metals limit of 1 ppm is introduced
- in diesel, the derived cetane number and cetane index are set at 55 and polycyclic aromatic hydrocarbons are limited to 2 per cent.

E Staged introduction of world standards from 2020, with a review in 2022 to determine next steps.

This alternative proposes a phased-in approach to reduce sulfur in petrol commencing in 2020. Alternative E is designed to give industry significant lead time to reduce sulfur content in petrol. This alternative also includes revisions to other parameters detailed under alternative B above.

Key changes under alternative E are:

- Commencing in 2020, sulfur in unleaded petrol (91 RON) is limited to 50 ppm, sulfur in premium unleaded petrol (95 RON) is limited to 25 ppm, and introduction of a new octane standard for premium unleaded petrol (98 RON) with a 10 ppm limit on sulfur.
- These changes will be reviewed in 2022 to determine next steps.
- For premium unleaded petrol (98 RON), the introduction of this alternative is similar to the Worldwide Fuel Charter standards.

Please note that no changes are being proposed to the autogas standard.

31 Hart Energy 2014. *International Fuel Quality Standards and Their Implications for Australian Standards*. The Department commissioned this report in 2014 to compare Australian fuel quality standards with comparable fuel standards in other countries, and to examine points of difference, 27 October 2014.

Table 3: Key parameter changes for each fuel under the alternatives in this discussion paper

Alternative	Petrol		Diesel	Autogas	Biodiesel	Ethanol E85	Biodiesel B20
A No changes to the fuel standards	No change RON 91 95 98 MON 81 85 88 Sulfur 150 ppm 50 ppm 50 ppm	Aromatics 45% In ethanol, sulfur 30 ppm and inorganic chloride 32 ppm	No change Derived cetane number 51 (diesel containing biodiesel) Polycyclic aromatic hydrocarbons 11%	No change	No change	No change Sulfur 70 ppm RON 100 MON 87	No change
B Revisions based on Hart report and/or to harmonise with the EU	RON* 95 98 MON 85 88 Sulfur 10 ppm 10 ppm * phase out of unleaded petrol (91 RON)	Aromatics 35% In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 51 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 8%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6
C Revisions retaining low octane petrol	RON 91 95 98 MON 81 85 88 Sulfur 10 ppm 10 ppm 10 ppm	Aromatics 35% In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 51 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 8%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6
D Revisions based on the Worldwide Fuel Charter	RON* 95 98 MON 85 88 Sulfur 10 ppm 10 ppm * phase out of unleaded petrol (91 RON)	Aromatics 35%, olefins 10%, induction period 480 min, trace metals 1 ppm In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 55 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 2%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6
E Staged introduction of world standards from 2020 with a review in 2022	RON 91 95 98 MON 81 85 88 Sulfur 50 ppm 25 ppm 10 ppm	Aromatics 35% In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 51 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 8%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6

Legend:

- no change
- significant changes are listed–for other changes see technical annex
- non–significant change–see technical annex
- new standard–see technical annex

The key advantages and disadvantages of revisions to fuel standards are discussed in more detail below.

Alternative A. No changes to the fuel standards (business as usual)

Advantages

There are no new or additional regulatory costs proposed under this alternative. Current level of protection for the environment and human health is maintained.

Disadvantages

Does not contain measures to improve air quality and therefore provides no additional benefits to human and environmental health. Australia is 66th in the 'Top 100' world ranking of petrol quality (based on sulfur content[32]) and is the lowest ranked of the 35 OECD member countries. The presence of sulfur in Australian petrol has negative health impacts and can diminish the performance of vehicle catalysts which reduce noxious emissions.

Alternative B. Revisions to the fuel standards as recommended by the Hart Report or to harmonise with European standards

Advantages

Sulfur, aromatics and other noxious emissions are reduced. Increased benefits from Euro 5 and 6 emission reduction technology.

The changes proposed to the petrol standard should provide better air quality, better fuel efficiency and improved protection from engine corrosion. Changes to the diesel standard should reduce toxic engine emissions and reduce engine deposits.

Sulfur limits of 10 ppm in petrol allow the use of lean burn engine technologies and wider use of other high compression technologies, which can reduce fuel consumption and greenhouse gas emissions, as well as providing human health and environmental benefits.

A new fuel standard for B20 diesel biodiesel blend has been proposed by a number of stakeholder groups as a way to reduce administrative burden. Currently, fuel suppliers who wish to sell B20 fuel in Australia are required to apply for special approval under section 13 of the *Fuel Quality Standards Act 2000* as B20 is not subject to an existing fuel standard. The application and its assessment require a significant amount of administrative work on the part of the applicant and the Department. Development of a B20 standard would also provide greater certainty for the biodiesel industry, and may improve consumer confidence in this product. The technical inclusions for the proposed B20 standard are covered in Appendix A of this discussion paper.

Disadvantages

Under this alternative, there may be additional costs for fuel refineries to produce petrol with a sulfur limit of 10 ppm, a higher Research Octane Number, and fewer aromatics. These costs are discussed in section 4.

32 Stratas Advisors 2016. *Nine Countries Move Up in Top 100 Ranking on Gasoline Sulfur Limits*, Hart Energy. Available from: https://stratasadvisors.com/Insights/Top-100-Sulfur-Gasoline

Alternative C. Revisions to the fuel standards to align with alternative B, unleaded petrol (91 RON) is retained

Advantages

The benefits of retaining unleaded petrol (91 RON) are that it is a readily available and cost-effective fuel which is preferred by some consumers, particularly those with older cars that may not be designed to receive any benefit from using higher octane fuel.

The additional health and environmental benefits discussed above in alternative B would be delivered.

Disadvantages

Potential costs to industry of changing other parameters are consistent with alternative B.

Unleaded petrol (91 RON) is lower octane petrol, and lower compression engines using this fuel do not realise the efficiency and environmental benefits that could be achieved with high compression engines, all other factors being equal. Higher octane petrol can be used in high compression petrol engines which are more energy efficient and use less fuel, and produce fewer noxious emissions. As high compression engines use less fuel, they produce less greenhouse gas and may reduce motorists' fuel bills.

Alternative D. Revisions to the fuel standards to align with standards recommended by the Worldwide Fuel Charter

Advantages

This alternative would deliver the health and environmental benefits of at least alternative B, with additional vehicle performance and fuel efficiency benefits.

Based on the Worldwide Fuel Charter Category 5 standards, which have been developed by the world's major automobile companies, the Category 5 standard for fuel quality is described as:

> *'Markets with highly advanced requirements for emission control and fuel efficiency, enables technologies that can help increase vehicle and engine efficiency, in addition to enabling sophisticated NOx and particulate matter after-treatment technologies'.*

As many countries take steps to require vehicles and engines to meet strict fuel economy standards in addition to stringent emission standards, Category 5, which raises the minimum research octane number (RON) to 95, will enable some petrol technologies that can help increase vehicle and engine efficiency.[33]

Disadvantages

This alternative would deliver the same disadvantages as alternative B.

There is the potential for an adverse impact if reductions in olefins and aromatics in petrol are achieved through an increase in the use of other octane enhancers such as methyl tertiary butyl ether (MTBE). MTBE is a volatile organic compound which is used as an octane enhancer in some countries, including the European Union and Asia. It is easily dispersed and persists in groundwater, and at low concentrations can affect the taste and odour of drinking water.

33 Worldwide Fuel Charter Committee 2013. *Worldwide Fuel Charter Fifth Edition*. Available from: https://www.acea.be/uploads/publications/Worldwide_Fuel_Charter_5ed_2013.pdf

There are varied views on the use of MTBE as an octane enhancer, with some groups, such as the Asian Clean Fuels Association, advocating for its use referencing air quality benefits, and others opposing it on environmental and health grounds. In the United States, various states have enacted statutes to limit or ban the use of MTBE due to groundwater issues. Therefore, careful consideration of this issue is required to manage the competing risks posed by alternative octane enhancers. See section 1.4 for further information.

Alternative E. Staged introduction of world standards from 2020 with a review in 2022 to determine next steps

Advantages

While reducing maximum sulfur limits for unleaded petrol (91 RON) and premium unleaded petrol (95 RON), this alternative would deliver some health and environmental benefits but not as great as alternative B.

For premium unleaded petrol (98 RON), from 2020 this alternative would deliver the advantages of alternative B for petrol and increase the likelihood that better vehicle technology could be used to reduce emissions.

The additional health and environmental benefits discussed above in alternative B would be retained for revisions to other parameters.

Disadvantages

Under this alternative, there may be additional costs for fuel refineries to produce petrol with a sulfur limit of 10 ppm. These costs are discussed in section 4.

QUESTION SET 1. Questions in relation to the fuel standards

Policy alternatives outlined in this paper

1. Can you provide evidence of the costs and/or benefits of any of the listed policy alternatives (A, B, C, D or E)?
2. Do you have a different alternative which is not covered in this paper?
3. Are there any changes which would improve or clarify the operation of the fuel standards?
4. Should any other fuel standards be developed (other than the proposed fuel standard for the B20 diesel biodiesel blend)?

Additional questions

5. Can you provide evidence of the extent to which the current fuel standards limit the adoption/importation of existing technologies and models that meet higher specifications?
6. What changes to the fuel standards would best reduce emissions, ensure engine operability and facilitate new engine technologies?
7. What changes to the fuel standards do you believe will be required if the Australian Government mandates Euro 6 emissions standards for light vehicles?
8. Each fuel standard includes required test methods for analysis of fuel samples. Do you have any comments on the test methods specified in the fuel standards?
9. Are there any other issues you would like to raise in relation to the fuel standards?

