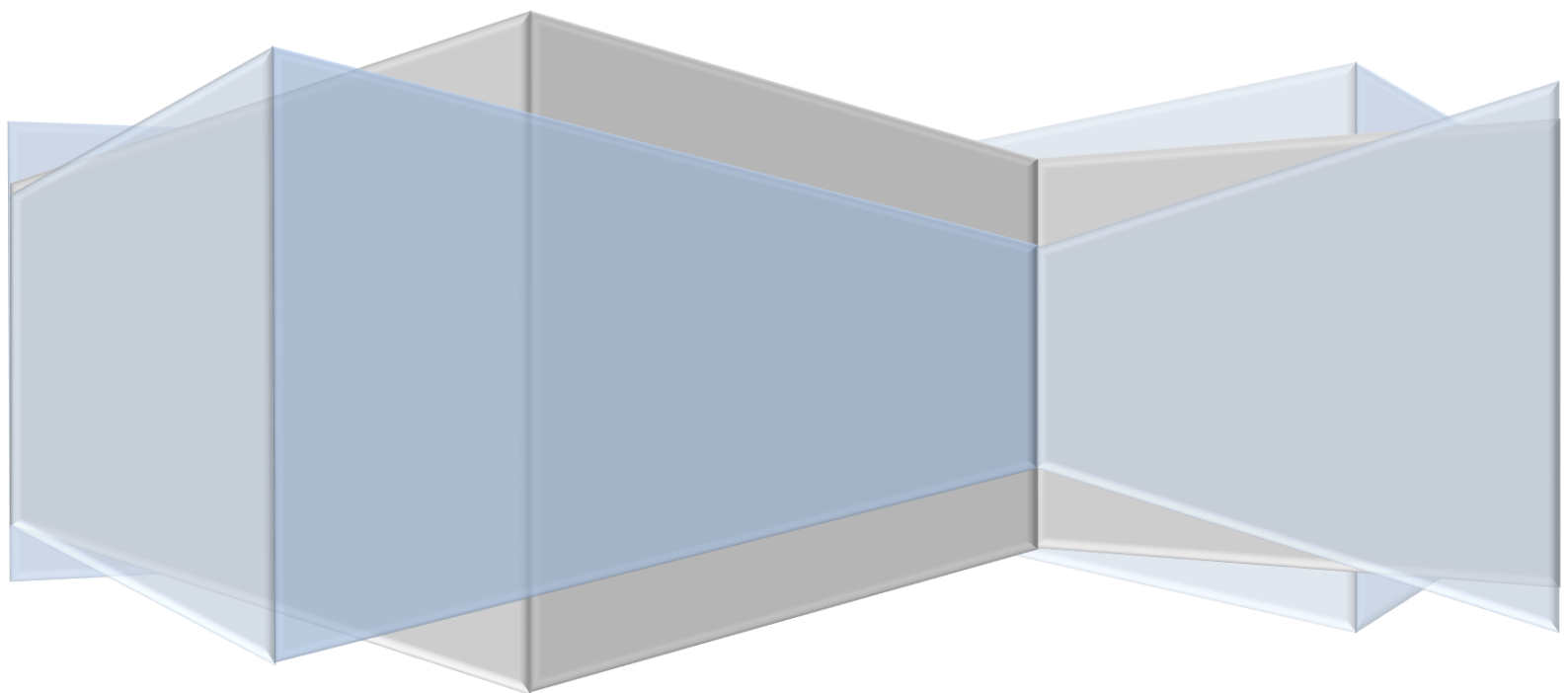


**Revision A**

# **Standard Petrol & FCC Additive Technical Analysis on Wear Scar Diameter**

**ADDF-REP-TA-0003**

**Michelle Lam**



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## STANDARD PETROL & FCC ADDITIVE TECHNICAL ANALYSIS ON WEAR SCAR DIAMETER

ADDF-REP-TA-0003

Revision Number: A

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## 1 EXECUTIVE SUMMARY

Fuel Conditioner Concentrate (FCC) is added directly to fuel storage tanks to eliminate the problems associated with water contamination. FCC ensures that vehicle fuel systems remain clean and free from corrosion, gums, and varnishes. The main benefit of the FCC is derived from its regular use to maintain fuel systems free from liquid water. This prevents biological activity, reduces corrosion and inhibits reaction of the fuel with water. Regular use of FCC ensures that carburetors and fuel injectors work at peak performance eliminating poor running problems and expensive maintenance. The benefits of FCC extend throughout the fuel system.

