NSW Centre for Road Safety

POWER-ASSISTED PEDAL CYCLES
PROPOSAL FOR A NEW AB VEHICLE DEFINITION

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Executive Summary

This paper is the latest step of a series of initiatives to develop a national strategy in Australia to apply consistent design standards and registration requirements for power-assisted pedal cycles (PAPCs). A new definition is recommended along with the appropriate justification and analysis with the emphasis on road safety.

The preferred definition for discussion is:

> A pedal cycle [vehicle designed to be propelled through a mechanism solely by human power] to which is attached one or more auxiliary propulsion motors having a combined maximum **continuous rated power** not exceeding **250 watts, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.**

This would replace the current definition:

> A pedal cycle to which is attached one or more auxiliary propulsion motors having a combined maximum power output not exceeding 200 watts.

The reasons for the need to pedal in order to get assistance from the motor(s) are detailed as is the lack of specification for the type of motor activation. The effect of power assistance on maximum speed has been analysed before deciding on the maximum value of 250 watts and opting for not restricting power assistance up to a maximum speed. It does not specify a type of power source in order to avoid restricting the design and future development of PAPCs. To facilitate enforcement, it is proposed to require a permanent label to be affixed to PAPCs.

A literature review on pedal cycle safety has been undertaken to assess the impact of PAPCs on road safety, especially regarding their interaction with pedestrians, the effect of an increased travelling speed while going uphill and a possible increase in the number of cyclists due to the reduced physical effort needed to ride a PAPC compared to a pedal cycle. The conclusion is that the road safety benefits of PAPCs should not be negative, although it is emphasised that only limited literature is available on which to base this claim on.

Finally, a review of the existing regulations in several countries was carried out to assess whether the proposed definition would facilitate free trade. The proposed definition would allow the import of vehicles built to the European and Japanese markets, the two biggest markets outside China. Australian manufacturers could also build products compliant to both the proposed definition and the European and Japanese regulations, although this would not be necessary to sell products only in Australia.

Critical Items

Items that are most likely to instigate discussions are:

Should the rider need to pedal to obtain assistance from the motor?

- Simplest and arguably the only effective way to ensure that a vehicle is designed to be propelled through a mechanism by human power.
- Existing PAPC could not continue to be sold.
- Allows clear distinction between a bona fide PAPC and one with pedals as a simple 'add-on'.
- Allows a closer alignment to the European and Japanese definitions.

Should electric motors only be allowed?

- This restriction would make the Australian definition closer to harmonisation with the European and Japanese standards. In Europe and Japan, only electric motors are allowed.
- Internal combustion (IC) engines are noisier than electric motors.
- It is unclear how many, if any, IC engines on the market are generating less than 250 watts.
- Mandating a particular power source restricts possible innovations.
- The main objective from a road safety point of view is to limit the power output, not the type of power source.
- A Regulatory Impact Statement is likely to be undertaken to assess the impact of this restriction.

Should motor assistance cut at a determined speed?

- A 250 watt power limit maintains the maximum speed on level ground within the limits of most unassisted pedal cycles.
- A maximum assisted speed could prevent some riders from travelling faster than without assistance on level grounds.
- This restriction may make the Australian definition closer to harmonisation with the European and Japanese definitions. In Europe and Japan, a maximum assisted speed is mandated.
- A Regulatory Impact Statement is likely to be undertaken to assess the impact of this restriction.

Background

Since the beginning of the exemption from registration of power-assisted pedal cycles thirty years ago, the range of models of these vehicles have expanded enormously: from kits which can be attached to vehicles, to pedal cycles powered with motors in excess of 200 watts through to larger scooter-type vehicles which are deliberately marketed as not requiring pedalling while not needing registration nor driver licence. Many of these vehicles have caused enforcement problems. NSW Police are unable to readily determine which vehicles are entitled to the registration exemption or to enforce the safe use of motorised vehicles in places, such as cycle paths, which are normally set aside for bicycles. At the same time, concerns about traffic congestion, environmental impacts of conventional vehicles and growing interest in healthier lifestyles have coalesced to focus attention on the place of power-assisted pedal cycles in the current transport mix.

To address these issues, the RTA released a Discussion Paper on power-assisted pedal cycles in February 2008, *Better regulation of motor assisted pedal cycles: issues and solutions paper*. It was intended that this paper would be developed to form a national strategy to apply consistent design standards and registration requirements for PAPCs.

To help progress the paper into a formal strategy, the New South Wales Roads and Traffic Authority (RTA) convened a workshop on 28 July 2008 in Sydney. Representative from Australian Jurisdictions, bicycle supply interests, Australia Post and the NSW Police attended the workshop. Following that workshop there was an agreement that there needs to be a revised standard and description of the characteristics of a power-assisted pedal cycle that is exempt from registration without creating a new category of vehicle. The RTA undertook the development of a description of these characteristics, circulate this to other jurisdictions and interested parties for comment, and then seek consistent adoption of this description.

Purpose

This paper discusses the proposed characteristics for PAPCs to develop a new definition that will be included in the Australian Design Rules (ADR) definitions and subsequently in the Road Rules referring to the ADRs. This proposed definition will be circulated to other Jurisdictions and interested parties for comment and, ultimately, to enable consistent adoption across Australia.

The analyses carried out in this paper assume that PAPCs will continue to be considered as a form of pedal cycle in all Jurisdictions' Road Rules. Discussions regarding possible registration or licensing of PAPCs are not further examined.

Proposed Definition

Proposed Definitions to be incorporated into the ADRs

1.1.1. PEDAL CYCLE (AA)

A vehicle designed to be propelled through a mechanism solely by human power. [unchanged]

1.1.2. POWER-ASSISTED PEDAL CYCLE (AB)

A pedal cycle [vehicle designed to be propelled through a mechanism solely by human power] to which is attached one or more auxiliary propulsion motors having a combined maximum **continuous rated power** not exceeding **250 watts, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling,**

Further details about the rationale for this proposed definition are included in Appendix A.

Appendix A – Detailed Rationale

General Comments

Firstly, this Paper is looking specifically at PAPC and is not investigating the practicality of power-assisted cycles without pedals. These vehicles are currently considered as mopeds, however Jurisdictions may wish to develop a new category for powered assisted cycles without pedals.

Secondly, the proposed definition for discussion has a similar form to the current definition as it refers to the term 'pedal cycle', but defines it in square brackets to avoid the requirement to read two definitions in conjunction to fully understand what is a PAPC. The agreed definition should be less likely to create confusion, convey the stakeholders' understanding of what is a PAPC and facilitate enforcement.

Thirdly, this Paper is based on current technology and the investigation of the requirements in other countries. A list of these requirements is presented in Appendix B.

Is there a need to pedal to obtain assistance from the motor?

Objective: To make sure that PAPCs are fundamentally pedal cycles, vehicles designed to be propelled through a mechanism solely by human power, to which is attached one or more auxiliary propulsion motors.

Three different conditions for obtaining assistance from the motor were considered in defining a PAPC.

1. No need to pedal to obtain assistance from the motor

This would make the verification that a vehicle is fundamentally designed to be propelled by human power more difficult. Many existing PAPC could continue to be sold as this is compatible with the current definition.

There is a possibility to include requirements or guidelines at Jurisdiction level to help the interpretation of 'designed to be propelled through a mechanism solely by human power'. If the creation of such guidelines is the preferred option, consistency across the States and Territories is essential. The guidelines could be similar to one or a combination of the following:

- The rider must be able to pedal the PAPC on a level surface for two minutes continuously,
- A maximum pedal crank width,
- Adjustability of seat post,
- Suitable gearing, and
- Maximum weight.

It is not believed that these criteria would be truly effective at discerning vehicles that are bona fide pedal cycles, compared to the requirement to pedal to get motor assistance. There is also a possibility that these guidelines put undesired restrictions to the design of PAPCs. Additionally, it would need to be proven that pedalling or not on a PAPC with 250 watts of power assistance has an effect on safety.

2. Need to pedal to obtain assistance from the motor

This is the simplest and arguably the only effective way to ensure that a vehicle is designed to be propelled through a mechanism by human power. This requirement would also allow for a closer alignment to the European and Japanese definitions that require pedalling in order to get motor assistance. Additionally, it could be argued that having a stricter requirement will force people who would otherwise not be constrained to undergo training and licensing intended for heavier machines. There are unintended consequences about this policy, notably the fact that existing PAPC could not continue to be sold as most of them would not meet this new requirement.

3. Pedalling is required to get motor assistance after reaching a minimum speed on motor only

In addition to the benefits and disadvantages of the second option, a power-only start-up would make acceleration easier for people with less strength. This would also allow delivery people to walk alongside a PAPC at walking pace. The Canada Regulatory Impact Statement[1] mentions a 'carrying assist feature' that would help a dismounted cyclist to push a power-assisted bicycle and that would be deactivated automatically when the rider mounted the bicycle. It is stated that this feature is popular in Japan where cyclists consider it invaluable when climbing hills.

