

# GREEN CAR GUIDE: RATING PROTOCOL

Editorial Note: This is a draft document and does not necessarily represent the views or policy of any organisation. Several matters and responsibilities (usually indicated by XXX) have yet to be resolved. In some cases these are indicated by items in [square brackets].

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## 1 INTRODUCTION

### 1.1 Purpose of rating system

The main purpose of the rating system is to provide consumers with a guide to the fuel-efficiency and environmental friendliness of new motor vehicles. The primary aim of such a system is to reduce the environmental impact of motor vehicles.

## 2 VEHICLE SELECTION

### 2.1 Models to be included in the Guide

The vehicles to be included in the rating system are popular light vehicles such as passenger cars and derivatives, people movers, four-wheel-drives and light commercial vehicles. Heavy vehicles, motorcycles and motorcycle derivatives are not intended to be included but the methodology can deal with these vehicles, as well as vehicles fuelled by other than petrol.

"Popular" models are determined from industry sources such as VFACTS. The *approximate* targets for each type of vehicle are:

- Large cars - 5 models
- Medium cars - 8 models
- Small cars - 8 models
- People movers - 5 models
- Small/medium 4WDs - 5 models
- Large 4WDs - 5 models
- Light commercials - 5 models

See Clause 5.2 for definitions.

For each engine family (primarily 4, 6 or 8 cylinder) the most popular selling variant is chosen for assessment. Exceptions would be where a less-popular, or new, variant is expected to become more popular or the popular variant is about to be withdrawn from sale.

In addition to popular models, examples of "bookend" performers are chosen from time to time to give an indication of:

- good and bad performance and
- alternative fuels such as diesel, LPG and hybrid/electric.

In the case of dual-fuel vehicles, consideration is given to separate ratings.

The intention is to have ratings for the 40 most popular models (as described above) plus up to 10 "bookends".

## 2.2 Selection of representative vehicles for testing

### 2.2.1 Sources of vehicles

Arrangements are made with motor dealers, car rental firms and government departments for vehicles to be made available for testing purposes. The requirements for these vehicles are:

- The variant is the same as the one chosen to be representative of the model, or can be expected to deliver the same environmental performance (same engine, tuning specifications and kerb mass),
- At least 500km on the odometer (engine is "run in") and more than 10,000km.
- Vehicle has undergone normal pre-delivery check by dealer (a tune up is only to be performed if this is part of the pre-delivery check),
- Minimal fuel in fuel tank (the test organisation will use prescribed fuel for the test).

## 3 VEHICLE TESTING

### 3.1 Types of tests to be conducted

Petrol fuelled vehicles are subjected to the IM240 test procedure. Diesel and other hydrocarbon fuelled vehicles are subjected to the NEPC CUE test procedure for light vehicles. Electric vehicles are subjected to the CUE driving cycle, during which electricity consumption is measured.

#### 3.1.1 Reference procedures (call up recognised procedures)

[Refer to IM240 reference document]

[Refer to Short-cycle/CUE reference document]

#### 3.1.2 Brief description of procedures

##### IM240

This is a variable speed driving cycle test that is essentially an abbreviated version of the exhaust emissions test of Australian Design Rules 37/00. It was developed by the US EPA primarily for inservice emissions testing. It does not normally include a "cold start" procedure and does not include an evaporative emissions test.

##### Short test based on CUE Driving Cycle

An abbreviated "Composite Urban Emission" drive cycle has been developed by the National Environment Protection Council, primarily for testing diesel vehicles. It contains less-demanding acceleration requirements than IM240 in recognition of the lower acceleration capability of most diesel vehicles. There are 6 driving cycles, one for each ADR vehicle category. Each cycle contains four modes to simulate different traffic conditions.

*[Note: a short driving cycle is being developed from the work on the CUE driving cycle and the short test will be used for this protocol.]*

### 3.2 Test facilities

#### 3.2.1 Equipment requirements

[list of pollutants to be measured - separate lists for petrol, diesel and LPG]

#### 3.2.2 Approval of facilities

[Requirements for approval/certification of test facilities]

## **3.3 Vehicle Preparation**

### **3.3.1 Fuel**

#### **Petrol and Diesel Vehicles**

The test fuel for petrol vehicles is [specify typical Sydney ULP with tolerances].

The test fuel for diesel vehicles is [specify typical Sydney diesel with tolerances].

The test fuel may be supplied to the vehicle via a separate fuel line or it may be added to the vehicle fuel tank. If the test fuel is to be added to the fuel tank then the fuel tank is drained as far as practicable before the test fuel is added. It is preferred that the tank is drained by running the vehicle engine but a minimal amount of the original fuel may be retained provided that the engine is run for an extra ten minutes prior to testing.