Addition of FCC reduces the Wear Scar Diameter from 685  $\mu\text{m}$  to 200  $\mu\text{m}$  which is a significant **71%** improvement of lubricity on the petrol fuel. The wear scar diameter is a measure of lubricity of fluid which is the ability of fluid or compound (in this case petrol fuel) to act as a lubricant to minimize friction and damage to surfaces in contact under relative motion load. The smaller the scar, the less wear has occurred and hence the better the lubricity of the fuel. Hence this significant reduction of wear scar diameter which is improvement of lubricity of the fuel will greatly increase durability of equipment which prevents premature wear of equipment and allowing equipment to operate to its intended design life. This increase in lubricity directly improves engine's performance and minimises maintenance requirement.

## 2 INTRODUCTION

FCC is an innovative and scientifically proven blend of surfactants (detergents), oxygenates and corrosion inhibitors developed to meet the challenge of today's engines. It's a non-hydrocarbon fuel conditioner that cleans fuel and improves performance whilst lowering emissions and increasing fuel efficiency. It is suitable for use for a large variety of fuel types.

With FCC, improvements in fuel efficiency and savings in maintenance costs are achieved through cleanliness and a better burn; as opposed to tampering with the combustion characteristics of the fuel.

### 2.1 DOCUMENT SCOPE

The intent of this document scope is to provide technical analysis on Standard Petrol's property i.e. wear scar diameter after addition of fuel additive (spiked with ratio of 1:4000), herein referred to as FCC.

### 2.2 ABBREVIATIONS

Abbreviations	Definition
AddFuel	AddFuel Pty. Ltd.
ASTM	American Standard Test Method
FCC	Fuel Conditioner Concentrate
HFRR	High Frequency Reciprocating Rig
WSD	Wear Scar Diameter

### 2.3 REFERENCES

The references used in this document are:

1. Report of Analysis Laboratory Report ID: 2279679, Sample ID: 2016-PTAD-000126-001, 26-Feb-2016 (Att. 1).
2. Diesel Fuel Technical Review, Chevron.
3. Practical Lubrication for Industrial Facilities 2<sup>nd</sup> Edition, Heinz Bloch.
4. <http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards/diesel>
5. [https://www.dieselnet.com/tech/fuel\\_diesel\\_lubricity.php](https://www.dieselnet.com/tech/fuel_diesel_lubricity.php)
6. [http://www.fuelcenter.rwth-aachen.de/fileadmin/user\\_upload/Bilder\\_und\\_pdf/Z\\_TMFB/Veranstaltungen/2TMFB/Presentations/IR\\_F3\\_2\\_Fatemi\\_presentation.pdf](http://www.fuelcenter.rwth-aachen.de/fileadmin/user_upload/Bilder_und_pdf/Z_TMFB/Veranstaltungen/2TMFB/Presentations/IR_F3_2_Fatemi_presentation.pdf)

### 2.4 ATTACHMENTS

1. Intertek Geotech, Report of Analysis Laboratory Report ID: 2279679, Sample ID: 2016-PTAD-000126-001, 26-Feb-2016.
2. Australia Government Department of Environmental and Energy, Fuel Quality in Australia – Diesel Fuel Quality Standard.

