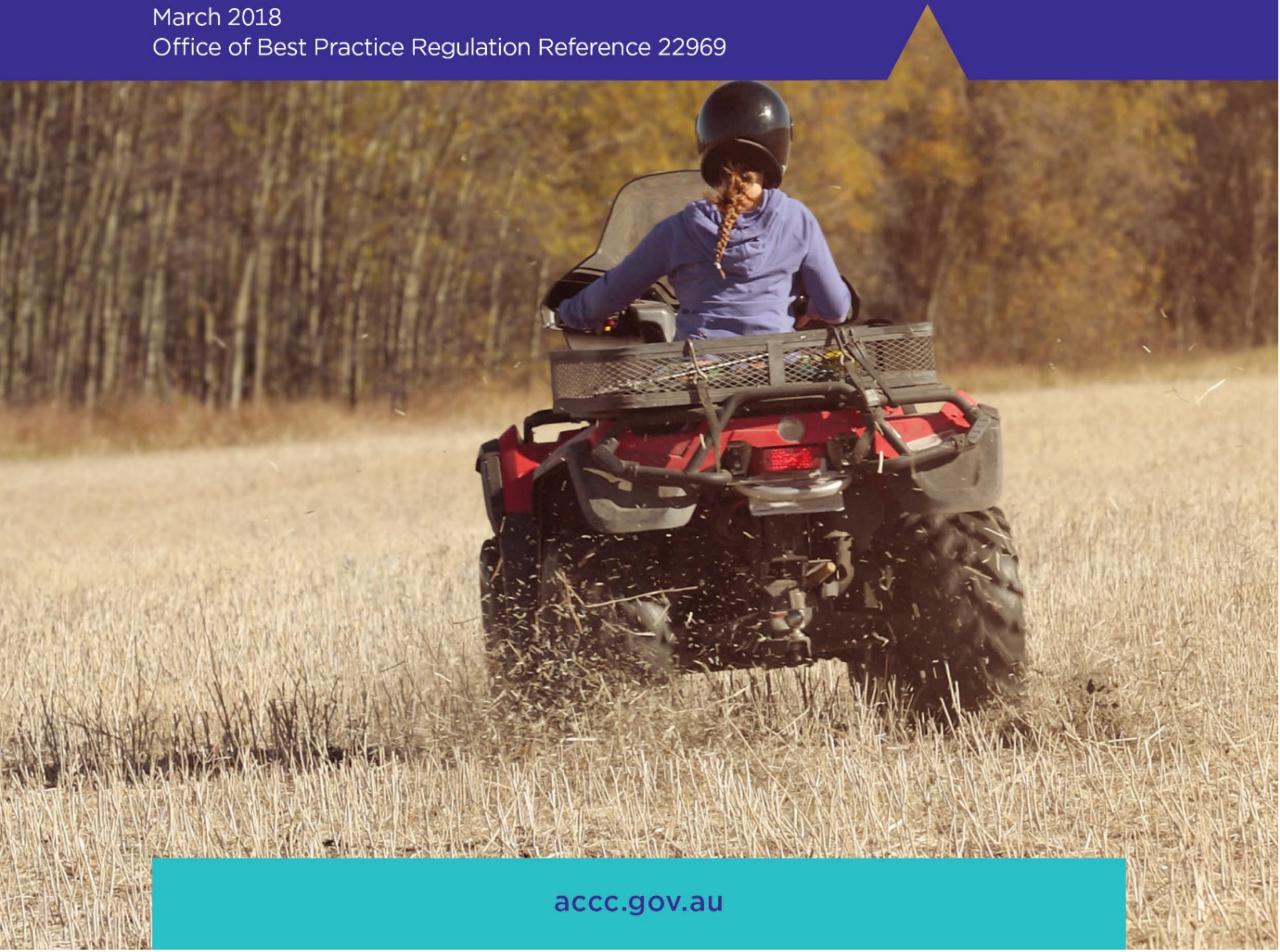
AUSTRALIAN COMPETITION & CONSUMER COMMISSION