3.2 Review of the Fuel Quality Information Standards

The Minister has made two fuel quality information standards under section 22A of the *Fuel Quality Standards Act 2000*: the Fuel Quality Information Standard (Ethanol) Determination 2003 and the Fuel Quality Information Standard (Ethanol E85) Determination 2012.

Fuel Quality Information Standards (Ethanol E85) Determination 2012

The Fuel Quality Information Standards (Ethanol E85) Determination 2012 provides that the petrol pump from which ethanol E85 is supplied must clearly display one of the following:

a) the words 'Contains 70–85% ethanol', and 'Not Petrol or Diesel';

b) the words 'Contains x% ethanol', where x is a number between 70 and 85, and 'Not Petrol or Diesel'.

Submissions to the 2016 review of the *Fuel Quality Standards Act 2000* identified that the current wording of the Information Standard for Ethanol (E85) is inconsistent with other fuel information standards, and is not clear on whether the stated number range includes fuels that are either 70 or 85 per cent ethanol.

To address these concerns, the Department proposes a minor amendment to section 6(a)(ii) of the Fuel Quality Information Standard for Ethanol (E85) to read: 'x% ethanol, where x is a number more than 70 but less than or equal to 85'. This will achieve better consistency with the other Fuel Quality Information Standards.

QUESTION SET 2. Questions in relation to the Fuel Quality Information Standards

10. Do you have any views on the Department's proposal to amend the Fuel Quality Information Standard for Ethanol (E85)?
11. To what extent are you aware of misfueling (the use of a fuel that is inappropriate for a given vehicle)? Do you believe the Fuel Quality Information Standards are useful in preventing misfueling?

3.3 Review of the Fuel Quality Standards Regulations 2001

The *Fuel Quality Standards Regulations 2001* have been amended a number of times since their enactment. The latest amendments include:

a) The Fuel Quality Standards Amendment (Fuel Blends) Regulation 2015. This Regulation amended the definition of fuel in sub-regulation 3(2) to specifically include fuel blends so that fuel standards may now be made for fuel blends.

b) The Fuel Quality Standards Amendment (Fees) Regulation 2016. This Regulation amended the fee for applications under section 13 of the *Fuel Quality Standards Act 2000* to vary a fuel standard or fuel information standard.

Views are sought on the suitability of the current definition of fuel within the Regulations.[34] The definition currently excludes certain types of fuel, which means that fuel standards cannot be made for these particular fuels.

34 The current definition of 'fuel' within the Fuel Quality Standards Regulations 2001 can be found at https://www.legislation.gov.au/Details/F2008C00561

QUESTION SET 3. Questions in relation to the Fuel Quality Standards Regulations 2001

12. Have you identified any issue with the Regulations that you would like to draw to our attention?
13. Is the definition of 'fuel' adequate to enable all relevant standards to be made? For example, should the definition of fuel be expanded to cover marine diesel, synthetic diesel, methanol-based fuels, etc to enable standards to be made for these fuel types?
14. Currently, aviation gas (avgas) is explicitly excluded from the petrol standard. Do you believe avgas should be covered by a fuel standard?

3.4 Review of the Fuel Quality Standards (Register of Prohibited Fuel Additives) Guidelines 2003

The Fuel Quality Standards (Register of Prohibited Fuel Additives) Guidelines were made in 2003 and set out the matters that the Minister must consider before entering or removing a fuel additive from the Register. The guidelines are intended to ensure that a consistent, objective process is followed in deciding whether or not a fuel additive should be prohibited. They also provide a process for interested parties to make submissions on the proposed listing or delisting of any fuel additives.

Additives can increase the octane in fuel, or act as corrosion inhibitors or lubricants, allowing the use of higher compression engines for greater efficiency and power. Types of additives include metal deactivators, corrosion inhibitors, oxygenates and antioxidants. While some additives can be beneficial, there are some that are harmful and are therefore regulated or banned in some countries.

The Department proposes that consideration be given to creating a Register of Prohibited Additives through the listing of the following four fuel additives:

- tetraethyl lead (already prohibited in petrol, but to be extended to all road vehicles, including racing vehicles). This needs to be done in a way that does not preclude the use of lead in aviation gasoline, as unleaded alternatives are not readily available.
- n-methylaniline (NMA)
- methylcyclopentadienyl manganese tricarbonyl (MMT)
- polychlorinated n-alkanes (chlorinated paraffins).

There is significant evidence that tetraethyl lead has an adverse impact on human health and anecdotal evidence that suggest the other three additives listed above can pose a risk to human health and engine operability.[35]

Listing these fuel additives on the Register of Prohibited Fuel Additives would require public consultation and a legislative process. If the proposed listings were approved, supplying these fuel additives (except for specified purposes, e.g. use in aviation gasoline) in Australia would be a contravention of the *Fuel Quality Standards Act 2000* and may result in civil penalties for individuals and corporations.

35 National Health and Medical Research Council (NHMRC) 2015. *Information paper: Evidence on the effects of lead on human health*, NHMRC, May 2015.

QUESTION SET 4. Questions in relation to the Fuel Quality Standards (Register of Prohibited Fuel Additives) Guidelines 2003

15. Do you agree with the Department's proposal to list the above additives on the Register of Prohibited Fuel Additives? If not, why not?
16. Should MMT (methylcyclopentadienyl manganese tricarbonyl) or other additives such as N-methylaniline be allowed in Australian fuel as an octane enhancer?
17. Are you aware of any substitute octane enhancers that can be used in place of MTBE and other ethers?
18. What (if any) other substances should be considered for listing on the Register of Prohibited Fuel Additives?

3.5 Review of the Guidelines for more stringent fuel standards

Subsection 21(2) of the *Fuel Quality Standards Act 2000* states that a fuel standard made under section 21 may provide for more stringent parameters to apply in respect of supplies of the fuel in specified areas in Australia, for example in a particular state or territory.

Section 22 of the *Fuel Quality Standards Act 2000* provides that the Minister must, by legislative instrument, develop guidelines that he or she must have regard to in applying subsection 21(2). To date, no guidelines have been written. If there is a need for more stringent fuel standards in any specified areas within Australia, guidelines will first need to be developed. If developed, these guidelines will be the tenth legislative instrument made under the *Fuel Quality Standards Act 2000*.

QUESTION SET 5. Questions in relation to the proposed Guidelines for more stringent fuel standards

19. Are there any areas in Australia that require more stringent fuel standards? If so, which fuel standards should the more stringent standards apply to, and where should they be applied?
20. Are changes to fuel standards necessary to better align them with other legislation, such as the *Low Aromatic Fuel Act 2013*?

4 How will the alternative policies be assessed?

Key messages:

- A detailed cost benefit analysis of the impacts of the policy alternatives will be undertaken.
- The costs of the policy alternatives to government, business and the community will be quantified using the Australian Government Regulatory Burden Measurement Framework.
- Stakeholder input will be used to inform this assessment process.

In the coming months the Department will undertake a more detailed quantitative analysis of the impacts of the various policy alternatives in the form of a cost benefit analysis. The analysis will include an estimate of the regulatory burden.

This section describes the preliminary scope, method and key information sources that are proposed to be used for both analyses.

As separate cost–benefit analyses will be conducted for the additional two regulation impact statement (RIS) exercises related to vehicle emissions (i.e. regulatory impact statements for fuel efficiency and noxious emissions) it will be important to ensure that the assumptions and methods used across the analyses are consistent (for example, in relation to growth in the Australian vehicle fleet). In addition, where there are synergistic/additive impacts associated with particular combinations of the policy options across the various RIS exercises, these relationships will need to be clearly articulated. For example, phasing in a new base fuel premium unleaded petrol (95 RON)) would create opportunities for improved vehicle efficiency, but such efficiency gains will be technology-dependent.

The assessment will also consider the criteria developed by the Department of the Environment and Energy for the consideration of international standards.[36]

4.1 Cost–benefit analysis methodology

The methodology for undertaking cost–benefit analysis provides an objective framework for weighing up a range of different impacts, which are likely to occur at different times in the future. A comprehensive cost–benefit analysis will be undertaken on the five policy alternatives outlined in Section 3, and in accordance with the Australian Government guidance.[37] Other options identified as a result of consultation on this discussion paper may also be analysed.

In order for the cost–benefit analysis to inform decision makers and support identification of the preferred policy, all relevant costs and benefits need to be clearly identified. Data used to quantify these costs and benefits must be as reliable and current as possible, and all assumptions clearly identified and explained. The alternative with the greatest net benefit will typically be presented as the preferred policy, although qualitative discussion on aspects of policy implementation which are difficult to quantify can also be considered.

36 Department of Environment and Energy 2016. *International Standards and Risk Assessment Criteria*. Available from: https://www.environment.gov.au/about-us/accountability-reporting/isra

37 Department of Prime Minister and Cabinet 2016. *Cost-benefit analysis guidance note*. Available from: www.dpmc.gov.au/resource-centre/regulation/cost-benefit-analysis-guidance-note

When comparing the five alternatives specified in section 3, the following benefit categories will be considered:

- chronic (long term) and acute (short term) health implications associated with changes to air quality including the economic cost of motor vehicle-related mortality (deaths) and morbidity (illness), including specific health benefits associated with reductions in nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs) and particulate matter (PM)
- greenhouse gas emissions including the likely net benefits for carbon dioxide equivalent emissions, as well as other greenhouse gas emissions
- savings through increased fuel economy only possible with low sulfur, higher octane fuel using existing and available new technologies
- savings to producers due to less customisation by car manufacturers of new stock for the Australian market
- savings for distributors for example, if fewer fuels were supplied at service station forecourts in the future.