Pedal or throttle activation

On current PAPCs sold across the world, the two common way of activating the motor are either through a mechanism activated by pedalling or through a handle bar twist grip similar to the throttle control on motorcycles. The organisation Extra Energy calls these two systems 'pedelecs' or 'e-bikes' respectively and both types meet the European definition of a PAPC, detailed in Appendix B. The tests conducted since 2001 on a variety of European PAPCs on the website www.extranergy.com cover both systems.

A field test in Canada conducted in 2000 concluded that 'the two e-bike systems – electrically propelled and electrically assisted – were equally safe [according to the perception of users during a trial]. Therefore, the new regulations [i.e. amendments to the Canadian Motor Vehicle Safety Regulations made in 2001] should not include restrictions on the motor's operating apparatus'.[2] They refer to PAPC with twist grip activation as 'electrically propelled' and to a PAPC with pedal activation as 'electrically assisted'.

Requiring a pedal or throttle activation is seen as an unnecessary design restriction with no proven road safety benefits, therefore the motor activation mechanism will not be specified in the definition, although a condition for its activation could be specified. For example, a throttle control can still be used on a PAPC which motor can only provide assistance when the rider is pedalling.

[1] APRIL 2001, Canada Gazette Vol. 135, No. 8.Part II Statutory Instruments 2001 SOR/2001-109 to 129 and SI/2001-44 to 47 Pages 630 to 689

[2] Centre d'évaluation du vélo électrique du Québec. (2001) Electric bike 2000 project, prepared for Transport Canada. TP 13732E.

Maximum power output

Objective: Provide sufficient power assistance to the rider and facilitating free trade without compromising safety.

Existing power limits allowed overseas are evaluated for their relevance in Australia. The existing limits, with an indication of the resulting unassisted speed on level ground, are:

200 watts: This is the current situation in Australia. This definition limits the possibility to import overseas products designed to comply with overseas standards that allow higher power output limits. No recent documented case showing a direct relation between a power assistance of this amplitude and the cause of a serious crash in New South Wales has been found.
Typical unassisted speed: 23.5 km/h.

250 watts: This is the limit in Europe, and all Japanese models are understood to comply with that limit.
Typical unassisted speed: 25.5 km/h.

300 watts: This is the limit allowed in New Zealand. No safety analysis has been found to justify this level of assistance.
Typical unassisted speed: 27.5 km/h.

500 watts: This is the limit allowed in Canada. Transport Canada's Regulatory Impact Statement says that '500 watts is a level that well-trained athletes can maintain for a short period of time'[3]. The NSW Centre for Road Safety believes that 500 watts is far beyond a sustainable power output for an average cyclist, therefore it would provide PAPCs with a level of performance superior to a standard bicycle.
Typical unassisted speed: 33.0 km/h.

750 watts: This is the limit allowed in the United States. Canada's Regulatory Impact Statement says that '750 watts would not be representative of a cyclist's actual performance and could prove dangerous'. The same arguments used for the 500 watt limit apply for the 750 watt limit, with the safety risks proportionally greater.
Typical unassisted speed: 37.6 km/h.

It is recommended that the maximum allowed power output in Australia be increased to 250 watts continuous. It is specified that the power output is continuous to regulate the effective power, not the peak power in the case of electric motors where the short duration of its effect has limited effect on maximum speed. The analysis on the next page shows that this power limit maintains the maximum speed within the limits of most unassisted pedal cycles while providing an acceptable level of performance uphill compared to unassisted pedal cycles. This level of assistance does not require a maximum assisted speed for an average cyclist, however to prevent motor assistance at speeds above typical cycling speeds, a maximum assisted speed can be introduced. A motor assistance cut-off in function of speed would increase the design complexity of PAPCs, however this technology is readily available to accommodate for the European and Japanese definitions.

This is the smallest power increase that allows compatibility with some overseas standards. The European market, with 250,000 estimated PAPCs sold in 2007 and Japan, with an estimated

[3] APRIL 2001, Canada Gazette Vol. 135, No. 8.Part II Statutory Instruments 2001 SOR/2001-109 to 129 and SI/2001-44 to 47 Pages 630 to 689

300,000 PAPCs sold in the same year[4], are the two most significant markets outside China for PAPCs and a 250 watt power limit would allow the import of PAPCs compliant to both the Japanese and European standards. This would open the Australian market to a volume of high quality PAPCs designed and manufactured for bigger markets and will facilitate the export of locally designed and manufactured products.

A greater power limit increase will have a lesser impact on the compatibility with overseas standards in terms of market size and, in the absence of a maximum assisted speed, will further increase the maximum speed of PAPCs therefore potentially increasing safety risks. It is considered to be a conservative approach considering that road safety studies for bicycles, especially regarding the impact of speed, are limited. Moreover, a 250 watt power limit is still in line with the perception that a PAPC is a vehicle with comparable performance to a pedal cycle.

Analysis of the impact of power output on maximum speed

For the following analysis, it is assumed that the rider with equipment weights 75 kg and is on a 20kg PAPC including the battery. A 20 kg PAPC is representative of the lightest models available on the market and would allow for faster maximum speeds on hills than a heavier PAPC. The equation used to model the maximum speed is the same as the one used in a previous study from the Bicycle Industries Australia Ltd (BIA Paper)[5]. It is:

$$P = C_r mgv + mgv\sin(\theta) + C_w A v^3$$

Where
P = Power (watt)
C_r = Coefficient of rolling resistance = 0.005
m = Mass of rider and machine (kg) = 20 + 75 = 95kg
g = Gravitational acceleration = 9.81m/s^2
v = Velocity of rider (m/s)
θ = Angle of slope (degree)
C_wA = Product of coefficient of wind resistance and cross-sectional area = 0.6 for a fairly upright rider on a mountain bike or hybrid type bicycle, and 0.35 for a rider in racing position on a road bicycle. Values were determined with measurements published in the German magazine Radfahren on February 1990[6].

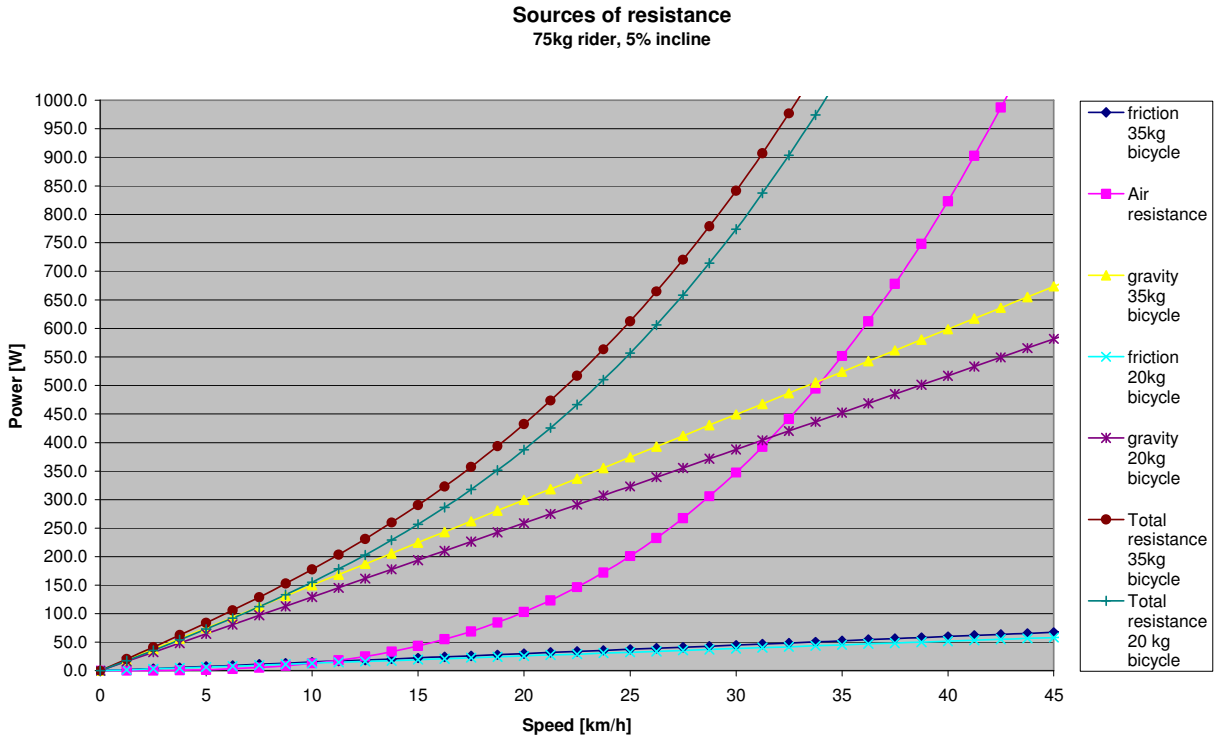
The 'C_wA' coefficient represents a rider in a fairly upright position typical of the majority of PAPCs currently sold. Some calculations have been done with a more aerodynamic riding position representing a rider lowered on a road bicycle to assess the maximum possible speed.