### 3 WEAR SCAR DIAMETER

#### 3.1 DEFINITION

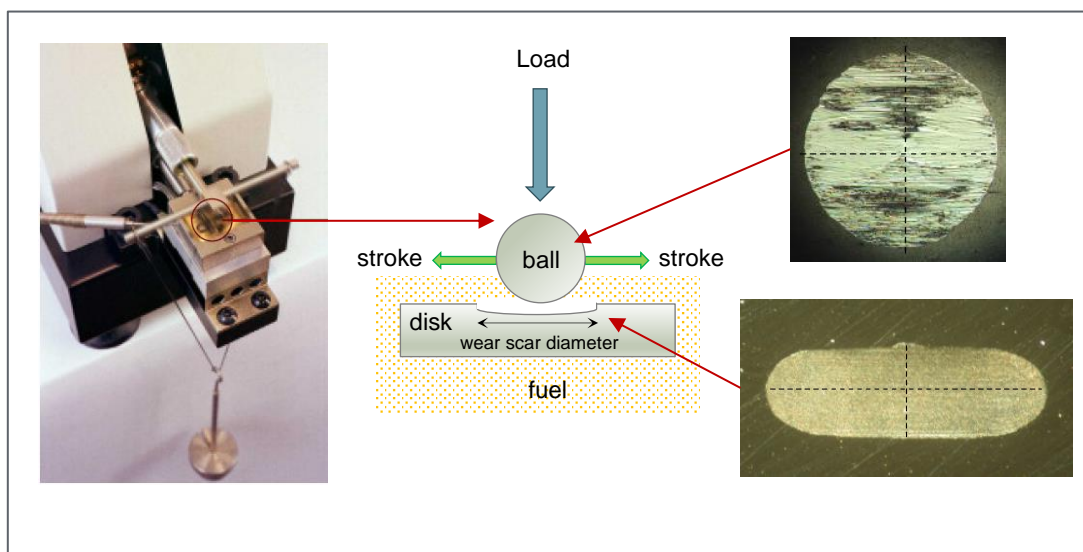
Wear Scar Diameter is a measure of lubricity of fluid which is the ability of fluid or compound (in this case petrol fuel) to act as a lubricant to minimize friction and damage to surfaces in contact under relative motion load.

Some moving parts of petrol fuel pumps and injectors are protected from wear by the fuel. Lubricity is ability of a lubricant (in this case petrol fuel) to minimize friction between and damage to surfaces in relative motion under load. The lubrication mechanism is a combination of hydrodynamic lubrication and boundary lubrication. In hydrodynamic lubrication, a layer of liquid prevents contact between the opposing surfaces. For petrol fuel pumps and injectors, the liquid is the fuel itself and viscosity is the key fuel property. Fuels with higher viscosities will provide better hydrodynamic lubrication. Petrol fuels with viscosities within the ASTM D975 specification range provide adequate hydrodynamic lubrication. Boundary lubrication becomes important when high load and/or low speed have squeezed out much of the liquid that provides hydrodynamic lubrication, leaving small areas of the opposing surfaces in contact. Boundary lubricants are compounds that form a protective anti-wear layer by adhering to the solid surfaces.

#### 3.2 TEST METHOD

That standard petrol and petrol with FCC additive are tested using IP 450 method “HFRR” (high frequency reciprocating rig) method. The test is conducted by placing a hardened steel ball against a hardened steel disk with a load applied to create a certain force between the two surfaces. The fuel sample being tested is poured into a cup that contains these steel samples, and a motor is turned on to force the ball to scour on the surface back and forth motion at a certain rate over a certain distance for 90 minutes. Under a microscope, the width and length of the “wear scar” produced by the scouring motion of the ball is measured. The average of these two dimensions is the “wear scar diameter.” The smaller the scar, the less wear has occurred and hence the better the lubricity of the fuel sample.

**Figure 3.1: High Frequency Reciprocating Rig (HFRR) Test**



### 3.3 OVERVIEW / SPECIFICATIONS

Description	Definition
Lubricity	Ability of a lubricant (in this case petrol fuel) to minimize friction between and damage to surfaces in relative motion under load.
Wear Scar Diameter	Measure of length/diameter of “wear scar” as a result of friction wear from the ball and disk in contact immersed in lubricant (HFRR test). The WSD indicates lubricity of the fluid.
Test Method	IP 450
Effect of Property on Performance / Significance of Property	Poor lubricity causes excessive wear and at the extreme, causes catastrophic failure of engine.
Upper Limit / Specification	>600 µm might not prevent excessive wear.
Maximum Standard Lubricity	<450 µm should provide sufficient lubricity.