#### **Electric vehicles**

If there is no quantifiable indication of the level of battery charge then electric and hybrid vehicles should start the test with the batteries fully charged. After the test the batteries are recharged to the initial level and electricity consumption is measured during the recharge. If external electricity is required during the test then this should be measured and reported.

### **3.3.2 Pre-conditioning**

Internal combustion engines must be run continuously for at least five minutes prior to the test to ensure that all components have reached normal operating temperature.

### **3.3.3 Tuning**

No special tuning of the vehicle is to be performed. If the mistuning is suspected then the vehicle should be returned to the supplier for a tune-up. XXX will reimburse the supplier for this extra cost.

### **3.3.4 Specifications and measurements (model, variant, engine, kerb mass...)**

At least the following vehicle parameters are to be measured and recorded:

- Make
- Model
- Variant
- Body style (sedan, hatch, waggon etc)
- VIN
- Build date
- Engine number
- Engine capacity
- Number of cylinders
- Type of fuel(s)
- Method of fuelling (injection, carburettor etc)
- Kerb weight
- Seating capacity

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- Odometer reading
- Type of transmission and number of gears

### 3.3.5 Environment-related features

Any notable environmental features claimed for the vehicle are to be recorded. This should include the source of the information.

Compliance with stringent overseas standards, such as Californian Air Resources Board tiers (TLEV, LEV etc) should be noted, including the source of information.

### 3.3.6 Photographs

At least the following photographs should be taken:

[diagram and list]

## 3.4 Test Procedure

### 3.4.1 Pre-test calibration

[pre test calibration of equipment]

### 3.4.2 Driving requirements

[refer to test procedure]

### 3.4.3 Engine operation

[refer to test procedure]

### 3.4.4 Number of tests to be conducted

At the completion of each test cycle the values for HC and NOX, in grams per kilometre, are to be calculated. At least three tests are to be conducted. If at the end of the third test the HC *and* NOX results for all three tests are within +/-5% then the tests are regarded as valid. If they are not within this range then additional tests are to be performed until any three test results (not necessarily consecutive) are within the prescribed range. The results of these three tests are to be used in the assessment (Section 4).

Measurements for other pollutants need not be within the ranges specified above in order for the test to be valid but variations greater than +/-10% should be highlighted in the test report.

### 3.4.5 Post-test calibration

[refer to test procedure]

### 3.4.6 Test Report

The test report for each vehicle shall include:

- The test organisation and address
- A description of the equipment used in the test and its calibration status.
- The name of the person who supervised the tests.
- The vehicle specifications described in section 3.3.4
- The test results
- Any relevant comments on the test results or procedures.

## 4 ASSESSMENT AND RATING

### 4.1 *General description of the methods*

The rating system is based on the derivation of an Environmental Damage Index (EDX) for each vehicle. The EDX is the sum of the damage-weighted emissions resulting from the use of the vehicle. Due to data uncertainties the emissions resulting from manufacture and disposal ("life cycle analysis") are not included in the current rating system but the methodology provides for these factors to be readily incorporated into the process.

In essence the tailpipe emissions, measured in grams per kilometre, are determined for each pollutant. Emissions related to fuel consumption (including electricity generation in the case of electric vehicles) are also determined on a grams per kilometre basis. The measurements for each pollutant are multiplied by an index factor to derive a relative damage index. These are summed to give the EDX. Separate values are also calculated for health/smog related pollution and global-warming related pollution.

The following section describes calculations for tailpipe and fuel-consumption related emissions.

### 4.2 *Calculation of in-use (km travelled) emissions*

#### 4.2.1 **Exhaust emissions data**

For each pollutant measured in accordance with the test procedures, the mean of the three valid test results shall be used as the value of exhaust emissions, in grams per km.

If the test measurement of one to the pollutants (not being HC or NOX) *exceeds* the mean of the other two measurements by more than 10% then only the two lower measurements shall be used in the calculation.

#### 4.2.2 **Adjustment factors (e.g. deterioration)**

No deterioration or other adjustment factors shall be applied to the test measurements.

#### 4.2.3 **Estimates of other emissions based on km travelled**

In the absence of reliable data, only those pollutants that are measured during the test procedures shall be included in the calculation.

### 4.3 *Calculation of fuel-consumption-related emissions*

#### 4.3.1 **Fuel consumption data**

The mean of the three test measurements shall be used to derive the fuel consumption for rating and publication purposes. Note that this value is unlikely to match fuel consumption determined by other means, such as Australian Standards.

Fuel consumption is reported in litres per 100km.