For a given slope, travelling speed has been varied to analyse the effect on the required total power necessary to travel at constant speed. Power from the rider and/or the auxiliary motor is needed to fight three sources of resistance when travelling at constant speed:

Friction: $C_r mgv$
Gravity: $mgv\sin(\theta)$
Air resistance: $C_w A v^3$

[4] Jamerson, Frank E. and Ed Benjamin. Electric Bikes Worldwide Reports, 2008 Update to the 2007 Edition.
[5] Christie, Ian. *Bicycle Industries Australia Ltd.* Power Assisted Bicycles (PABs). A Comparison of the Theoretical Performance of 200 Watt and 300 Watt PABs.
[6] http://www.sheldonbrown.com/rinard/aero/measuring.htm

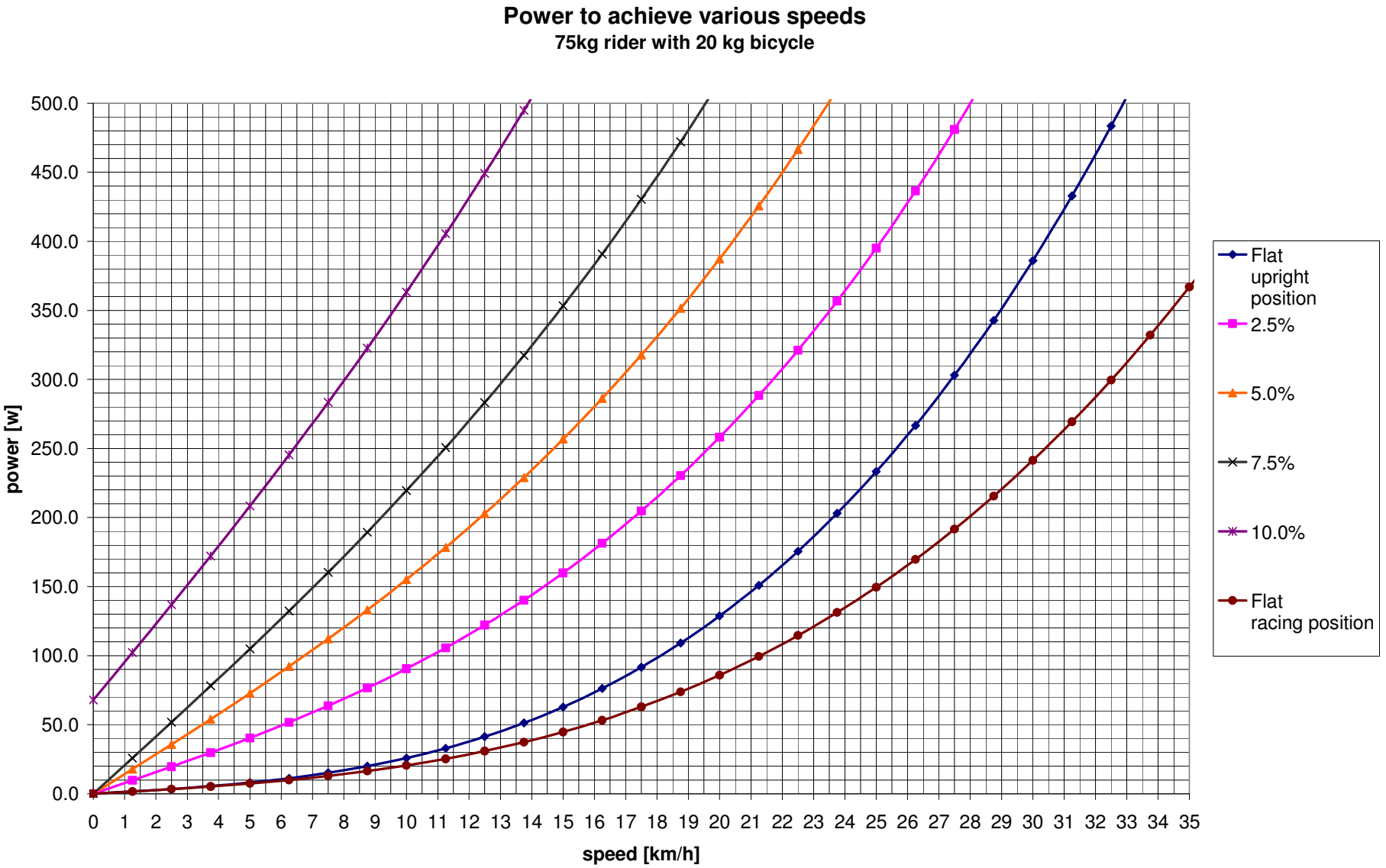
The following figure shows the magnitude of these three sources of resistance for a rider going up a hill of 5% gradient in function of speed with two different bicycle weights.



On a significant incline of 5% gradient, the power needed to overcome gravity far outweighs the power needed to fight wind resistance.

The gradients used in the analysis vary from a flat road up to a very steep 10% gradient, with 2.5% increments. As a guide, Bradley's Head road, on Sydney's lower North Shore, has many sections between 6 and 7% gradient between Taronga zoo's parking and the ferry wharf. Around the same area, the southern approach to the bridge in Cammeray on Miller Street is a very steep section with a gradient of 10%. A road with a 10% gradient usually requires the rider to be standing on the pedals to climb up the hill. Around Melbourne, the Mountain Highway from The Basin up to Sassafras has a steady gradient of 5%.

The following figure shows the power needed in function of speed on various inclines.



From the previous chart, it is possible to evaluate the maximum speed for different scenarios:

	Maximum speed in km/h for a given incline					
	Racing position	Upright position	Upright position			
	Flat terrain	Flat terrain	2.5% gradient	5% gradient	7.5% gradient	10% gradient
Rider only (100W)	21.5	18	11	6.5	4.5	1.5
Motor only (200W)	28	23.5	17.5	12.5	9	4.5
Motor only (250W)	30.5	25.5	19.5	14.5	11.5	6.5
Rider & motor (200W motor)	32.5	27.5	21.5	17	13	8
Rider & motor (250W motor)	34.5	29	23.5	18.5	15	9.5

For safety reasons, the maximum speed on a flat terrain with an upright position should be in the same range as the speed of a cyclist on an unassisted pedal cycle to avoid increasing risks to pedestrians on shared paths and cycle ways as well as to the cyclists themselves in the event of a collision with an object or another vehicle travelling in a different direction. The increase of the travelling speed for cyclists when travelling in the same direction as faster motorised vehicles on the roads is not seen as a safety risk because the speed differential will decrease. Additionally, an increase in travelling speed for cyclists going uphill could reduce the safety risk because the wobbling that results from travelling at a very low speed would diminish.

A Monash University study on 1162 cyclists over 5 days across different locations in Melbourne found that the 85th percentile speed of cyclists is 32km/h[7]. The maximum speed with assistance for a target user delivering a power output of 100 watts with an upright riding position is lower than the measured 85th percentile. Additionally, the extra 50 watts over the currently allowed 200 watts translates into an extra 2km/h in all conditions that is relatively more significant on hills where speeds are lower.

The effect of limiting motor assistance to a certain travelling speed can be analysed in the following way. Knowing that the 85th percentile of cycling speed is 32.5km/h without motor assistance, it can be calculated that the power needed to travel at that speed is 300 watts in a "racing" position. At 32.5 km/h, the power needed by a tall cyclist riding upright on a hybrid bicycle (the rider used in this discussion paper along with a power output of 100 watts) would be 484 watts. This is an unlikely power output for the majority of the population. For this reason, combined with the reasonable assumption that the cyclists achieving the top 15% of travelling speeds are more likely to be on road bicycles in a crouched position, only the 300 watt case will be analysed.

In the scenario that a cyclist providing 300 watts unassisted on a road bike is given a similar bicycle with 250 watt motor (that is not speed limited), the same effort from the cyclist would propel him or her at 40.5 km/h. This is a 24.6% increase in speed over 32.5km/h and a 55% increase in kinetic energy before considering the increased weight. A 75 kg rider travelling on a PAPC weighting 20 kg instead of a 10 kg road bicycle would carry a further 11.7% more energy. The increase in speed

[7] Email from Geoff Rose, Director, Institute of Transport Studies, Dept. of Civil Engineering, Monash University. August 15, 2008

and weight would require an additional 15 watts to compensate for the greater friction, but this small effect is not considered in this analysis.

This example shows that an "enthusiast" cyclist riding a "road bike type" PAPC is likely to carry 2/3 more energy at cruising speed. The road safety risks associated with the increased travelling speed and kinetic energy involved are considered unacceptably high. For this reason, a speed limitation on the power assistance mechanism is strongly recommended. (See Maximum Assisted Speed page 16)

The influence of bicycle weight on performance can be estimated from the same equations. During a hill climb of 5% gradient using only a 250 watt motor, the difference in climbing speed between a cheaper 35kg PAPC with a lead acid battery and a more advanced 20kg bicycle with a lithium-ion battery is a little over 1 km/h, or equivalent to having an additional 30 watts available on the heavier PAPC.