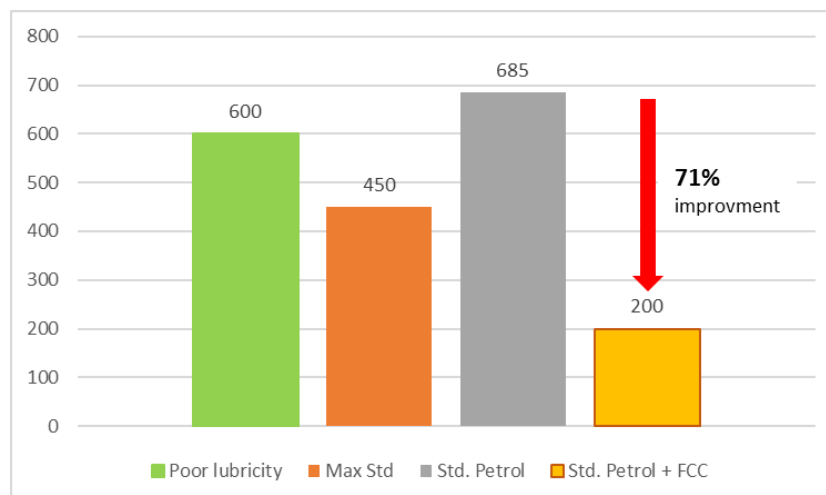
### 3.4 ANALYSIS

The maximum standard lubricity is 450 µm (Ref. 4) as per Australia fuel specification to ensure sufficient lubricity for the engine’s operation. Poor lubricity (>600 µm) could potentially causes excessive wear and at the extreme, causes catastrophic failure.

Based on the test results (Att. 1), the standard petrol wear scar diameter is 685 µm. When the standard petrol is added with FCC, the wear scar diameter is drastically reduced to only 200 µm. The lubricity of the fuel after addition of FCC improves from 685 µm (standard petrol) to 200 µm which is a significant **71%** improvement of lubricity on the petrol fuel.

This increase in lubricity for FCC, will significantly improve durability of equipment and prevent premature wear of equipment by allowing equipment to operate to its intended design life. The improvement on lubricity is illustrated graphically in Figure 3.2 with the specifications of lubricity (upper limit, maximum standard and control sample).

**Figure 3.2: Lubricity Specifications (Std. Petrol and with FCC)**



**Intertek****Report of Analysis**

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Australia

Laboratory Report ID : 2279679  
Job No. : 2016-PTAD-000126  
Client Reference : Not Supplied

**Sample ID** : 2016-PTAD-000126-001  
**Sample Designated as** : E10  
**Sampling Point** : Not Supplied  
**Job Location** : Adelaide, SA  
**Representing** : Petrol with additive added in dilution ration of 1:4000

**Date Taken** : Not Supplied  
**Date Submitted** : 24-Feb-2016  
**Date Tested** : 26-Feb-2016  
**Drawn By** : Client

Method	Test	Result	Units
IP 450 - modified	Corrected Mean Wear Scar Diameter	200	µm
ASTM D2699	Research O.N.	91.4	

Sample Received Condition : Good (No Seal)  
Seal Number : Not Applicable  
Sampling Method : Not Applicable  
Remarks : Method IP 450 was modified as the sample type was outside the scope of the test method and the test temperature was 25C.  
Therefore results should be considered indicative only.

**Sample ID** : 2016-PTAD-000126-003  
**Sample Designated as** : E10  
**Sampling Point** : Not Supplied  
**Job Location** : Adelaide, SA  
**Representing** : E10 Petrol with no additive

**Date Taken** : Not Supplied  
**Date Submitted** : 24-Feb-2016  
**Date Tested** : 01-Mar-2016  
**Drawn By** : Client

Method	Test	Result	Units
IP 450 - modified	Corrected Mean Wear Scar Diameter	685	µm

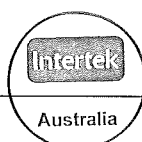
Sample Received Condition : Good (No Seal)  
Seal Number : Not Applicable  
Sampling Method : Not Applicable  
Remarks : Method IP 450 was modified as the sample type was outside the scope of the test method and the test temperature was 25C.  
Therefore results should be considered indicative only.

*The analysis results denoted by (j) are part of the laboratory NATA accreditation. Accredited for compliance with ISO/IEC 17025.*

This report has been reviewed for accuracy, completeness, and comparison against specifications when available. The reported results are only representative of the samples submitted for testing. This report shall not be reproduced except in full, without approval of the laboratory. All work is performed in accordance with Intertek Standard Terms and Conditions of Service which is available on request and at <http://www.intertek.com/terms>.