#### 4.3.2 **In-use fuel emissions**

The following in-use emissions are assumed, based on each litre of fuel consumed:

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Table 1. Fuel Consumption-Dependent Emissions

Grams per litre of fuel consumed

Pollutant	Petrol	Diesel	LPG
HC Evap (ADR37 vehicle or equivalent for diesels)	2.5	4.05	10.18
HC Evap (TLEV, LEV, ULEV)	1.25	-	-
HC Evap (SULEV)	0	-	-
SOX	0.51	4.5	0.21
CH4	0.5	0.76	0.52
N2O	1.06	0.76	0.05
CO2	2260	2690	1527

### 4.3.3 Calculation of emissions per kilometre travelled

In-use emissions (grams/litre consumed) are multiplied by the fuel consumption (converted to litres per kilometre) to obtain the fuel-related emissions per kilometre travelled.

### 4.3.4 Electricity emissions

Table 2 sets out emissions factors to use for electric vehicles. These are values at the recharging point, assuming typical Australian electricity sources.

Table 2. Emissions from Electricity Generation

Pollutant	Electricity g/MJ
NMOG (HC)	0.005
NOX	0.78
PM10	-
SOX	1.11
CH4	0.0027
N2O	0.0024
CO	0.033
CO2	278

### 4.3.5 Calculation of emissions per kilometre travelled for electric vehicles

Electricity consumption, if any, during the test is measured, together with electricity consumed to recharge the battery after the test.

Estimated in-use emissions (grams/MJ of electricity consumed) are multiplied by the electricity consumption (converted to MJ per kilometre) to obtain the (electric) fuel-related emissions per kilometre travelled.

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## 4.4 Calculation of Environmental Damage Index (EDX)

### 4.4.1 Inputs

For each pollutant and each source (exhaust, in-use fuel, fuel cycle and power generation), the emissions in grams per kilometre of vehicle travel are obtained from the above calculations.

### 4.4.2 Reference damage index for each pollutant

Based on health and related studies and estimates of the effects of global warming, the following environmental damage indices apply to each pollutant.

Table 3. Damage indices by weight of pollutant. Relative to CO2

Pollutant	Greenhouse Index*	Smog/Health Index#
CO	0	2
HC	0	190
NOX	0	180
PM10	0	5150
SOX	0	25
CH4	21	0
N2O	310	0
CO2	1	0

\* *AGO National Greenhouse Gas Inventory, 1997*

# *Based on Attachment D of the document "Explanatory Statement: Road Vehicle (National Standards) Determination No2 of 1999" issued by the Minister for Transport and Regional Services in December 1999. These are for emissions at the vehicle exhaust. Under ACEEE methodology "Factory" sources are divided by 5 and power station sources (e.g. Table 2) are divided by 10 to account for remoteness from population at risk. There is no adjustment for Greenhouse factors.*

[Possible separate table for CUE tests, or adjustment factor]

### 4.4.3 Calculation of damage index for each pollutant from vehicle (damage/km)

Each input value obtained in clause 4.4.1 is multiplied by an environmental damage index, as set out in Table 3, with adjustment for factory/power station sources where appropriate.

Separate calculations are done for Greenhouse and smog values.

### 4.4.4 Overall Environmental Damage Index

The values derived in clause 4.4.3 are summed to give an overall EDX

In addition, the "smog" index is calculated by summing the smog/health components and the Greenhouse index is calculated by summing the Greenhouse components.

### 4.4.5 Star rating

The number of stars awarded depends on the value of the EDX. The lower the EDX the more stars awarded. The (*proposed*) breakpoints are:

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Table 5: Breakpoints for star ratings

Stars	EDX	Greenhouse	Smog
5 Stars	<=240	<=120	<=120
4 Stars	<=480	<=240	<=240
3 Stars	<=720	<=360	<=360
2 Stars	<=960	<=480	<=480
1 Star	<=1200	<=600	<=600
0 Stars	>1200	>600	>600

These are based on the formula:

$$\text{Stars} = \text{INT}(1200 - 240 \times \text{EDX}) \text{ where } \text{EDX} < 1200$$

[For reference the ACEEE 1999 EDX ratings were equivalent to:

- Average (US) car: 2.64 c/mile = 866 = 2 stars
- Best current passenger car (Honda Civic CVT): 1.9 c/mile = 623 = 3 stars
- LEV vehicle: 1.37 c/mile = 449 = 4 stars
- Average light truck: 3.26 c/mile = 1069 = 1 star
- Worst large SUV (4WD): 4.71 c/mile = 1545 = nil stars
- GM Electric Car: 0.85 c/mile = 279 = 4 stars
- Theoretical hydrogen fuel cell vehicle\*: 0.18 c/mile = 59 = 5 stars

Where 527 Aust EDX = 1 ACEEE US cents per km Costs are not used in the Australian system.