Finally, the following exercise estimates the greatest possible improvement in performance caused by a new PAPC definition. The estimate is made by comparing a heavier PAPC using a lead acid battery with a rated electric motor of 200w with 67% efficiency, an average measure according to the BIA Paper that translates into 134 watts of continuous power, and a lighter PAPC with a lithium ion battery and 250 watts of continuous power that represents a Japanese or European-built PAPC. The BIA Paper states that 'the power ratings of electric motors usually refer to the electrical power consumed by the motor. The useable power delivered by the motor will be lower than the rated power by the efficiency factor of the motor. … Small motors of below 750w typically have maximum efficiencies in the range 50% - 80%.'[8]

These two scenarios represent the lower end of the market in Australia against the higher end of the market in Europe with no significant power assistance from the cyclist. That would represent possible gains from a clarification of the definition and an increased competitiveness of the market.

terrain	134 watts 35kg bike max speed [km/h]	250 watts 20kg bike max speed [km/h]
flat	20	25.7
5% gradient	8	14.8
10% gradient	4.2	8.8

The most significant gains in speed are achieved in this extreme example when travelling on a hill of 5% gradient and higher.

Where to measure power

The common practice in the automotive industry is to refer to the power output measured at the engine, not at the wheel. Specifying detailed measurement methods could create confusion, especially in the case of a hub motor where the expression 'power measured at the shaft' could not apply. It is proposed to include the wording 'combined maximum continuous rated power'.

[8] Christie, Ian. Bicycle Industries Australia Ltd. Power Assisted Bicycles (PABs). A Comparison of the Theoretical Performance of 200 Watt and 300 Watt PABs.

For enforcement purpose, measuring the power at the wheel is the simplest method as it can be applied regardless of the power source and of the vehicle configuration. This methodology provides a slight underestimation of the power at the motor because the power losses in the drivetrain are not measured. Therefore if rear wheel power exceeds the limit, then the electric motor power will also exceed the limit.

A chassis dynamometer designed to measure the power of motorcycles could be used initially, as in an inquiry undertaken in Tasmania[9]. The same type of dynamometer is available in every State and Territory across Australia[10].

Effect of peak power and continuous power on electric motors

The proposed PAPC definition specifies that the power output is continuous, therefore a PAPC equipped with an electric motor of 250 watts continuous power will be able to deliver a greater amount of power for a limited time, depending on the characteristics of the motor and of the controller. The Canadian manufacturer BionX specifies that its motor with 250 watt continuous power output has a 450 watt peak power output, whereas the model with 350 watt continuous power has a 700 watt peak power[11].

The overload capacity is the ability of a drive to withstand currents above its continuous rating. It is defined by NEMA [National Electrical Manufacturers Association] as 150% of the rated full-load current for 'standard industrial Direct Current (DC) motors' for one minute.[12]

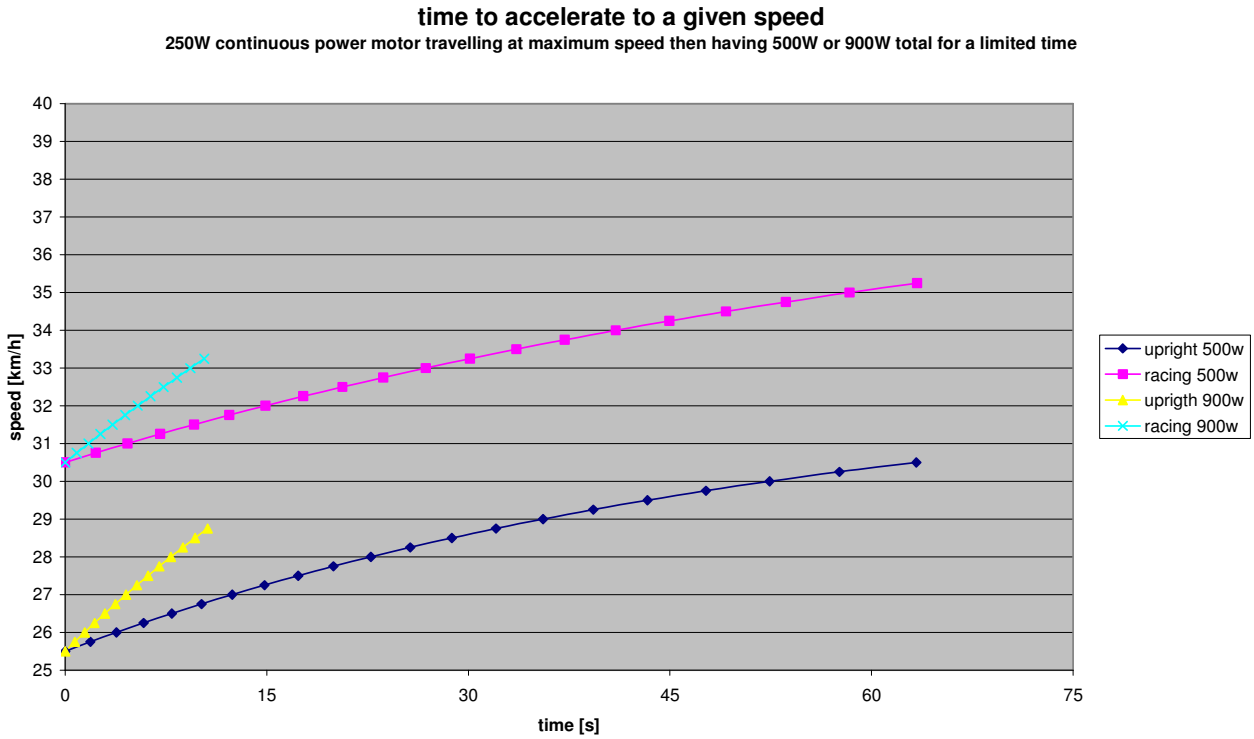
During a discussion with a local PAPC manufacturer, it was suggested that the maximum current output of the controller influences the possible peak power of the motor. In the case of a 36 volt battery combined with a 25 Ampere controller, the theoretical peak power of the motor would be 900 watts. It was estimated that the system could not sustain this power for more than 10 seconds.

The worst case scenario in terms of maximum achievable speed would be that peak power is available when the bicycle is already at top speed (on motor only). The extra power would then accelerate the PAPC for a given time. Two scenarios were analysed:

1. 500 watts delivered during one minute. The BionX motors can allow a peak power output of around 200% the continuous power output, and it is supposed, based on the NEMA definition, that this peak power can be sustained for one minute.

2. 900 watts delivered during 10 seconds, based on the discussion with the local manufacturer.

[9] TASELEC ELECTRICAL ENGINEERING. Product test report for the Department of Infrastructure Energy and Ressources Tasmania. June 2008.
[10] http://www.dyno.com.au/dyno/controller/locator/showDealers
[11] http://www.bionx.ca/en/main/default/45.shtml
12 http://www.engineersedge.com/motors/motors_definitions.htm



After one minute, the maximum speed of an upright rider would be 30.4km/h and would subsequently come down to a slower speed of 25.4 km/h without the extra peak power. A cyclist in racing position would, during the same time, go from 30.5km/h to 35.1 km/h, however this case is of less interest as it doesn't represent the typical user of a PAPC. Both scenarios using 900 watts during 10 seconds offer a smaller maximum speed.

In conclusion, the short speed burst created by a hypothetical peak power available at top speed would result in a low acceleration for a limited time, within the 85th percentile speed of a cyclist. In the case that a maximum assisted speed is required, the effect of peak power would be contained within the limits of the maximum assisted speed.

Maximum Assisted Speed

The objective of a maximum assisted speed is to ensure that the power assistance does not compromise safety by significantly increasing the speed at which the rider would normally travel on level ground without assistance. The previous analysis shows that a 250 watt power limit maintains the maximum speed on level ground within the limits of most unassisted pedal cycles. This assumption is based on the power output of an average cyclist. Faster cyclists would also benefit from motor assistance without a maximum assisted speed, although the relative benefit of assistance decreases sharply with an increase in travelling speed. The safest option would be to limit motor assistance to a certain speed above which the cyclist is providing all the motive power. For this reason it is proposed to require a maximum assisted speed of 25 km/h combined with the power restriction to 250 watts.

Two speeds are mentioned in the major overseas definitions. The European and Japanese definitions specify that the motor assistance must stop at 25 km/h and 24 km/h respectively. According to the previous power analysis, 233 watts are required to propel a rider with an upright position on flat ground at 25km/h, or 93% of the maximum proposed maximum value of 250

watts. The rider could add to this power in order to travel faster, but because power increases with a cubic relation to speed, it is believed the majority of the target riders would not travel faster than the 85th percentile speed as measured by Monash University.

The Canadian and American definitions mention a speed of 32km/h. This is not a maximum assisted speed, but rather an indication of the speed achievable on motor power only. In Canada, the British Columbia Motor Vehicle Act states: 'The motor of a motor assisted cycle must … not be capable of propelling the motor assisted cycle at a speed greater than 32km/h on level ground.'[13]
The 32 km/h speed limit, as described by the Canadian and American Regulations, cannot be seen as effectively limiting the speed achievable with motor assistance, because at speeds above 32 km/h, the motor can still assist the rider.