The following key cost categories will also be included within the cost benefit analysis:

- changes to capital, operating costs and greenhouse gas emissions for refineries including additional production costs and increased energy inputs associated with changing the compositions of fuels associated with alternatives B, C, D and E
- changes to costs for distributors for example in relation to updating/replacing aspects of their transport/retailing equipment, educating consumers about changes in fuel standards
- costs to government and business associated with changes to administration arrangements.

Costs and benefits of alternatives B, C, D and E (along with others that may be identified as part of this consultation) will be compared with the base case (alternative A) for each of these categories. For the purpose of the cost benefit analysis, the base case has zero costs and benefits.

Consideration will be taken to avoid double-counting of costs to industry and consumers. For example, the fuel quality cost benefit analysis will consider the cost benefit analyses of the other regulation impact statements under the Vehicle Emissions Ministerial Forum.

The examination of any impacts which affect a particular geographic area, industry, or subset of the population will be an important aspect of the analysis. Particular attention will be given to the impacts on domestic refinery operations (including employment), regional communities (who may experience similar costs to urban populations without experiencing an equivalent health benefit) and across socio–economic groups (particularly relevant for the phase out of unleaded petrol (91 RON)).

In addition, the cost benefit analysis will also include the consideration of second order impacts, such as potentialchanges to fuel consumption levels and associated impact on government revenue from the fuel excise.

4.2 Estimation of regulatory burden

As part of the cost–benefit analysis, the costs of the various policy alternatives to government, business, community organisations and individuals will be quantified using the Australian Government's regulatory burden measurement framework (RBMF).[38] The framework requires consideration of the following cost categories:

- Administrative costs: costs incurred by regulated entities primarily to demonstrate compliance with the regulation (usually record keeping and reporting costs)
- Substantive compliance costs: costs incurred to deliver the regulated outcomes being sought (usually purchase and maintenance costs)
- Delay costs: expenses and loss of income incurred by a regulated entity through an application delay or an approval delay.

38 Department of Prime Minister and Cabinet 2016. *Regulatory burden measurement framework guidance note*. Available from: www.dpmc.gov.au/resource-centre/regulation/regulatory-burden-measurement-framework-guidance-note

The method used for the estimate of the regulatory burden must ensure that the decision on the preferred policy considers all likely costs to businesses and consumers. This must include an estimate of the cost of compliance to Australian industry (e.g. for installation and operation of equipment to meet new fuel composition requirements) and, without double-counting, any additional costs borne by the consumer 'at the bowser' when they purchase the cheapest available fuel that meets the new standard.

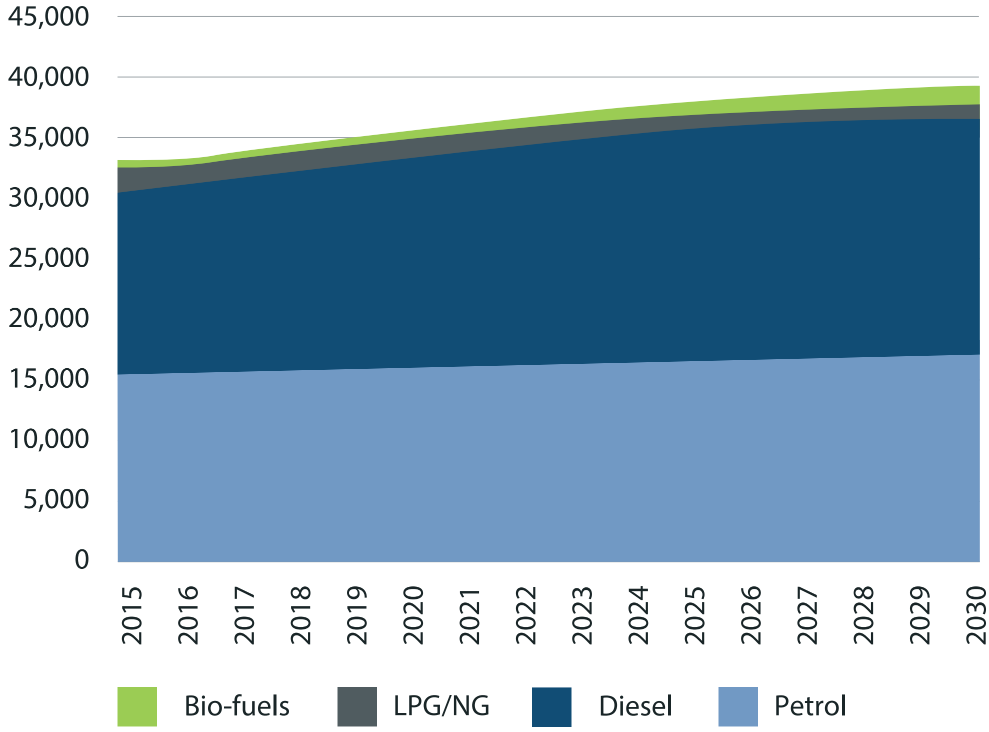
There are a number of key assumptions that will enable the regulatory burden to be estimated. Section 1.3 outlines the basic information for the parameters which will be key determinants of regulatory burden, for which assumptions will be established.

4.3 Key cost and benefit data

Projected fuel consumption in Australia

When considering the 'base case' (i.e. alternative A, no change to the fuel standards), the following fuel consumption projections (Figure 5) are proposed to be used as the 'base case' in the cost benefit analysis. Figure 5 shows relatively stable fuel consumption by the Australian vehicle fleet, with a projected increase in diesel consumption until 2030.

Figure 5: Projected consumption by fuel type for Australian vehicle fleet (2015–2030) in millions of litres



Source: BITRE (2015), Fleet data with projections - xlsx, Communication with David Cosgrove from Bureau of Infrastructure, Transport and Regional Economics, August 2015

Cost benchmarks for refinery upgrades for sulfur reduction in fuel

There are two main mechanisms through which Australian fuel retailers will be able to provide fuels that satisfy new fuel standards. They will need to either source from refineries that have the capacity to produce the required fuel or they will need to purchase from importers.

While it is difficult to provide accurate estimates of the cost of making the infrastructure upgrades necessary in Australia to deliver on the new fuel standards, there is a range of international experiences that can be used as a costing benchmark. Table 4 includes a sample of recent costs of infrastructure upgrades in the United States, South Africa and the European Union.

Table 4: International data on refinery upgrades for sulfur

Country (Date)	Upgrade details	Cost
Australia (2005)	Reducing *maximum* sulfur specification for premium petrol from 50 ppm to 10 ppm	Capital upgrades of AUD1,150 million for 2020 upgrade and additional operating costs of USD0.006/litre (in 2005 dollars)[39]
USA (2014)	Reduction of *average* sulfur content from 30 ppm to 10 ppm	0.007 USD/gallon (approx 0.002 AUD/litre)
Republic of South Africa (2015)[40]	Reduction of sulfur content in six refineries from 500 ppm to 50 ppm	USD3.1 billion (4.09 billion AUD)
	Reduction of sulfur content in six refineries from 500 ppm to 10 ppm	USD3.7 billion (4.88 billion AUD)
EU (2001)	Reduction of sulfur content from 50 ppm to 10 ppm	0.001–0.003 Euros/litre (approx 0.0014 to 0.004 AUD/litre)

It is expected that the cost–benefit analysis will include a sensitivity analysis of price impact projections, including on the crude oil price.

Cost benchmarks for introducing a new base fuel

As Australia is a net importer of refined petrol, the price of fuel supplied into the Australian market, whether refined domestically or imported, generally reflects the international price.[41] The price 'at the bowser' reflects the price of petrol in the source location (typically Singapore and South Korea) refined to Australian fuel standards, plus the distribution costs in Australia, Australian Government taxes and company margin.[42]

The price differentials between the various types of petrol will vary over time. Retailers will generally set the price of unleaded petrol (i.e. 95 RON and 98 RON) at a fixed premium to unleaded petrol (91 RON). Premiums are adjusted from time to time in response to factors such as international benchmark differentials and local demand and supply conditions. In 2014–15 the average retail price differential between unleaded petrol (91 RON) and premium unleaded petrol (95 RON) was 10.6 cents per litre, and in 2015–16 the price differential was 10.7 cents per litre.[43]

39 McLennan Magasanik Associates Pty Ltd 2005. *Costs and Benefits of Introducing 10 ppm Sulfur in Premium Unleaded Petrol*, Final Report to the Australian Greenhouse Office, South Melbourne Victoria, J1221, 21 October 2005.

40 https://www.bloomberg.com/news/articles/2016-06-07/south-africa-crude-refinery-upgrades-seen-costing-2-7-billion

41 OECD 2013. *Competition Policy Roundtables. Competition on Road Fuel*, Competition Committee, 18, 21 November 2013.

42 The following report stated that oil company profits equated to 1.8 cents/L of fuel sold on average. Australian Institute of Petroleum 2011. *Downstream Petroleum 2011*, Canberra ACT.

43 Australian Competition and Consumer Commission 2016. *Report on the Australian petroleum market–June quarter 2016*, Canberra ACT, August 2016.