\* This includes ACEEE's estimates of embodied emissions.

*Final star breakpoints will depend on analysis of Australian vehicles.]*

## 4.5 Technical Report

For each batch of vehicles that is assessed the assessing organisation shall prepare a technical report setting out the basis for the ratings. This report shall be in a form suitable for distribution to vehicle manufacturers and stakeholders.

[outline of contents of technical report]

## 5 CONSUMER INFORMATION (PRESENTATION)

### 5.1 General description

Each release of information for consumers shall include at least the following:

- A summary sheet showing all current models for the class, or classes, of vehicles covered by the release.
- A class summary, showing key details for each vehicle in each class.
- A detailed description of the results for each vehicle.

**5.2 Classes of vehicle**

Vehicle classes are based on the following definitions:

- Large cars - XX
- Medium cars - XX
- Small cars - XX
- People movers - XX
- Small/medium 4WDs - XX
- Large 4WDs - XX
- Light commercials - XX

**5.3 Preparation of overall summary**

The overall summary shall have the following layout:



Figure 1. Sample Overall Summary

If there is more than one class of vehicle then a separate table shall be prepared for each class. Within each class, the vehicles shall be sorted by EDX, with the lowest EDX (least environmental damage) at the top.

## 5.4 Preparation of class summary (contents and layout)

The class summary gives test results and scores in tabular form.

Make, Model & Engine	Fuel Cons. (l/100km)	Kerb mass (kg)	Smog Index	Greenh ouse Index	Overall Index	Stars	Class Rank
XXXXXX	6.02	910	50	60	110	***	A
Class average							
All vehicle average							

Class Rank: A= top 15% ...

Figure 2. Sample Class Summary

## 5.5 Preparation of detailed sheets (contents and layout)

A detailed sheet shall be prepared for each vehicle. This shall include the scores and ratings, notable Green features of vehicle, Green initiatives of manufacturer and comments.

A sample detailed sheet is provided in Appendix B [to be developed once initial results are available].

## 5.6 Distribution of brochures and information

Each release will have an embargo time and date. Information is not to be released to the public prior to the embargo.

### 5.6.1 Printed material

Printed and/or electronic material shall be despatched to the following organisations so that it is available for internal distribution at least 3 working days prior to the release.

Table 6. Distribution List

Organisation and Contact	Delivery Address and email	Quantity
XXX	XXX	XX

### 5.6.2 Media releases

Media releases may be arranged by each stakeholder. A draft media release should be circulated to stakeholders at least one week prior to the embargo date. Comments on the draft should also be circulated to stakeholders, who may then prepare their own media release.

### 5.6.3 Updates to website

Media coverage is likely to generate Internet traffic. Updates to the Green Car Website should therefore be available on the day of the release.

## 6 Monitoring and review

The following items should be monitored and, where appropriate, procedures reviewed.

### 6.1 *Response to rating system*

- Stakeholder feedback
- Proportion of fleet covered by Guide
- Consumer demand for information
- Consumer feedback
- Response of motor industry
- Media coverage

### 6.2 *Technology*

- Vehicle developments
- Government developments (regulation, related initiatives, sharing information)
- Test procedures developments (technology and procedures, test facilities)

### 6.3 *Factors used in calculations*

- Tables 1, 2, 3 and 4
- Research on health effects and global warming effects.
- Other Green Car rating systems.

The main sources for the factors are:

- Australian Greenhouse Office National Greenhouse Gas Inventory (NGGI), 1997, Workbooks 1 to3.
- "Explanatory Statement: Road Vehicle (National Standards) Determination No2 of 1999" issued by the Minister for Transport and Regional Services in December 1999
- NSW EPA Regulatory Impact Statement and Pollution Control Regulation 1998
- *Rating the Environment Impacts of Motor Vehicles: The Green Guide to Cars and Trucks Methodology*. American Council for an Energy-Efficient Economy, Washington, 1999.

### 6.4 *Responsibilities*

#### 6.4.1 *Operations*

- Vehicle selection - XXX
- Emissions testing (contract supervision...) - XXX
- Assessment (contract supervision) - XXX
- Preparation of documentation - XXX
- Maintenance of website - XXX

#### 6.4.2 *Monitoring*

- Response to rating system (see 6.3.1) - XXX

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- Technology (see 6.3.2) - XXX
- Factors used in calculations (see 6.3.3) - XXX

### 6.4.3 Administration

- Stakeholders (including meetings) - XXX
- Advice to Minister(s) - XXX
- Media enquiries and draft releases - XXX
- Amendments to this protocol - XXX

*This document is a draft for discussion purposes and does not necessarily represent the views or policy of any organisation.*

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