The Centre d'Évaluation du Vélo Électrique du Québec (CEVEQ) study found that riders perceived no benefit in using an electric bicycle if its propulsion assistance were limited to 23 or 24 km/h, since this speed is slower than their peak estimated speed of 30km/h, with or without assistance. Another reason cited in that study for the increase of the maximum assisted speed to 32km/h, compared to their initial proposal of 25 km/h, is the harmonisation with the US requirements.[14]

Prescription of the power source

The proposed definition does not require a particular source of power. The emphasis is on the power output and it is not desired to restrict the design options available to manufacturers. The most common alternatives are currently electric motors and petrol engines. In Europe, Japan and Canada, only electric motors are allowed, so it is foreseen that most of the potential imports from Europe and Japan would be propelled by electric motors. There are many concerns regarding petrol engines propelling vehicles restricted to a 200 watt power output. These concerns would remain valid with a 250 watts power output limit, and the following extract from a Regulatory Impact Statement on motorised scooters by the National Transport Committee summarises the main issues.

> The benefits of allowing electric motors include less noise, no exhaust emissions (common knowledge), a greater ability to identify the power of the motor, the ability to modify the output power of the motor without fitting a governor, and generally lower speed capability. However, petrol motors produce considerably more noise (and even more with a lesser exhaust system), more exhaust emissions (generally increasing with age and use), engine governors that are easily removed (anecdotal evidence suggests that in many cases instructions are given by the retailer or manufacturer on how to remove the governor) and are capable of higher speeds.
>
> The current motor output power requirement is 200W, and this Regulatory Impact Statement recommends that remain. Anecdotal evidence suggests that there are few, if any, petrol powered motorised scooters [i.e. foot scooter with a petrol engine attached] on the market with an output power under 200W…
> Conversion tools available on the Internet show there are about 15 to 17cc to 1 horsepower, and 1 horsepower is about 745.7W (see also Commonwealth National Measures Regulations 1999, Schedule 11). Using this formula, 200W would be provided by roughly 4cc. The lack of precise conversion factors clearly demonstrates the difficulty in establishing the output power in watts for petrol motors. This makes compliance

[13] http://www.qp.gov.bc.ca/statreg/reg/m/motorvehicle/151_2002.htm
[14] APRIL 2001, Canada Gazette Vol. 135, No. 8.Part II Statutory Instruments 2001 SOR/2001-109 to 129 and SI/2001-44 to 47 Pages 630 to 689

> unenforceable. In any case, the examples vary from 750 to 2155W, and are indicative of most petrol powered motorised scooters available on the market, and well in excess of the current 200W requirement.
> A model aeroplane motor at 7.5cc can also be considered for comparison purposes. Using the above scenario the aeroplane motor would range from 328 to 374W (in excess of the required 200W): model aeroplane motors are much smaller than those fitted to motorised scooters.
>
> Alternatively, petrol powered motors under 200W could be permitted. However, for this to work effectively, a regime of testing and certification would need to be developed and set in place so that users of these devices can be satisfied that what they are buying meets legislative requirements. This regime would also be needed by enforcement agencies so that they too can determine whether a particular device meets the requirements. It is considered that the cost and logistics of setting up this type of regime (satisfactory to the judiciary) would far outweigh any benefits in allowing petrol powered motorised scooters to be used on road and road-related areas.[15]

It must be emphasised that the comment in the last paragraph on the testing and certification applies to electric motor as well.

In summary, petrol engines, or more generally internal combustion (IC) engines, are noisier than electric motors and it is unclear how many, if any, IC engines on the market are generating less than 250 watts. On the other hand, mandating a particular power source restricts possible innovations where the main objective from a road safety point of view is to limit the power output, not the type of power source.

Identification plate or label

The objective of a standardised identification is to facilitate enforcement by providing agencies with a simple way of determining at the side of the road as to whether a vehicle complies with the definition of a PAPC or not.

To facilitate the enforcement of the PAPC definition, it is proposed to have a durable label affixed by the manufacturer in a conspicuous location to certify that the power-assisted pedal cycle complies with the relevant ADR definition. This would be simpler and more cost effective than requiring the Australian Federal Government to certify every PAPC model entering the country. Such a label is similar to the Canadian approach[16.]

The labelling requirement would be issued by each Jurisdiction in a consistent way and will not be explicitly mentioned in the ADR definition. To ensure consistency across Australia, the requirements for an identification plate or adhesive label should be in accordance with the Australian Motor Vehicle Certification Board's Circular 0-3-2 'Identification Plates', except from the need for an approval number. It is proposed that the durable label refers to an individual identification number permanently marked on the frame and the main components of the powertrain. Considering the high market value of some PAPC models, permanent identification marks would facilitate the retrieval of stolen PAPCs and render their rebirth more difficult.

[15] National Transport Committee, SAFETY OF SCOOTERS AND OTHER WHEELED RECREATIONAL DEVICES - Regulatory Impact Statement. July 2005

[16] http://canadagazette.gc.ca/partII/2001/20010411/html/sor117-e.html

Enforcement

For enforcement purposes, the maximum power output is verifiable with a motorcycle dynamometer as explained in the section 'Where to measure power'. A verification that pedalling is needed to get assistance from the motor will be sufficient to confirm that a PAPC is a vehicle designed to be propelled through a mechanism solely by human power to which is attached one or more auxiliary propulsion motors. This will assist with enforcing the provisions consistent with the result of the case *Matheson v Director of Public Prosecutions*[17] where a person was identified as riding a vehicle deemed not to be a bona fide PAPC based on the fact that this person was observed riding the vehicle while not pedalling.

The use of an identification plate or label as discussed above will assist in the on-road enforcement of these provisions.

Note: penalties against manufacturers or importers who do not comply with the technical specifications are not discussed in this Paper.

[17] http://www.austlii.edu.au/au/cases/nsw/supreme_ct/2008/550.html

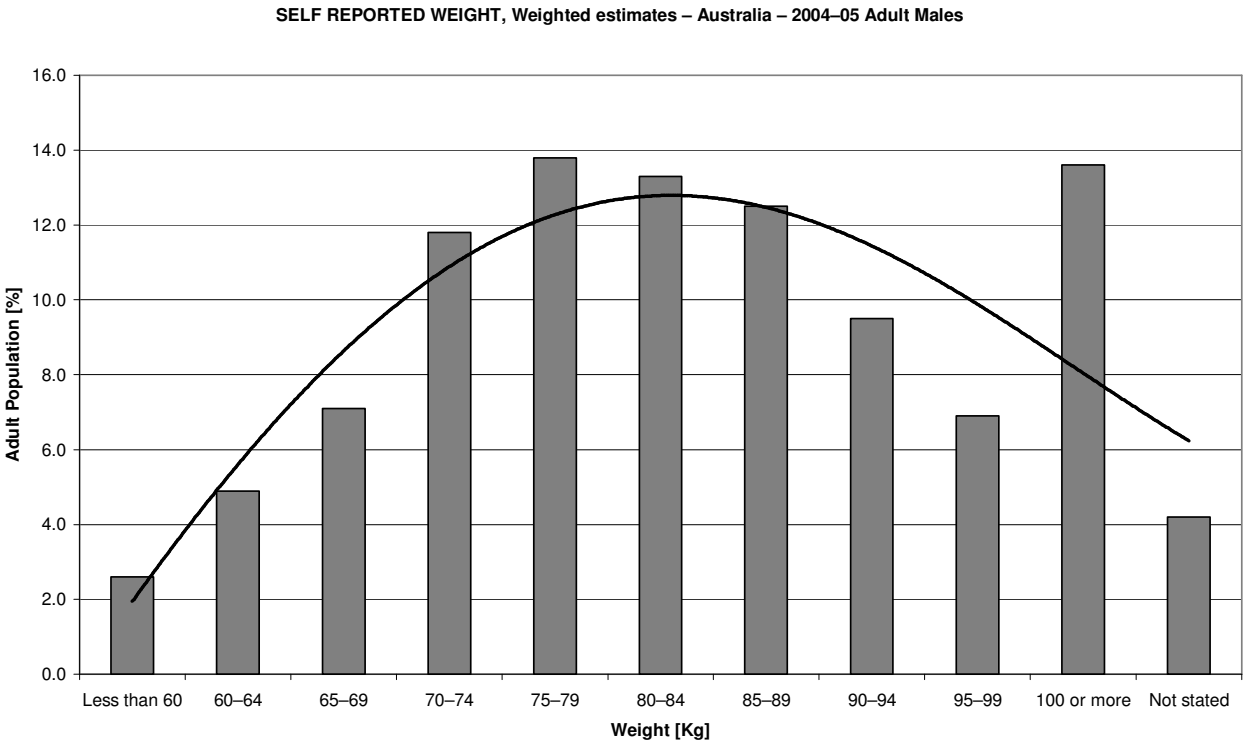
General notes on safety

Additional weight of PAPCs

PAPCs are heavier than similar pedal cycles because of the additional weight of the powertrain and energy storage device, usually a combination of battery, controller and electric motor or internal combustion engine and a fuel tank. PAPCs weights vary from less than 20 kg for some Japanese models up to almost 40 kg for some heavier Australian models.
To assess the possible impact of the weight difference between PAPCs and pedal cycles, the following analysis will consider:

- A 14 kg 'hybrid' style pedal cycle,[18]
- A 21 kg PAPC, typical of the light European models available,[19] and
- A 36 kg PAPC with lead acid battery available in Australia[20].