The consultation completed under the *Fuel Quality Standards Act 2000* review stated the following in relation to the likely costs of meeting tighter fuel standards:

> *'Some fuel traders have indicated that there is likely to be a price differential at present (albeit difficult to quantify), but over the next few years this differential is likely to tend towards zero or close to zero as a majority of large fuel markets (including the EU, Japan, the US and eventually China) and the major sources of refined fuel to Australia (including Singapore and South Korea) move to ultra-low sulfur fuel consumption and production respectively.'*

Any phase out of unleaded petrol (91 RON) will likely also have impacts along the supply chain within Australia. For example, if premium unleaded petrol (95 RON) petrol were to be the new base fuel provided at service stations, it may have the effect of simplifying fuel distribution networks and fuel storage arrangements as there would be one less type of fuel to distribute throughout Australia.

The cost–benefit analysis and the regulatory burden calculation will not only reflect the historical retail price differential between unleaded petrol (91 RON) and premium unleaded petrol (95 RON) when estimating the impacts of the phase out (alternatives B and D), but also the potential for local and international production and distribution improvements to narrow this differential.

Health benefit estimates

One of the objects of the *Fuel Quality Standards Act 2000* is to reduce the level of noxious emissions that can adversely affect human health. As outlined in Section 1.2, there is a growing body of evidence to suggest that air pollution is a significant cause of death and illness in urban areas and this evidence will inform the consideration of health within the cost–benefit analysis. The following are key examples of relevant health impact estimates:

- The review of the *Fuel Quality Standards Act 2000* estimated the avoided health costs of strengthening fuel standards in 2020 at $110 million per year.[44]
- Recent studies conducted in the United States estimated that new vehicle emission standards and reducing the average sulfur level from 30 ppm to 10 ppm under their 'Tier 3 standard' will, by 2030, annually prevent the following:[45]
  - between 770 and 2,000 premature deaths
  - 2,200 hospital admissions and asthma related emergency room visits
  - 19,000 asthma exacerbations
  - 30,000 upper and lower respiratory symptoms in children
  - 1.4 million lost school days, work days and minor restricted activities.

These estimates should be considered in the context of the United States population and therefore Australian health benefits would be relatively smaller.

44 Marsden Jacob 2016. *Review of the Fuel Quality Standards Act 2000*, p87, 28 April 2016

45 USEPA 2014. *Tier 3 Gasoline Sulfur Standard's Impact on Gasoline Refining*, US EPA, March 2014.

In terms of quantifying the health benefits in Australia associated with the policy alternatives within the cost–benefit analysis, it is proposed that health impacts associated with exposure to five fuel combustion pollutants (particulate matter, sulfur oxides, nitrogen oxides, volatile organic compounds and carbon monoxide) will be considered through an integrated emissions, air quality and health risk model.[46] This modelling will incorporate changes in mortality, hospital admissions, emergency department attendances and changes in cancer risk that can be linked to exposure to such pollutants.

The health costs will be valued by applying reference data on:

- Costs: Value of a Life Year (VOLY), reduced quality of life and costs of hospitalisation or emergency department visits associated with respiratory and cardiovascular illnesses, lung cancer and other illnesses
- Affected people: Number of people affected by each of those pollutants in two key metropolitan areas; Sydney and Melbourne, which will then be used to extrapolate to the rest of Australia.

Greenhouse gas emission benefit estimates

The changes to the fuel standards explored in the policy alternatives that involve a phase out of unleaded petrol (91 RON) (alternatives B and D) will likely result in decreases in vehicle-related carbon dioxide emissions. As noted by the Worldwide Fuel Charter:

> *'Increasing the minimum octane rating available in the marketplace has the potential to help vehicles significantly improve fuel economy and, consequently, reduce vehicle greenhouse gas emissions. While the improvement will vary by power train design, load factor and calibration strategy, among other factors, vehicles currently designed for 91 RON gasoline could improve their efficiency by up to three percent if manufacturers could design them for 95 RON instead'.*

Hence, these fuel efficiency improvements need to be considered in the cost–benefit analysis, but must reflect the uptake of changes to technology that improve engine operability based on the non-availability of unleaded petrol (91 RON), and in turn reduce greenhouse gas emissions.

There may also be greenhouse gas emission increases from refineries to reduce the sulfur content in fuel.

The modelling of greenhouse gas impacts will include assumptions that correspond to the likely fuel standard policy alternatives and will ensure that any costs or benefits are not double counted.

46 Pacific Environment Limited (PEL) 2016. *Health Risk Assessment for the Cost Benefit Analysis–Independent Review of the Fuel Quality Standards Act 2000*, 10 May 2016.

QUESTION SET 6. General questions regarding the approach for assessing the policy alternatives

21. Do you have any comments in relation to whether all likely costs or benefits have been identified?
22. Can you provide information that may improve the reliability of the cost and benefit estimates for any of the policy alternatives?

Cost implications

23. Do you have any evidence regarding the change in retail price of premium unleaded petrol (95 RON) fuel if unleaded petrol (91 RON) fuel were to be phased out (assuming taxes etc do not change)?
24. Noting the economies of scale in the provision of premium and high octane petrol (95 and 98 RON), what impact would phasing out or banning unleaded petrol (91 RON) have?
25. What are the associated issues, costs and benefits of reducing the sulfur parameter in petrol to 10 ppm?
26. If there was an immediate requirement to move to 10 ppm (sulfur), would a stepped approach mitigate problems that might be faced by refineries?
27. What, if any, are the costs in making the changes proposed under the five alternatives? Is there an alternative more cost effective approach that would produce better environmental and health outcomes?
28. To what extent are refineries already producing low sulfur petrol? What might be the additional costs for those refineries that choose to upgrade to produce low sulfur and higher octane petrol?

5 Who will be consulted?

Key messages:

- Representatives from environmental and health organisations, the refining industry, fuel importers and distributors, fuel retailers, the automotive industry and consumer groups will be consulted.
- Views from industry, government and the community are welcomed.
- Submissions are requested by close of business 10 March 2017 (AEDT).

Extensive consultation on the setting of the current standards and their technical parameters was undertaken during the initial drafting of each of the standards, including consultation with the Fuel Standards Consultative Committee (FSCC) as required under Section 24A(1) of the Act.

The advice of the FSCC will similarly be sought to inform the outcomes of this current consultation, as will the advice of Australian, state and territory government agencies. The FSCC includes representatives from environmental and health organisations, the refining industry, fuel importers and distributors, fuel retailers, the automotive industry, and consumer groups.

This discussion paper will be placed on the Department's website and will be distributed by email to industry, government and community stakeholders. In addition to the views expressed by stakeholders in response to this discussion paper, the Department will also seek technical advice regarding the testing methodology, correct units for parameters and undertake a cost–benefit analysis on the proposed alternatives.

Relevant results of previous consultation

The review of the Act resulted in stakeholder feedback on a range of issues through two rounds of consultation (Issues Paper in June–July 2015) and Draft Report (February–March 2016). In responding to the review of the Act, some stakeholders provided their perspectives on potential changes to the fuel standards which have been taken into account in developing this discussion paper. Similar views were also put forward in response to the Ministerial Forum Vehicle Emissions discussion paper and are available at: https://infrastructure.gov.au/roads/environment/forum/submissions.aspx'. Views put forward on fuel standards through these consultation processes included:

- Australia should continue to align with international vehicle emission and fuel standards which are largely set in Europe and, to some extent, USA.
- The Federal Chamber of Automotive Industries stated that meeting Euro 6 emission standards will require maximum sulfur limits to be set at 10 ppm.
- The Australian Institute of Petroleum stated that it is not necessary for Australia to move from current standards for sulfur in unleaded petrol and premium unleaded petrol in order to achieve Euro 6 emission standards.
- The costs of motoring and the operability of vehicles for consumers are major concerns of the Australian Automobile Association with respect to fuel standards.

6 Technical annex

Table 5: Key parameter changes for each fuel under the alternatives in this discussion paper

Alternative	Petrol		Diesel	Autogas	Biodiesel	Ethanol E85	Biodiesel B20
A No changes to the fuel standards	No change RON 91 95 98 MON 81 85 88 Sulfur 150 ppm 50 ppm 50 ppm	Aromatics 45% In ethanol, sulfur 30 ppm and inorganic chloride 32 ppm	No change Derived cetane number 51 (diesel containing biodiesel) Polycyclic aromatic hydrocarbons 11%	No change	No change	No change Sulfur 70 ppm RON 100 MON 87	No change
B Revisions based on Hart report and/or to harmonise with the EU	RON* 95 98 MON 85 88 Sulfur 10 ppm 10 ppm * phase out of unleaded petrol (91 RON)	Aromatics 35% In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 51 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 8%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6
C Revisions retaining low octane petrol	RON 91 95 98 MON 81 85 88 Sulfur 10 ppm 10 ppm 10 ppm	Aromatics 35% In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 51 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 8%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6
D Revisions based on the Worldwide Fuel Charter	RON* 95 98 MON 85 88 Sulfur 10 ppm 10 ppm * phase out of unleaded petrol (91 RON)	Aromatics 35%, olefins 10%, induction period 480 min, trace metals 1 ppm In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 55 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 2%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6
E Staged introduction of world standards from 2020 with a review in 2022	RON 91 95 98 MON 81 85 88 Sulfur 50 ppm 25 ppm 10 ppm	Aromatics 35% In ethanol, sulfur 10 ppm and inorganic chloride 1 ppm	Derived cetane number 51 (including diesel not containing biodiesel) Polycyclic aromatic hydrocarbons 8%	No change	See technical annex 4	Sulfur 10 ppm RON 104 MON 88	See technical annex 6

Legend:

- no change
- significant changes are listed–for other changes see technical annex
- non–significant change–see technical annex
- new standard–see technical annex

These tables set out the parameters defined in the current fuel standards and shows comparisons with equivalent standards in the European Union (EU), United States of America (USA), Japan, South Korea and those specified in the Worldwide Fuel Charter (WWFC)[47], where available. The proposed alternatives are as recommended by the Hart Report,[48] and to harmonise where possible with EU standards. Shaded cells in all of the tables in the Technical Annex indicate a change from the current parameters.