Signed: \_\_\_\_\_

Joshua Camens, Supervisor



Date: \_\_\_\_\_

01-Mar-2016



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## Diesel fuel quality standard

### Management of Diesel Oil Burn Systems

The use of oil burn systems in diesel vehicles can potentially breach section 20 of the *Fuel Quality Standards Act 2000* if the addition of oil to the diesel within the engine results in the diesel not complying with the Fuel Standard (Automotive Diesel) Determination 2001.

As the Australian Government is committed to international best practice regulation of fuel quality, it has been decided not to amend the determination to allow the use of oil burn systems in any diesel vehicles operating in Australia.

It is considered that there is enough concern about the potential impacts on sulfur levels in diesel from the addition of used motor oil to warrant this decision.

[Management of Diesel Oil Burn Systems](#) - position paper

### Environmental standards

The first suite of national fuel standards, which came into force on 1 January 2002, regulates petrol and diesel parameters that have a direct impact on the environment ('environmental standards').

The standards will have a major impact on the amount of toxic pollutants in vehicle emissions, such as benzene and particles, with studies estimating reductions of up to 50 per cent for some pollutants over 20 years. This is great news for our health, with cleaner air helping to reduce the number of serious respiratory illnesses and asthma cases, particularly in children.

### Operability standards

A second suite of national fuel standards came into force on 16 October 2002. These standards ('operability standards') address those parameters of diesel that do not have a direct impact on emissions but, if not controlled, can have adverse impacts on the efficient operation of the engine.

Further operability standards are being developed that may include:

- for diesel - the parameters are appearance, acidity, cloud point and cold filter plugging point.

### Summary table

The environmental and operability standards are consolidated in the following tables. The legal instrument implementing the standard is:

[Fuel Standard \(Automotive Diesel\) Determination 2001](#)

#### Diesel standards

Parameter	National standard	Date of effect	Test Method
Biodiesel <sup>1</sup>	5.0% volume by volume (max)	1-Mar-09	EN 14078
Sulfur	500 ppm (max)	31-Dec-02	ASTM
	50 ppm (max)	1-Jan-06	D5453
	10 ppm (max)	1-Jan-09	
Cetane Index	46 (min) index	1-Jan-02	ASTM D4737
Derived Cetane Number (of diesel containing biodiesel)	51.0 (min)	21-Feb-09	ASTM D6890
Density	820 (min) to 860 (max) kg/m <sup>3</sup>	1-Jan-02	ASTM
	820 (min) to 850 (max) kg/m <sup>3</sup>	1-Jan-06	D1298
Distillation T95	370°C (max)	1-Jan-02	ASTM D86
	360°C (max)	1-Jan-06	
Polyaromatic hydrocarbons (PAHs)	11% m/m (max)	1-Jan-06	IP391
Ash	100 ppm (max)	1-Jan-02	ASTM D482
Viscosity	2.0 to 4.5 cSt @ 40°C	1-Jan-02	ASTM D445
Carbon Residue (10% distillation residue)	0.2 mass % max	16-Oct-02	ASTM D4530
Water and sediment	0.05 vol % max	16-Oct-02	ASTM D2709
Water (all diesel containing biodiesel)	200 mg/kg (max)	21-Feb-09	ASTM 6304
Conductivity @ ambient temp	50 pS/m (Min) @ambient temp (all diesel held by a terminal or refinery for sale or distribution)	16-Oct-02	ASTM D2624
Oxidation Stability	25 mg/L max	16-Oct-02	ASTM D2274
Colour	2 max	16-Oct-02	ASTM D1500
Copper Corrosion (3 hrs @ 50°C)	Class 1 max	16-Oct-02	ASTM D130

Flash point	61.5°C min	16-Oct-02	ASTM D93
Filter blocking tendency	2.0 max	16-Oct-02	IP 387
Lubricity	0.460 mm (max) (all diesel containing less than 500 ppm sulfur)	16-Oct-02	IP 450

<sup>1</sup> The biodiesel component of diesel must meet the requirements of fuel quality standard for biodiesel set out in the Fuel Standard (Biodiesel) Determination 2003.

## Disclaimer

The information contained on this page is of a general nature only and should be read in conjunction with the *Fuel Quality Standards Act 2000*, Fuel Quality Standards Regulations 2001 and the Fuel Standard (Automotive Diesel) Determination 2001. Fuel suppliers may wish to seek legal advice about their obligations under this legislation.