Considering a 75 kg rider, a 21 kg PAPC represents an increase of 8% in weight compared to the same rider on a pedal cycle, whereas a 36 kg PAPC represents an increase of 25%. While pedal cycle weights vary between models and types, the weight of the rider will also vary between individuals. Data from the Australian Bureau of Statistics' National Health Survey 2004-2005 can help estimating this weight variation, based on self reported weights. Below is the weight distribution of adult males aged 18 years old and over[21].



It can be argued that the difference between a 'hybrid' type pedal cycle and the lightest PAPCs is of similar magnitude to the variation in weight for the adult male population in Australia and that the heavier the individual, the smaller the relative impact of the additional weight of the PAPCs. Nevertheless, the impact of a heavier PAPC will be assessed in the worst case scenario: a 36 kg PAPC compared to a 14 kg bicycle ridden by the same person.

[18] Pedal Cycle Seller website with an extensive list of pedal cycle weights. http://www.thebicycleescape.com/bicycleweights.html
[19] Extra Energy Test Report 2007. www.extraenergy.org
[20] Cruiser Nomad model from the Electric Bicycle Company. http://www.electricbicycle.com.au/cruiser_nomad.html
[21] Australian Bureau of Statistics' National Health survey 2004-2005. http://www.abs.gov.au.

The two main safety impacts of a heavier pedal cycle or PAPC are the increased energy in the case of an impact with a vulnerable road user and the increased braking distance.

Impact with a vulnerable road user

A heavier PAPC travelling at the same speed as a lighter pedal cycle will carry more energy in the case of an impact. The increase in energy is directly proportional to the increase in weight, therefore a PAPC and rider combination that is 25% heavier will carry 25% more energy, increasing the risk of inducing more damage in the case of a crash. Speed is significantly more important in this scenario, where a 25% speed increase with the same weight would result in 56% more energy to be dissipated in a crash. The literature review that follows in the next section suggests that serious crashes between a pedal cycle rider and another vulnerable road user are rare.

Increased braking distance

The comparative braking distance on a pedal cycle can be calculated using the following two scenarios. The first scenario is when braking capability is limited by weight transfer lifting the rear wheel off the ground, a scenario more common on pedal cycles with a shorter wheelbase and powerful brakes. Provided that the rider can apply a greater force on the levers than the one necessary to lift the rear wheel off the ground, the additional mass of a PAPC may reduce the braking distance compared to a similar pedal cycle because the typical battery and motor locations would lower the centre of gravity of the PAPC and rider combination. A lower centre of gravity helps preventing rear wheel lift-off that is caused by weight transfer.

The second scenario is where braking is limited by the force that can be applied on the brakes. It can be limited by the hand strength of the rider, or by the design of the brakes that can be found on cheaper or older pedal cycle models. This is the worst case scenario where additional weight is added on a vehicle which braking system is already reaching its limit. In this case, the braking distance is increased proportionally to the weight of the rider and PAPC combination.

In conclusion, the additional weight of PAPCs, compared to similar pedal cycles, increases the energy dissipated in a crash and can increase the braking distance when the braking system is limiting the achievable deceleration. Both the energy and the braking distance increase proportionally with the total weight of the rider and PAPC. The weight difference between PAPCs and pedal cycles can be minimised by using recent technology, especially regarding battery types. Lithium-ion batteries offer a significant weight reduction and increased durability compared to lead-acid and Nickel Metal Hydride batteries, at a price premium. The use of good quality brakes, already widely available on the market, would also minimise the impact of additional weight for riders with sufficient hand strength. Weight is a major impediment to performance, usability and range, therefore it is reasonable to predict that consumers will prefer lighter models if their prices are competitive.

Literature review on bicycle safety

A consequence of the proposed change to the PAPC definition may be to increase the number of cyclists on the roads by allowing a greater variety of products that can provide an increased assistance to the cyclist. A literature review has been conducted to better understand the circumstances of crashes involving bicycles and the effect of increasing the number of vulnerable road users on the roads.

The Centre for Automotive Safety Research (2008)[22] studied bicycle crashes in South Australia. The following findings concern pedal cyclist casualties aged 16 and over in the period 2001-2004:

- 87 per cent of the pedal cycle crashes in the dataset involve a moving motor vehicle. (A great number of cyclists who are injured without a motor vehicle being involved do not report their crash.)
- The majority of casualties occur at intersections.
- 93 per cent of casualties occur on roads where the speed limit is 60 km/h or lower.
- Crashes termed 'right angle' were the most common. Going straight ahead at the time of the right angle collision was the most common movement of both the pedal cycle and the motor vehicle.
- The researcher's interpretation is that there is some real effect (on the probability of the injury being serious) of speed of motor vehicle (tending to be slower at intersections) and of relative velocity of the motor vehicle and the pedal cycle (tending to be less when they are moving in the same direction), but that whether this shows up as statistical significance of one or more of the available variables depends on exactly which of these are in the equation.

Austroads (2006)[23] examined the minimisation of conflicts between pedestrians and cyclists on shared paths and footpath. Some relevant extracts:

- A report on Pedestrian and Cyclist Safety from the TravelSafe Committee (1993) states that the main cause of fatal bicycle accidents is the collision with motor vehicles. The report comments that segregating cyclists from road traffic provides clear safety benefits to cyclists. Integration of cyclists with pedestrians may cause an increase in pedestrian/cyclist accidents. However, these will be considerably less severe than cyclist/motorist collisions which often result in serious injury or death to the cyclist.

- A study carried out for the UK's Department for Transport by the Transport Research Laboratory has shown that crashes occurring in these areas [shared paths] are 'very rare' (only one pedestrian/cyclist accident in 15 site years) in the sites studied (Department for Transport 1993).

- Graw & König (2002) produced a report on fatal pedestrian-bicycle collisions which investigated the circumstances of such crashes. Again the relative rarity of bicycle/pedestrian collisions is stated. Findings included:
    - the cyclist is usually the cause of the crash though the pedestrian suffers the more serious injuries
    - cyclists involved in the crashes are usually young persons, whilst seniors are the most likely pedestrian victims.

[22] Hutchison et al. Bicycle crashes in South Australia. Centre for Automotive Safety Research. 2008

[23] Austroads. Pedestrian-Cyclist Conflict Minimisation on Shared Paths and Footpaths. AP-R287/06. 2006.

- Stutts, JC & Hunter, WW(1999) carried out a survey of a total of 2558 persons treated for injuries incurred while bicycling or walking, at eight hospital emergency departments over a one year period in three US states. The results show that only 0.8% of people injured occurred in a pedestrian-bicycle collision.

- Pedestrians have taken issue with speeds at which cyclists travel on shared paths (Road Safety Council 1998a and correspondence from the Pedestrian Council). The current Australian road standards for design specify that shared paths must be able to accommodate the range of speeds at which cyclists travel, recommending that standard shared footways should accommodate cyclists travelling at up to 30 km/h, and that where it services a high proportion of commuting cyclists it should be up to 50 km/h (McInnes, 1998).

- In the long term, however, widening paths and separating pedestrians and cyclists and creating safe on-road alternatives for higher speed cyclists may be the best solutions.

The Australian Transport Safety Bureau (2006)[24] gives an overview of the circumstances of road crashes in which cyclists died in the period 1991 to 2005. Findings include:

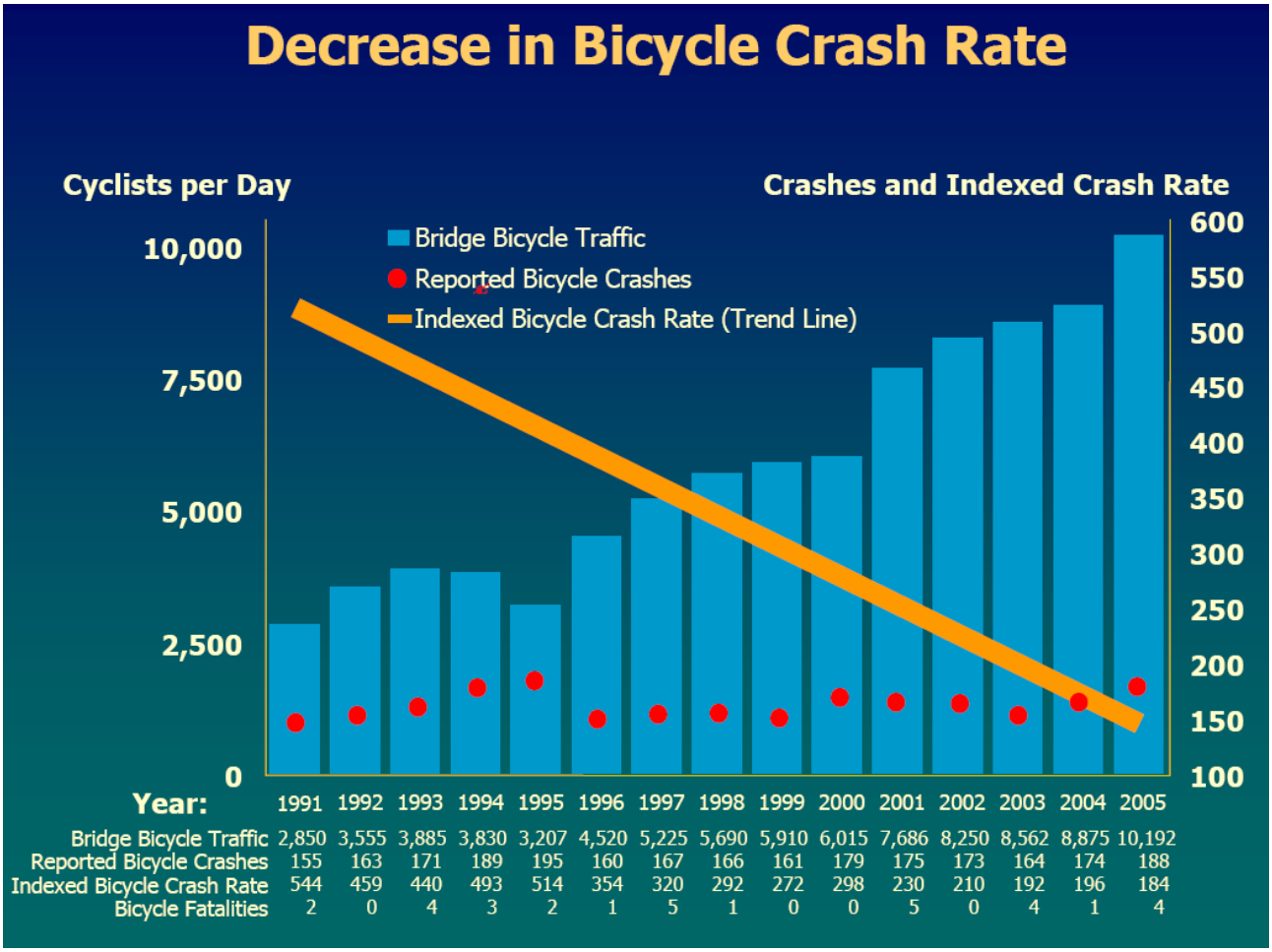
- The most common type of crash in which cyclists were fatally injured was the cyclist being hit from behind by a motor vehicle travelling in the same lane in the same direction. …The next most common crash type was the cyclist riding from the footway into an intersection or onto a road and being hit by an oncoming motor vehicle.
- In each of the 5-year periods since 1990, the largest proportions of cyclist deaths have occurred on roads where the speed limit was 60 km/h.
- About 86 per cent of cyclist deaths resulted from a collision between their bicycle and a motor vehicle.
- In the 46 crashes where the cyclist was run over from behind, 10 of the motor vehicle drivers failed to observe the cyclist, 5 drivers were under the influence of alcohol or drugs and the vision of 5 drivers was obscured for some reason, e.g. glare. For the other crashes, the reasons were many and varied or unknown.
- In over 60 per cent of crashes, the cyclist was deemed to be 'responsible' for the action that precipitated the fatal crash. This was particularly the case in crashes at intersections where the cyclist was either riding through the intersection on the road or moving from the footway onto the intersection.

The Regulatory Impact Statement done in Canada regarding the introduction of a power-assisted pedal cycle definition states that cyclists felt safer with a PAPC than a conventional bicycle because they had more power from standing start and were more likely to obey stop signs as the vehicle is easier to start again.

[24] Deaths of cyclists due to road crashes. ATSB ROAD SAFETY REPORT. July 2006

A study conducted in Oregon[25], in the United States, found that crash rate for cyclists decreased with an increase in the number of cyclists. The number of cyclists in a particular area was monitored along with cycling crashes. The increase in cycling was partially due to an improvement in the quality of the infrastructure. The following table shows the improvement in pedal cycle crash rate.

Decrease in Pedal Cycle Crash Rate



Jacobsen (2003)[26] found that:

- The likelihood that a given person walking or bicycling will be struck by a motorist varies inversely with the amount of walking or bicycling overall. This pattern is consistent across communities of varying size, from specific intersections to cities and countries, and across time periods.
- A motorist is less likely to collide with a person walking and bicycling if more people walk or bicycle. Policies that increase the numbers of people walking and bicycling appear to be an effective route to improving the safety of people walking and bicycling.

[25] Source: Birk M., Geller R., 2007 On-Street Bikeways and Off-Street Trails: An Integrated Approach: Overview, State of Oregon, United States.
http://www.ibpi.usp.pdx.edu/media/IBPI%20Bikeways%20Course.pdf

[26] Jacobsen P.L., 2003 Safety in numbers: more walkers and bicyclists, safer walking and bicycling, Injury Prevention, Vol. 9, p. 205 – 209.

Robinson (2005)[27] verified if Australian data followed the same rule showed by overseas research where fatality and injury risks per cyclist and pedestrian are lower when there are more cyclists and pedestrians. It was found that as with overseas data, the exponential growth rule fits Australian data well. If cycling doubles, the risk per kilometre falls by about 34%; conversely, if cycling halves, the risk per kilometre will be about 52% higher.

Litman and Fitzroy (2005)[28] found that as non-motorised travel increases in a community, both total per capita traffic casualty rates and per-mile pedestrian and cyclist crash rates tend to decline. …In summary, although non-motorised travel is more hazardous to users per mile of travel, for various reasons increased non-motorised travel tends to reduce total traffic risk in a community.

Greater London Authority (2007)[29] states that Transport for London is making real progress improving safety for cyclists. Against an increase of 83 per cent in cycling since 2000, the number of cyclists killed or seriously injured on London's roads has fallen by 28 per cent compared with the Government's baseline figures from the mid to late 1990s.

Relevance to PAPC

Firstly, the most common type of serious bicycle crash involves motor vehicles, where the two most common types are collisions at intersections and bicycles being hit from behind while travelling in the same direction. It may be suggested that an increase speed capability of PAPC on hills may reduce the speed differential between motor vehicles and bicycles therefore reducing the severity of crashes where cyclists are hit from behind. However, the factors for these crashes cited in ATSB (2006) (failed to observe the cyclist, influence of alcohol or drugs and the driver's vision obscured) do not lead to the assumption that the likelihood of such crashes would decrease with a decrease in speed differential between motor vehicles and cyclists.

Secondly, a variety of sources present crashes between cyclists and pedestrians as a 'rare occurrence', which is supported by crash data from NSW: an analysis of pedestrian crashes in NSW between 1997 and 2007 reveals that 3 pedestrians were killed and another 334 were injured following a collision involving a cyclist but no motor vehicle, which represents 0.29% of pedestrians killed and 1.16% of pedestrians injured in all crashes during the same period. While cyclist speed is a concern for pedestrians sharing their path with cyclists, the analysis summarised in this document shows that the maximum cycling speed on a flat terrain is not affected significantly, therefore the impact on both perceived and real safety for pedestrians should be minimal.

Thirdly, a potential increase in the number of cyclists due in part to an increase in product variety and assistance capability could lead to a reduction of crash rates for bicycles. It must be mentioned that some studies supporting this claim saw an increase in cycling following significant investments in cycling facilities. Without a comparable improvement in cycling facilities across Australia, it is uncertain if the potential increase in cycling and related crash rate reduction will occur.

[27] Robinson, Dorothy L. Safety in numbers in Australia: more walkers and bicyclists, safer walking and bicycling. Health Promotion Journal of Australia 2005:16, pp.47-51

[28] Litman T., Fitzroy S., 2005 Safe Travels: Evaluating Mobility Management Traffic Safety Impacts, Victoria Transport Policy Institute, Victoria, Canada. http://www.vtpi.org/safetrav.pdf

[29] Greater London Authority, 2007 The Mayor announces huge rise in cycling in London, Media Release, 1st May. http://www.london.gov.uk/view_press_release.jsp?releaseid=11791

Transition to new definition and treatment of existing power-assisted pedal cycles

The proposed definition would necessitate all new PAPCs to comply with a revised 'Vehicle Standard (Australian Design Rule - Definitions and Vehicle Categories)' from the implementation date. It should not be necessary to undertake a Regulatory Impact Statement regarding the increase in power output as this is a relaxation of the current situation. Similarly, the need to pedal in order to obtain motor assistance is in line with the concept that the motor is auxiliary and human power is the main power source. The maximum assisted speed may be perceived as an additional restriction compared to the current situation and this issue would need to be discussed further. Once an agreement is reached and a timeframe is established for the modification of the ADR definition, the bicycle industry should be informed in a timely manner to allow for the manufacturing or import of products compliant to the new definition.