Parameters for consideration in the petrol standard

Parameter that would change under Alternative B	Proposed change reasoning
Aromatics	To harmonise with the European Union and the Worldwide Fuel Charter, the Hart report recommends a decrease in aromatics to 35%. Lowering the aromatic content decreases the toxic content of exhaust, particularly benzene emissions, which are known to be carcinogenic.[47] Such toxic emissions are highest in the first minutes of the operation of a car when the emission control technology has not yet warmed up, typically impacting air quality in closed spaces such as home garages or car parks close to human activity.
Octane, phase out of unleaded petrol (91 RON) and introduction of a new octane standard for premium unleaded petrol (98 RON)	The proposed phase out of unleaded petrol (91 RON) fuel aligns internationally with fuel standards in Europe. There is evidence that vehicles introduced into the Australian market do not perform as effectively or reduce emissions to the extent they do overseas (particularly Europe). The use of vehicles with premium unleaded petrol (95 RON) and high octane petrol (98 RON) allows some engines to operate more efficiently and at higher compression, while the introduction of a new octane standard for premium unleaded petrol (98 RON) will ensure that consumers buying fuels can be assured of its octane value. Higher compression engines are more efficient, and can burn less fuel for a vehicle to travel the same distance. Vehicles with higher compression engines will generally produce less carbon dioxide, less noxious emissions, and be more fuel efficient.
Phosphorus	To harmonise with EU and US regulations, the Hart report recommends including a footnote with the phosphorus limit to clarify that 'no intentional adding of phosphorus to unleaded petrol is allowed'.
Sulfur	Sulfur is a natural component of crude oil. Its presence in refined fuel adversely affects the operation of a vehicle's catalytic converter. The catalytic converter is designed to reduce noxious emissions, particularly of carbon monoxide, nitrogen oxides, and volatile organic compounds. Additionally, particulate matter and sulfur oxides are emitted by high sulfur fuels, which are also harmful to human health and the environment. Ideally petrol should have no impurities or sulfur and have a high research octane number (RON), so that it will produce minimal noxious emissions and be suitable for more fuel efficient (such as higher compression) engines. Reducing emissions, ensuring engine operability and facilitating new engine technologies are the key objects of the Fuel Quality Standards Act 2000. A decrease in sulfur is also proposed for the Ethanol E85 standard. Australian petrol standards do not compare favourably with those from other OECD nations. Based on sulfur content, Australian petrol was rated 66 in the world in 2016[47] and indicates that Australian petrol does not have the RON or sulfur limits that are required by vehicle companies (according to the WWFC) to meet Euro 6 (or Euro 5) emissions standards. Note that there is no proposal to alter the sulfur content in diesel as Australian diesel is already of high quality (in terms of sulfur content), with a maximum sulfur limit of 10 ppm.
Ethanol contained in petrol (a part of the petrol standard)	A decrease in inorganic chlorides in the ethanol component of petrol is expected to protect engines from corrosion.

Parameters in alternative D are as recommended by the Worldwide Fuel Charter, or to align with the European Union.

47 Worldwide Fuel Charter 5th Edition September 2013

48 Hart Energy, 2014: *International Fuel Quality Standards and Their Implications for Australian Standards* October 27, 2014

49 *Nine Countries Move Up in Top 100 Ranking on Gasoline Sulfur Limits*, Stratas Advisors, May 24, 2016.

TA1. Options for parameters in the petrol standard

Parameter	Australia **Alternative A** (current)	Australia **Alternative B** (Revisions as recommended by the Hart Report or to harmonise with the EU)	Australia **Alternative C** (revisions plus retention of low octane)	Australia **Alternative D** (revisions as recommended by the Worldwide Fuel Charter)	Australia **Alternative E** (introduce changes in 2020 with a review in 2022)	EU[48]	USA[48]	Japan[48]	South Korea[48]	WWFC[45]
Aromatics	45% v/v[49] 42% v/v pool average over 6 months	35% v/v[50]	35% v/v	35.0% v/v[51]	35% v/v[52]	35 vol%			24 vol%[54]	35.0% v/v
Benzene	1% v/v	1% v/v[50]	1% v/v	1.0% v/v[51]	1% v/v	1 vol%	0.62 vol%	1 vol%	0.7 vol%	1.0% v/v
Copper corrosion	Class 1 (3 h at 50°C)	Class 1[50] (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C)
DIPE[55]	1% v/v	1% v/v[50]	1% v/v	1% v/v	1% v/v.					
Ethanol	10% v/v	10% v/v[50]	10% v/v	10% v/v	10% v/v	10 vol%		10 vol%		10% v/v
Existent gum (washed)	50 mg/L	50 mg/L[50]	50 mg/L	50 mg/L	50 mg/L	5 mg/100 mL	5 mg/100 mL	5 mg/100 mL	5 mg/100 mL	5 mg/100 mL
Induction period (oxidation stability)	360 minutes	360 minutes[50]	360 minutes	480 minutes[51]	360 minutes	360 minutes	240 minutes	240 minutes	480 minutes	480 minutes
Lead	0.005 g/L	0.005 g/L[50]	0.005 g/L	0.005 g/L	0.005 g/L	0.005 g/L	0.013 g/L	<0.001 g/L	0.013 g/L	1 mg/kg
Maximum final boiling point	210°C	210°C[50]	210°C	210°C	210°C	210°C	225°C	220°C	225°C	

50 Figures for the EU, USA, Japan and South Korea and taken from Stratas Advisors, *Global Fuel Specifications, 2016 and Hart Energy, International Fuel Quality Standards and Their Implications for Australian Standards*, October 2014

51 v/v' means 'volume by volume' and 'vol%'

52 Recommendation from Hart Energy, *International Fuel Quality Standards and Their Implications for Australian Standards*, October 2014

53 Recommendation of the Worldwide Fuel Charter, *5th edition, Category 5 unleaded gasoline*, September 2013

54 Recommendation from Hart Energy, *International Fuel Quality Standards and Their Implications for Australian Standards*, October 2014

55 Either aromatics 24 vol% and olefins 16 vol%, or aromatics 21 vol% and olefins 19 vol%

56 Diisopropyl ether (2-propan-2-yloxypropane)

Parameter	Australia Alternative A (current)	Australia Alternative B (Revisions as recommended by the Hart Report or to harmonise with the EU)	Australia Alternative C (revisions plus retention of low octane)	Australia Alternative D (revisions as recommended by the Worldwide Fuel Charter)	Australia Alternative E (introduce changes in 2020 with a review in 2022)	EU[48]	USA[48]	Japan[48]	South Korea[48]	WWFC[45]
Motor octane number (MON)	Unleaded petrol (91 RON): 81.0 Premium unleaded petrol (95 RON): 85.0	Phase out of unleaded petrol (91 RON)[55] Premium unleaded petrol (95 RON): 85.0[50] High octane petrol (98 RON): 88.0[51]	Unleaded petrol (91 RON): 81.0 Premium unleaded petrol (95 RON): 85.0 High octane petrol (98 RON): 88.0	Phase out of unleaded petrol (91 RON)[55] Premium unleaded petrol (95 RON): 85.0[50] High octane petrol (98 RON): 88.0[51]	Unleaded petrol (91 RON): 81.0 Premium unleaded petrol (95 RON): 85.0 High octane petrol (98 RON): 88.0	85.0[58]				82.5 / 85.0 / 88.0
MTBE[57]	1% v/v	1% v/v[50]	1% v/v	1% v/v	1% v/v	22 vol% total ethers		7 vol%		
Olefins	18% v/v	18% v/v[50]	18% v/v	10.0% v/v[52]	18% v/v	18 vol%			16 vol%	10.0% v/v
Oxygen	For petrol without ethanol: 2.7% m/m[57]	For petrol without ethanol: 2.7% m/m[50]	For petrol without ethanol: 2.7% m/m	For petrol without ethanol: 2.7% m/m	For petrol without ethanol: 2.7% m/m	2.7 wt%		For petrol without ethanol: 1.3 wt%	2.3% m/m	2.7% m/m
	For petrol with ethanol: 3.9% m/m	For petrol with ethanol: 3.9% m/m[50]	For petrol with ethanol: 3.9% m/m	For petrol with ethanol: 3.9% m/m	For petrol with ethanol: 3.9% m/m	3.7 wt%		For petrol with ethanol: 3.7 wt%		
Phosphorus	0.0013 g/L	0.0013 g/L Add 'no intentional adding of phosphorus to unleaded petrol is allowed'[50]	0.0013 g/L Add 'no intentional adding of phosphorus to unleaded petrol is allowed'[50]	0.0013 g/L Add 'no intentional adding of phosphorus to unleaded petrol is allowed'[50]	0.0013 g/L Add 'no intentional adding of phosphorus to unleaded petrol is allowed'[50]	0 Compounds containing phosphorus shall not be included	0.0013 g/L		0.0013 g/L	0.001 g/kg