The labelling requirements would be implemented at a jurisdictional level in a consistent manner, allowing for a parallel implementation to the ADR definition change process. Current products are not required to be labelled, so an enforcement strategy for such PAPCs excluded by the labelling requirement would have to be developed.

Proposed next steps

The comments of the various stakeholders will be collected and collated by the NSW Centre for Road Safety. A workshop will then be held to seek an agreement on the replacement of the current PAPC definition featured in the ADRs. An agreement on the labelling scheme and its implementation is also desirable and will be discussed at the same workshop.

Appendix B - Overseas requirements

Table 1. Summary of PAPC requirements around the world

Country	Need to pedal to be motor-assisted	Maximum power output [watts]	Power reduction before cut-off	Maximum assisted speed* [km/h]
Australia	NO	200	NO	none
New Zealand	NO	300	NO	none
Europe	YES	250	YES	25
Japan	YES	250**	YES	24
Canada	NO***	500	NO	none
USA	NO	750	NO	none

*From this speed the motor does not help propelling the pedal cycle and the rider must provide all the power.

**According to Parker (2006)[30], although the Japanese standard does not specify a maximum power output, none of the 47 Japanese models available in 2006 were over 250 watts. The Japanese definition of a PAPC, described in the following pages, is based on the input torque from the rider and the vehicle speed.

***Minimum speed to obtain assistance is 3km/h if no on/off switch is available

A sample of PAPC models built to the specifications described above is available in Appendix D.

New Zealand – Extract from the New Zealand Land Transport website

A *Gazette* notice was issued on 2 February 2006 by the Director of Land Transport declaring power-assisted pedal cycles powered by a motor with a maximum power output not exceeding 300 watts not to be motor vehicles. [31]

European Union – Extract from the European Commission website

Cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0.25 kW [250 watts], of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling,[32]

The European Union (EU) Directive 2002/24/EC came into effect on May 9, 2003 and replaced the Directive 92/61/EEC.

After May 9, 2003, the EU Member States had the choice of either keeping their current regulations for another 6 months or changing over to the EU-directive. Since November 9, 2003 all Members of the EU are required to integrate this Directive into their national legislation and abolish their previous regulations.[33]

[30] Parker, A.A. (2006). Electric Power-Assisted Bicycles Reduce Oil Dependence and Enhance the Mobility of the Elderly. 29th Australian Transport Research Forum

[31] http://www.landtransport.govt.nz/importing/notice-low-powered-vehicles.html

[32] 2002-24-EC type-approval of two or three-wheel motor vehicles 18 March 2002

[33] http://www.extraenergy.org/main.php?language=en&category=information&subcateg=39&id=384

Implementation of a new PAPC standard in Europe including magnetic compatibility

The new European standard EN 15194 for EPACs (Electrically Power Assisted Cycles) is far more complicated than the European Committee for Standardisation (CEN) standards currently in force for conventional bicycles. This standard is expected to be published on 30 April 2009.

The CEN Technical Committee TC333, with representatives from the bike industry and headed by Chairman Siegfried Neuberger from the German industry association Zweirad-Industrie-Verband (ZIV), expects the safety standard to be published in April 2009, along with an annex detailing Electro Magnetic Compatibility (EMC) requirements. These EMC requirements contribute significantly to the complicated and costly new safety standards for electric bicycles.

EMC requirements are already applied throughout Europe to all kinds of electric appliances and vehicles like cars, motorcycles and mopeds. EMC requirements are designed to, for instance, ensure the safety of people who use a pacemaker or hearing-aid when driving cars or e-Bikes.

Once vehicles that use electronics have passed EMC testing they obtain a European conformity mark (CE mark). According to the publication Bike Europe, all the e-Bikes (pedelecs) that are currently on the market meet the EMC requirements already in force throughout Europe.

Pedelecs that are to comply with the new EN 15194 EPAC safety standard will have to be tested in the same way as cars, motorcycles or mopeds. That means that, as TC333 chairman Siegfried Neuberger points out: 'Complete bikes and/or electronic/electrical subassemblies will have to be tested.'[34]

Canada

The current regulation specifies components for power-assisted bicycles including a maximum of three wheels, one or more electric motors that can assist the cyclist up to a speed of 32 km/h and that do not exceed a total output of 500 watts, and an on/off switch or mechanism that prevents the motor from being engaged until the bicycle reaches a speed of three km/h.

Power-assisted bicycles must also comply with the requirements of provincial and territorial regulations. Each province or territory may adopt the federal definition as is or add further restrictions to meet their own specific needs.[35]

The Canadian approach towards PAPCs seems different in some aspects to the proposal elaborated in this document. The Insurance Corporation of British Columbia, a Canadian Crown Corporation responsible for licensing and insurance at a provincial level, provides examples of vehicles that they consider as power-assisted bicycles. In the following illustration found on their website, the red vehicle looks similar to heavy mopeds with pedals with an excessive width between pedals that do not allow them to be propelled by human power for any length of time, therefore rendering the motor as the main source of power.

[34] http://www.bike-eu.com/news/3086/big-changes-ahead-for-european-e-bike-market.html
[35] http://www.tc.gc.ca/mediaroom/backgrounders/b01-R050.htm

What is a Motor-assisted cycle (MAC)?
A MAC is a two-or three- wheeled cycle with a seat, pedals and an electric motor that is 500 watts or less. MACs cannot be gas-powered.

MACs can range widely in appearance: from a bicycle with a small-sized motor to a scooter with bike pedals. [36]



Different examples of Motor Assisted Cycles

While the Canadian approach is still useful as a reference, further examples from their decision making process should be taken with the consideration that their conclusion differs from what is suggested through this document.

USA – Extract from Public Law

The term 'low-speed electric bicycle' means a two- or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 h.p.), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds [77.3 kg], is less than 20 mph [32 km/h].[37]

[36] http://www.icbc.com/registration/reg_rules_low_pwr_mtr_asstd_cycles.asp

[37] 116 STAT. 2776 PUBLIC LAW 107–319—DEC. 4, 2002

Japan – Based on an extract from a conference on bicycles in Taipei

Rule 3, Article 1, the Implementation Rules for the Road Traffic Law (the Prime Minister's Office Order) Standards established in the Prime Minister's Office Order of 2, No. 11, Item 1, Article 2, Standard Law of Bicycles Using Power Sources to Assist Human Energy is described as follows:

1. Power sources used for assisting human energy are those that match all of the following conditions.

A. Are Motors.

B. At speeds below 24km/h, power sources provide assistance to human energy at a rate 'X' that follows the rules described below:

(1) Speed below 15km/h
X = 100% of human energy

(2) Speed over 15km/h and below 24km/h
X = (1- [speed (km/h) - 15] / 9)% of human energy

C. Power sources do not provide any assistance at speed over 24km/h.

D. Power sources compliant with requirements A to C are designed to prevent any easy modification rendering them non-compliant with any of these requirements.

2. The operation of power sources assisting human energy is smooth, reliable and does not create any hindrance to the user.

Relation between Assist Rate and Speed

Rule 3, Article 1, the Implementation Rules for the Road Traffic Law (Prime Minister's Office Order) B and C of Standard 1 for bicycles that use prime movers to assist human energy (hereinafter referred to as 'assist rate')…:

1) At speeds below 15km/h, the assist rate is below 1:1.

2) At speeds over 15km/h and below 24km/h, the assist rate reduces with an increase of speed down to nil at speed over 24km/h.[38]

Japan – Amendment to the definition to allow higher assistance on hills at low speed

A Cabinet Office regulation enforced on December 1, 2008 that revises the drive assist ratio for the motor drive-assisted bicycles that is provided in the road traffic law enforcement regulations.
The ratio of motor power to human power (assist ratio) will become 1:2 at speeds of less than 10 km/h.[39]

[38] April 1, 2001. Masatoku Kokayu, Officer, PAS Business Department, Yamaha Motor Co., Ltd. Regulations on Electric Bicycles in Japan. Conference of Safety Popularisation for Electric Assist Bicycles

[39] http://www.eneloop.info/fileadmin/EDITORS/Portal/PRESS_RELEASES/1201_SANYO_eneloop_bikeNR.pdf

Appendix C - Example of power-assisted pedal cycles conforming to various legislation

Country's legislation	Model	Photo	Price[40] [AUD]	Weight [kg]	Power [watts]	Battery
Australia	Currie I-Zip Mountain Trailz Enlightened		$2,395	22	200	NiMH
New Zealand	Ezee Hi-Torq II speed bike		$2,528	25.6	300	NiMH
Europe	Schwinn Campus		$2,007	~18-20	250	Li-ion
Japan	Kalkhoff Pro Connect		$3,125	23.2	250	Li-ion
Canada	Heinzmann Estelle Comfort 26 'E-bike'		$3,261	25	500	NiMH
USA	Optibike		$9,339	21.8	800	Li-ion

[40] Prices as of June 2008. Shipping cost not included. Some models would need to be sourced overseas.