57 To align with the EU
58 Methyl *tertiary-butyl* ether
59 '% m/m' is the same as '% mass by mass', 'wt%' and '%mass'
60 EU member states may decide to continue to permit the marketing of gasoline with a minimum MON of 81 and a minimum RON of 91

Parameter	Australia **Alternative A** (current)	Australia **Alternative B** (Revisions as recommended by the Hart Report or to harmonise with the EU)	Australia **Alternative C** (revisions plus retention of low octane)	Australia **Alternative D** (revisions as recommended by the Worldwide Fuel Charter)	Australia **Alternative E** (introduce changes in 2020 with a review in 2022)	EU[48]	USA[48]	Japan[48]	South Korea[48]	WWFC[45]
Research octane number (RON)	Unleaded petrol (91 RON): 91.0 Premium unleaded petrol (95 RON): 95.0	Phase out unleaded petrol (91 RON)[55] Premium unleaded petrol (95 RON): 95.0[50] High octane petrol (98 RON): 98.0[51]	Unleaded petrol (91 RON): 91.0 Premium unleaded petrol (95 RON): 95.0 High octane petrol (98 RON): 98.0	Phase out unleaded petrol (91 RON)[55] Premium unleaded petrol (95 RON): 95.0[50] High octane petrol (98 RON): 98.0[51]	Unleaded petrol (91 RON): 91.0 Premium unleaded petrol (95 RON): 95.0 High octane petrol (98 RON): 98.0	95.0[58]		Regular 89 Premium 96	Regular 91 Premium 94	91.0 / 95.0 / 98.0
Sulfur (maximum limit)	Unleaded petrol (91 RON): 150 mg/kg[59] PULP 50 mg/kg	Phase out of unleaded petrol (91 RON)[55] Premium unleaded petrol (95 RON): 10 mg/kg[50] High octane petrol (98 RON): 10 mg/kg[51]	Unleaded petrol (91 RON): 10 mg/kg Premium unleaded petrol (95 RON): 10 mg/kg High octane petrol (98 RON): 10 mg/kg	Phase out of unleaded petrol (91 RON)[55] Premium unleaded petrol (95 RON): 10 mg/kg[50] High octane petrol (98 RON): 10 mg/kg[51]	Unleaded petrol (91 RON): 50 ppm Premium unleaded petrol (95 RON): 25 ppm High octane petrol (98 RON): 10 ppm	10 ppm	10 ppm from 2017[60]	10 ppm	10 ppm	10 mg/kg
TBA[61]	0.5% v/v	0.5% v/v[62]	0.5% v/v	0.5% v/v	0.5% v/v					
Trace metal elements (Cu, Fe, Na, P, Pb, Si, Zn)				1 mg/kg or non–detectable, whichever is lower[51]	.					1 mg/kg or non–detectable, whichever is lower
Parameters for ethanol contained in petrol	Ethanol content: 95.6% v/v	95.6% v/v[62]	95.6% v/v	95.6% v/v	95.6% v/v	98.7% vol%	92.1 vol%	99.5 vol%		92.2%m/m (including C3–C5 alcohols)

61 'mg/kg' is the same as 'ppm'

62 10 ppm refinery average from 2017. Currently 30 ppm refinery average

63 *tert-butyl* alcohol (2-methylpropan-2-ol)

64 No change proposed

Parameter	**Australia Alternative A** (current)	**Australia Alternative B** (Revisions as recommended by the Hart Report or to harmonise with the EU)	**Australia Alternative C** (revisions plus retention of low octane)	**Australia Alternative D** (revisions as recommended by the Worldwide Fuel Charter)	**Australia Alternative E** (introduce changes in 2020 with a review in 2022)	**EU[48]**	**USA[48]**	**Japan[48]**	**South Korea[48]**	**WWFC[45]**
Parameters for ethanol contained in petrol (continued)	Denaturant: Must contain denaturant, which must be ULP or PULP 1-1.5% v/v	Must contain denaturant, which must be ULP or PULP 1-1.5% v/v[62]	Must contain denaturant, which must be ULP or PULP 1-1.5% v/v	Must contain denaturant, which must be ULP or PULP 1-1.5% v/v	Must contain denaturant, which must be ULP or PULP 1-1.5% v/v	Permitted	Denaturant 1.95–5 vol%			
	Acidity: 0.007% m/m	0.007% m/m[62]	0.007% m/m	0.007% m/m	0.007% m/m	0.007 wt%	0.007 wt%	0.007 wt%		0.007% m/m
	Appearance: Clear and bright Visibly free of suspended or precipitated contaminants	Clear and bright Visibly free of suspended or precipitated contaminants[62]	Clear and bright Visibly free of suspended or precipitated contaminants	Clear and bright Visibly free of suspended or precipitated contaminants	Clear and bright Visibly free of suspended or precipitated contaminants	Clear and colourless				Clear and bright, no visible impurities
	C3–C5 saturated alcohols (anhydrous)			2% m/m[63]						2% m/m
	Copper: 0.1 mg/kg	0.1 ppm[62]	0.1 ppm	0.100 ppm[63]	0.1 ppm	0.100 ppm	0.1 ppm	0.1 ppm		0.100 mg/kg
	Heavy metals			Non–detectable[63]						Non–detectable
	Inorganic chloride: 32 mg/L	1 ppm[64]	1 ppm	1 ppm[64]	1 ppm	1.5 ppm	10 ppm			10.0 mg/L

65 Worldwide Fuel Charter, *Ethanol Guidelines*, March 2009
66 Matching the current E85 inorganic chloride limit

Parameter	**Australia Alternative A** (current)	**Australia Alternative B** (Revisions as recommended by the Hart Report or to harmonise with the EU)	**Australia Alternative C** (revisions plus retention of low octane)	**Australia Alternative D** (revisions as recommended by the Worldwide Fuel Charter)	**Australia Alternative E** (introduce changes in 2020 with a review in 2022)	EU[48]	USA[48]	Japan[48]	South Korea[48]	WWFC[45]
Parameters for ethanol contained in petrol (continued)	Methanol: 0.5 % v/v	0.5 % v/v[62]	0.5 % v/v	0.5 % v/v	0.5 % v/v			4.0 g/L		0.5 % v/v
	pHe: 6.5-9.0	6.5-9.0[62]	6.5-9.0	6.5-9.0	6.5-9.0		6.5-9.0			6.5-9.0
	Solvent washed gum: 5.0 mg/100 ml	50 mg/L[62]	50 mg/L	50 mg/L	50 mg/L					5.0 mg/100 mL
	Sulfate: 4 mg/kg	4 mg/kg[62]	4 mg/kg	4 mg/kg	4 mg/kg[62]	3.0 ppm				4 mg/kg
	Sulfur: 30 mg/kg	10 mg/kg[63]	10 mg/kg	10 mg/kg[63]	10 mg/kg[63]	10 ppm	30 ppm	10 ppm		10 mg/kg
	Water: 1.0% v/v	0.3% v/v[63]	0.3% v/v	0.3% v/v[63]	0.3% v/v[63]	0.300 vol%	1 vol%	0.7 wt%		0.3% v/v

Questions relating to the petrol standard

29. To what extent is the petrol fuel standard currently being met?
30. Should the maximum limit on aromatics be reduced to 35 per cent?
31. Do you think other parameters should be specified (e.g. methanol)?

New standards

32. Considering high octane petrol (98 RON) fuels are currently required to meet the premium unleaded petrol (95 RON) standard under the *Fuel Quality Standards Act 2000*, should the petrol standard include parameters for high octane petrol (98 RON) premium unleaded petrol fuels?
33. Would there be a negative impact to the fuel or motor vehicle industry to implement the EU's MON and RON standards? If yes, please explain.
34. Are the test methods specified in the fuel standards correct and appropriate?

MTBE

35. What would be the impact for the fuel and motor industry if MTBE limits remained at current limits in petrol? Should the level of MTBE in petrol be greater than 1 per cent?
36. Should a limit of 5 per cent to 10 per cent MTBE be permitted in high octane petrol (98 RON) petrol? Should similar limits be applied to ethanol in high octane petrol (98 RON) petrol?
37. Can you identify any other issues regarding emissions or operability?
38. Should oxygenates such as ethanol be used to increase the octane content of petrol, for example, adding 12% ethanol to ULP to create an E12 premium unleaded petrol (95 RON) fuel? Alternatively, are there other octane enhancers that can be used to create premium petrol?

TA2. Options for parameters in the automotive diesel standard

In considering the questions posed below, it may be helpful to reflect upon the rationale for the proposed changes to the diesel standard parameters. The amendments suggested are based on those proposed in the Hart Report.

Parameter that would change under Alternative B	Proposed change reasoning
Carbon residue	Carbon residue is an indicator of the relative coke formation tendency of the fuel. Coke formation can affect the fuel system and engine components. Limiting carbon residue to 0.15 per cent by mass is a recommendation of the Hart report. This will reduce engine deposits and align the limit with South Korea.
Derived Cetane Number (DCN):	This test refers to the ignition delay of the fuel in the combustion chamber. In general, higher cetane fuels will have a shorter ignition delay. A derived cetane number of 55.0 will reduce emissions of NOx, hydrocarbons, carbon monoxide and will also reduce engine noise. A value of 51 is used in Europe for diesel with and without biodiesel.
Polycyclic aromatic hydrocarbons (PAH)	PAHs are a suspected carcinogen produced as a result of combustion. A proposal to decrease the polycyclic aromatic hydrocarbons in diesel to align with the EU limit of 8% m/m would assist in decreasing NOx and particulate matter in Australia

Parameters in alternative D are as recommended by the Worldwide Fuel Charter, or to align with the European Union.

Parameter	Australia Alternative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU[48]	USA[48]	Japan[48]	South Korea[48]	WWFC[65]
Ash	0.01% m/m	0.01% m/m[50]	0.01% m/m	0.001% m/m[66]	0.01 wt%	0.01 wt%		0.02 wt%	0.001% m/m
Biodiesel (FAME) content[67]	5.0% v/v	5.0% v/v[50]	5.0% v/v	5.0% v/v	7 vol%	5 vol%	5 wt% in B5	5 vol%	5% v/v
Carbon residue	0.2 mass %[68] (10% distillation residue)	0.15 mass %[50]	0.15 mass %	0.15 mass %[50]	0.30 wt%	0.35 wt%	0.1 wt%	0.15 wt%	0.20% m/m
Cetane index	46	46[50]	46	55.0[66]	46	40	45–50	52	55.0
Colour	2	2	2	2					
Conductivity at ambient temperature–for all diesel held by a terminal or refinery for sale or distribution	50 pS/m at ambient temperature	50 pS/m[50] at ambient temperature	50 pS/m[50] at ambient temperature	50 pS/m at ambient temperature					
Copper corrosion	Class 1 (3 h at 50°C)	Class 1 (3 h at 50°C) [50]	Class 1 (3 h at 50°C)	Class 1[66]	Class 1 (3 h at 50°C)	Class 3 (3 h at 50°C)		Class 1 (3 h at 100°C)	Class 1
Density	820–850 kg/m³	820–850 kg/m³ [50]	820–850 kg/m	820–840 kg/m³ [66]	820–845 kg/m³		860 kg/m³ max	810–870 kg/m³	820–840 kg/m³
Derived cetane number	51 (containing biodiesel)	51[50]	51	55.0[66]	51	40	45–50	52	55.0
Distillation temperature, 95°C	360°C	360°C[50]	360°C	340°C[66]	360°C				340°C
Flash point	61.5°C	61.5°C[50]	61.5°C	61.5°C[50]	55.0°C	52°C	45–50°C	40°C	55°C
Filter blocking tendency	2.0	2.0[50]	2.0	2.0					
Lubricity	0.460 mm	0.460 mm[50]	0.460 mm	0.400 mm[66]	0.460 mm	0.520 mm		0.400 mm	0.400 mm

67 WWFC: Category 4–markets with advanced requirements for emission control. Category 4 fuels enable sophisticated NOx and PM after-treatment technologies.
68 Recommendation of the Worldwide Fuel Charter, *5th edition, Category 5 diesel*, September 2013
69 The biodiesel component of diesel must meet the requirements of the *Fuel Standard (Biodiesel) Determination 2003*
70 'mass%' is the same as 'wt%' and 'm/m'

Parameter	Australia Alternative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU[48]	USA[48]	Japan[48]	South Korea[48]	WWFC[65]
Oxidation stability	25 mg/L[69]	25 mg/L[50]	25 mg/L	25 mg/L[66]	25 g/m^3				25 g/m^3
PAH (polycyclic aromatic hydrocarbons)	11% m/m	8% m/m[50]	8% m/m	2.0% m/m[66]	8 wt%			5 wt%	2% m/m
Sulfur	10 mg/kg	10 mg/kg[50]	10 mg/kg	10 mg/kg[66]	10 ppm	15 ppm	10 ppm	10 ppm	10 mg/kg
Viscosity at 40°C	2.0–4.5 cSt[70]	2.0–4.5 cSt[50]	2.0–4.5 cSt	2.0–4.0 cst[66]	2.0–4.5 cSt	1.9–4.1 cSt	2.7–1.7 cSt	1.9–5.5 cSt	2.0–4.0 mm^2/s
Water and sediment	0.05 vol%	0.05 vol%[50]	0.05 vol%	0.05 vol%		0.05 vol%			
Water, for diesel containing biodiesel	200 mg/kg	200 mg/kg[50]	200 mg/kg	200 mg/kg	200 mg/kg			0.02 vol%	

Questions relating to the automotive diesel standard

39. Given a minimum value of 51 is proposed in diesel with or without biodiesel (as in the EU), is the current Derived Cetane Number (DCN) appropriate?
40. What would be the effect of reducing polycyclic aromatic hydrocarbons (PAH) in automotive diesel on industry and other stakeholders?
41. What would be the effect of reducing carbon residue limits in diesel on industry and other stakeholders?
42. Should the standard apply more broadly to all diesel engines, including ships operating around the Australian coast?
43. Should a standard be prescribed for synthetic diesel (non–crude oil)?
44. Are there any other issues regarding emissions or operability?
45. Do you think other parameters need to be specified?

71 'mg/L is the same as 'g/m3'
72 'cSt' is the same as 'mm2/s'

TA3. Options for parameters in the autogas (LPG) standard

The parameters in the autogas standard are already considered to be best practice and align with international standards. As such, no changes are proposed to this standard.

Parameter	Australia Alterative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU[48]	USA[48]	Japan[48]	South Korea[48]
Copper corrosion (1 h at 40°C)	Class 1	Class 1[50]	Class 1	Class 1	Class 1	Class 1	Class 1	Class 1
Dienes	0.3% (molar)	0.3% (molar)[50]	0.3% (molar)	0.3% (molar)	0.5% (molar)			
Hydrogen sulphide	Negative	Negative[50]	Negative	Negative	Negative	Pass		
Motor octane number (MON)	90.5	90.5[50]	90.5	90.5	89			
Odour	Detectable in air at 20% of lower flammability limit	Detectable in air at 20% of lower flammability limit[50]	Detectable in air at 20% of lower flammability limit	Detectable in air at 20% of lower flammability limit	Unpleasant and distinctive at 20% of lower flammability limit			
Residue on evaporation	60 mg/kg	60 mg/kg[50]	60 mg/kg	60 mg/kg	60 mg/kg	0.05 mL/ 100 mL		0.05 mL/ 100 mL
Sulfur (after stenching)	50 mg/kg	50 mg/kg[50]	50 mg/kg	50 mg/kg	50 ppm	123 ppm	50 ppm	40 ppm
Vapour pressure (gauge) at 40°C	800–1 530 kPa	800–1 530 kPa[50]	800–1 530 kPa	800–1 530 kPa	1 550 kPa (max)	1 434 kPa	1 550/ 1 250/ 520 kPa	1 270 kPa
Volatile residues (C5 and higher)	2.0% (molar)	2.0% (molar)[50]	2.0% (molar)	2.0% (molar)				
Water	No free water at 0°C	No free water at 0°C[50]	No free water at 0°C	No free water at 0°C	None			

Questions relating to the autogas standard

46. Should a standard be prescribed for Compressed Natural Gas (CNG)?
47. Should a standard be prescribed for Liquid Natural Gas (LNG)?
48. Are there any other issues regarding emissions or operability?

TA4. Options for parameters in the biodiesel standard

In considering the questions posed below, it may be helpful to reflect upon the rationale for the proposed changes to the biodiesel standard parameters, that is, to align with best practice in Europe.

Parameters that would change under Alternative B	Proposed change reasoning
Acid Value	A reduction in acid values to 0.50mg KOH/g aligns this limit with the European Union, United States, Japan and South Korea. A reduction will also allow better storage of biodiesel and reduce corrosion.
Oxidation Stability	An increase in the oxidation stability timeframe from six to ten hours is expected to increase the stability of the fuel in storage.
Phosphorus	Decreasing the phosphorus limit to 4mg/kg will help to improve the performance of catalytic converters and newer engine technologies.

Parameters in alternative D are as recommended by the Worldwide Fuel Charter, or to align with the European Union.

Parameter	Australia Alternative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU	USA	Japan	South Korea	WWFC[71]
Acid value	0.80 mg KOH/g	0.50 mg KOH/g[50]	0.50 mg KOH/g	0.50 mg KOH/g	0.5 mg KOH/g	0.5 mg KOH/g	0.5 mg KOH/g	0.5 mg KOH/g	
Carbon residue–10% distillation residue	0.30% mass	0.30% mass[50]	0.30% mass	0.30% mass	0.3% (m/m)		0.3 wt%	0.1 wt%	
Copper strip corrosion	Class 1 3 h at 50°C	Class 1 3 h at 50°C[50]	Class 1 3 h at 50°C	Class 1 3 h at 50°C	Class 1 3 h at 50°C	Class 3 3 h at 50°C	Class 1 3 h at 100°C	Class 1 3 h at 100°C	
Density at 15°C	860–890 kg/m3	860–890 kg/m^3 [50]	860–890 kg/m	860–890 kg/m^3	860–900 kg/m^3		860–900 kg/m^3	860–900 kg/m^3	
Derived cetane number	51.0	51.0[50]	51.0	51.0	51.0	47	51		51
Distillation T90	360°C	360°C[50]	360°C	360°C					
Ester content	96.5% m/m	96.5% m/m[50]	96.5% m/m	96.5% m/m	96.5% (m/m)		96.5 wt%	96.5 wt%	96.5% m/m
Flash point	120.0°C	120°C[50]	120°C	120°C	101°C	93°C/130°C	120°C	120°C	100°C

73 Worldwide Fuel Charter, *Biodiesel Guidelines*, March 2009

Parameter	Australia Alternative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU	USA	Japan	South Korea	WWFC[71]
Free glycerol	0.020% mass	0.020% mass[50]	0.020% mass	0.020% mass	0.02% (m/m)	0.02 wt%	0.02 wt%	0.02 wt%	0.02% m/m
Metals–Group I (Na, K)	5 mg/kg	5 mg/kg[50]	5 mg/kg	5 mg/kg	5 mg/kg	5 ppm	5 ppm	5 ppm	5 mg/kg
Metals–Group II (Ca, Mg)	5 mg/kg	5 mg/kg[50]	5 mg/kg	5 mg/kg	5 mg/kg	5 ppm	5 ppm	5 ppm	5 mg/kg
Methanol	0.20% (m/m)	0.20% (m/m) [50]	0.20% (m/m)	0.20% (m/m)	0.2% (m/m)	0.2 vol%	0.2 wt%	0.2 wt%	0.20% m/m
Oxidation stability at 110°C	6 h	8 h[50]	8 h	8 h[50]	8 h	3 h		6 h	
Phosphorus	10 mg/kg	4 mg/kg[50]	4 mg/kg	4 mg/kg	4 mg/kg	10 ppm	10 ppm	10 ppm	4 mg/kg
Sulfated ash	0.020% mass	0.020% mass[50]	0.020% mass	0.005% m/m	0.02% (m/m)	0.02 wt%	0.02 wt%		0.005% m/m
Sulfur	10 mg/kg	10 mg/kg[50]	10 mg/kg	10 mg/kg	10 mg/kg	15 ppm	10 ppm	10 ppm	10 ppm
Total contamination	24 mg/kg	24 mg/kg[50]	24 mg/kg	24 mg/kg	24 mg/kg		24 ppm	24 ppm	24 mg/kg
Total glycerol	0.250% mass	0.250% mass[50]	0.250% mass	0.250% mass	0.25% (m/m)	0.24 wt%	0.25 wt%	0.24 wt%	0.25% m/m
Viscosity	3.5–5.0 mm^2/s	3.5–5.0 mm^2/s[50]	3.5–5.0 mm^2/s	3.5–5.0 cSt	3.5–5.0 cSt	1.9–5 cSt	3.5–5 cSt	1.9–5 cSt	2.0–5.0 mm^2/S
Water and sediment	0.050% vol	0.050% vol[50]	0.050% vol	0.050% vol		0.05 vol%			0.05% v/v

Questions relating to the biodiesel standard

49. Do you have a view on whether the biodiesel standard allows for advancements in technology?
50. Noting that all biodiesel blends have a proposed minimum value of 51; do you believe the current Derived Cetane Number (DCN) appropriate?
51. Do you believe a reduction to the acidity parameter (to 0.50 mg KOH/g) in biodiesel be achievable? If so, can you identify any consequences for stakeholders?
52. Would reducing the phosphorus content or increasing the oxidation stability requirements raise any issues for you or your stakeholders?
53. Would you like to raise any other issues regarding biodiesel blends, emissions or operability?

TA5. Options for parameters in the ethanol E85[74] standard

In considering the questions posed below, it may be helpful to reflect upon the rationale for the proposed changes to the ethanol (E85) standard parameters.

Parameters that would change under Alternative B	Proposed change reasoning
Acidity	It is proposed to lower acidity so that it aligns with the European Union and the United States values. A reduction in acidity will also decrease corrosion.
Motor Octane Number (MON)	Alternatives B, C and D propose to change the MON parameter from 87 to 88 to harmonise with the EU.
Research Octane Number (RON)	Alternatives B, C and D propose to change the RON parameter from 100 to 104 to harmonise with the EU.
Sulfur	A reduction in sulfur to 10 mg/kg is recommended to align with international best practice, as well as to align with the petrol and diesel standard. | A reduction in sulfur will also protect emission control catalysts.

Parameters in alternative D are as recommended by the Worldwide Fuel Charter, or to align with the European Union.

Parameter	Australia Alternative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU[48]	USA[48]
Acidity (as acetic acid)	0.006% m/m	0.005% m/m[50]	0.005% m/m	0.005% m/m[50]	0.005 wt%	0.005 wt%
Benzene	0.35% v/v	0.35% v/v[50]	0.35% v/v	0.35% v/v		
Copper	0.10 mg/kg	0.10 mg/kg[50]	0.10 mg/kg	0.10 mg/kg	0.1 ppm	0.07 mg/L
Ethanol	70–85% v/v	75–85 vol%[50]	75–85 vol%	70–85% v/v	70–85 (summer) 50–75 (winter)	51–83 vol%
Ethers (5 or more C atoms)	1.0% v/v	1.0 vol%[50]	1.0 vol%	1.0% v/v	11 vol%	
Final boiling point (distillation)	210°C	210°C[50]	210°C	210°C		
Higher alcohols (C_3–C_8)	2.0% v/v	2.0 vol%[50]	2.0 vol%	2.0% v/v	6 ppm	2 vol%
Inorganic chloride	1 mg/kg	1 mg/kg[50]	1 mg/kg	1 mg/kg	1.2 ppm	1 ppm

74 There is no ethanol blend standard for Japan or South Korea

Parameter	Australia Alternative A	Australia Alternative B and Alternative E from 2020	Australia Alternative C	Australia Alternative D	EU[48]	USA[48]
Lead content	5 mg/L	5 mg/L[50]	5 mg/L	5 mg/L		
Methanol	0.5% v/v	0.5 vol%[50]	0.5 vol%	0.5% v/v	1.0 vol%	0.5 vol%
Motor Octane Number (MON)	87	88[55]	88	88[55]	88	
Oxidation stability	360 minutes	360 minutes[50]	360 minutes	360 minutes	360 minutes	
pHe	6.5–9.0	6.5–9.0[50]	6.5–9.0	6.5–9.0	6.5–9.0	6.5–9.0
Phosphorus	1.3 mg/L	1.3 mg/L[50]	1.3 mg/L	1.3 mg/L	0.00015 g/L	
Research Octane Number (RON)	100	104[55]	104	104[55]	104	
Solvent washed gum	5 mg/100 mL	5 mg/100 mL[50]	5 mg/100 mL	5 mg/100 mL	5 mg/100 mL	5 mg/100 mL
Sulfate	4.0 mg/kg	4.0 mg/kg[50]	4.0 mg/kg	4.0 mg/kg	4 ppm	
Sulfur	70 mg/kg	10 mg/kg[50]	10 mg/kg	10 mg/kg[50]	10 ppm	80 ppm
Vapour Pressure (DVPE)	38–65 kPa at 37.8°C	38–65 kPa at 37.8°C[50]	38–65 kPa at 37.8°C	38–65 kPa at 37.8°C	35–60 kPa (summer) 50–80 kPa (winter) at 37.8°C	38–103 kPa at 37.8°C
Water	1.0% m/m	1.0 % m/m[51]	1.0 % m/m	1.0% m/m	0.4 vol%	1 wt%

Questions in relation to the ethanol (E85) standard

54. Do you believe the test methods are appropriate?
55. Would a reduction in the sulfur or acidity parameters raise any issues for you or your stakeholders?
56. Would an increase in the solvent washed gum parameter raise any issues for you or your stakeholders?
57. Would you like to raise any other issues regarding emissions or operability?

TA6. Proposed parameters for a B20 Diesel Biodiesel Blend

The Department has previously engaged with industry and stakeholders on the development of a proposed B20 fuel standard in March 2012. It was considered appropriate to include the proposed B20 standard in this discussion paper, so that stakeholders would have the convenience of considering all current standards together.

The table below represents the parameters for the proposed standard. B20 is defined as diesel biodiesel blend that contains greater than 5 per cent but less than or equal to 20 per cent biodiesel. B20 blends are currently regulated through the Section 13 exemption process under the *Fuel Quality Standards Act 2000*.

Parameter	Australia (proposed)	EU	USA	South Korea
Acid value (max.)	0.3 mg KOH/g			
Ash (max.)	0.01% mass			
Biodiesel content (min–max)	5.1% v/v–20% v/v	14.0–20.0 vol%	6–20 vol%	17–23 (s) 7–13 (w) vol%
Carbon residue (10% distillation residue) (max.)	0.3% mass			
Copper strip corrosion (3 h @ 50°C) (max.)	Class 1			
Density @ 15°C, (min–max)	820 kg/m^3–860 kg/m^3 (at 15°C)	820.0–860.0 (t) kg/m^3		815–845 kg/m^3
Derived cetane number (min)	51.0	51.0 (t); 47.0 –49.0 (a &s) (8)(9)	40 (4)	45
Distillation temperature T90 (max.)	360°C		343°C	360°C
Flash Point (min.)	61.5°C	Above 55.0°C	52 (7)	40°C
Lubricity (max.)	460 µm			
Oxidation stability	8 h	20.0 h		
Sulfur (max)	10 mg/kg	10.0 ppm	15 ppm	30 ppm
Viscosity @ 40°C (min–max)	2.0–4.5 mm^2/s	2.000–4.620 (t)	1.9–4.1 (6) cSt	1.9–5.5 cSt
Water (max)	200 mg/kg	260 mg/kg		
Water and sediment (max)	0.050% v/v[73]		0.05% vol	0.02% vol

Questions relating to the proposed B20 standard

58. Do you believe the B20 standard allows for advancements in technology?
59. In your view, are the test methods valid?
60. In your view, are the B20 parameters appropriate?

75 Units and significant figures will need to align with the relevant test methodology.