Quad bike safety

Consultation
Regulation Impact Statement

March 2018
Office of Best Practice Regulation Reference 22969



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Glossary

Term	Definition
ACCC	Australian Competition and Consumer Commission
ACL	Australian Consumer Law, Schedule 2 of the *Competition and Consumer Act 2010.*
ANCAP	Australasian New Car Assessment Program
ANSI	American National Standards Institute
ANSI/SVIA 1–2010	American National Standard for Four-Wheel All-Terrain Vehicles Equipment Configuration, and Performance Requirements (2010 version)
ANSI/SVIA 1–2017	American National Standard for Four-Wheel All-Terrain Vehicles Equipment Configuration, and Performance Requirements (2017 version)
AORVA	Australasian Off Road Vehicle Association
ATVs	All-terrain vehicles (where possible referred to as quad bikes in this Consultation Regulation Impact Statement)
CARRS-Q	Centre for Accident Research and Road Safety – Queensland
CCA	*Competition and Consumer Act 2010* (Cth)
Consultation RIS	Consultation Regulation Impact Statement
CPD	Crush protection device – a device mounted to quad bike to minimise the risk of the rider being crushed by the vehicle if it rolls over.
CPSC	Consumer Product Safety Commission
DALY	Disability-Adjusted Life Year
EU	European Union
EU Regulation	EU Regulation 168/2013
FCAI	Federal Chamber of Automotive Industries
HORC Framework	Hierarchy of Risk Control Framework
HWSA	Heads of Workplace Safety Authorities
IDC	Inter-Departmental Committee for Quad Bike Safety
Issues Paper	Issues Paper on Quad Bike Safety released by the Australian Competition and Consumer Commission on 13 November 2017
NFF	National Farmers Federation
NPV	Net Present Value
OBPR	Office of Best Practice Regulation
OPDs	Operator protection devices, includes both CPDs and ROPSs
RACS	Royal Australasian College of Surgeons

RIS	Regulation impact statement
Rollover	Includes lateral, forward and rearward rolls
ROPS	Rollover protective structure – a protective structure that encloses the rider and should be used in conjunction with seatbelts.
ROHV	Recreational Off-Highway Vehicle
SEA	SEA Limited
SSVs	Side-by-side vehicles (also known as 'utility task vehicles' (UTVs))
SVIA	Speciality Vehicle Institute of America
TTR	Table Tilt Ratio
TRG	Technical Reference Group established by the Inter-Departmental Committee
UNSW TARS	University of New South Wales Transport and Road Safety Research Unit
UNSW TARS Project	University of New South Wales Transport and Road Safety Quad Bike Performance Project
US Standard	ANSI/SVIA 1–2017 for Four-Wheel All-Terrain Vehicles Equipment Configuration, and Performance Requirements
VISU	Victorian Injury Surveillance Unit

Vehicle types

For the purposes of this Consultation RIS, Quad Bikes and Side-by-Side Vehicles are referenced as below.

General-use model (marketed as Utility quad bikes in Australia)	A quad bike intended for recreational and/or utility use by an operator age 16 or older	
	A quad bike intended for recreational and/or utility use by an operator age 16 or older with or without a passenger	
Sport model	A quad bike intended for recreational use by an experienced operator, age 16 or older	
Youth model (sometimes marketed as 'Fun ATV' in Australia)	A quad bike of appropriate size intended for recreational use under adult supervision by an operator under age 16	
Side-by-side vehicle	Motorised off-road vehicle for an operator who remains seated and controls the vehicle by using a steering wheel, has the ability to carry one or more passengers and is fitted with a rollover protection system	
Polaris Ace ®	Motorised off-road single seat vehicle for a single operator that remains seated and controls the vehicle by using a steering wheel and is fitted with a rollover protection system	

Questions for response

Questions and points for feedback:

1. The ACCC has proposed five options. Which is your preferred option and why do you prefer it to the others?
2. If you are a quad bike manufacturer, importer or retailer what impact will these options have on your business? For example, how much will it cost to implement each of the requirements, (design changes and testing), and what is the likely effect on sales and the model range?
3. If you are a quad bike user what would be the impact of the proposed options?
4. What effect will each of the proposed options have in saving lives and reducing deaths?
5. The US Standard requires a number of general warning labels to be affixed to the quad bike. The ACCC is proposing additional labels and information in the owners' manual, alerting the operator to the risk of rollovers and differential selection. Provide comment on these two additional labels (see section 8.6)
6. Provide comment on the current model of the safety star rating system (see Attachment A).
7. In Option 3, the ACCC has suggested some safety and operational criteria that an Operator Protection Device (OPD), designed to protect the operator in the event of a rollover, could meet. What are your views on the proposed criterion an OPD may be required to meet? Should additional criteria be imposed?
8. Provide comment on the minimum performance criteria (see Attachment D) and the requirement for general-use model quad bikes to be able to have all wheels of the vehicle be able to rotate at different speeds, referred to in Option 4.
9. Options 3, 4 and 5 do not propose additional design solutions for SSVs and sport and youth quad bikes. If your view is that one or more of these vehicles should be subject to additional design solutions to improve safety, do you have information and data you can provide to the ACCC in support of this view?
10. Provide comment on the transition period for the proposed options (see Section 8.8).
11. Provide any additional information or data that you think may be useful to informing the ACCC's recommendation to the minister.

1. Executive Summary

The impact of the deaths and injuries attributed to the operation of quad bikes (also known as All-Terrain Vehicles or ATVs) and Side-by-Side Vehicles (SSVs) in Australia is substantial. Quad bike and SSV related deaths cause significant harm and disruption to Australian families and communities and injuries can result in disabilities that last for a lifetime. Those deaths and injuries cost the Australian economy over an estimated $200 million per annum.

Quad bikes and SSVs are heavily utilised in Australian forestry and agricultural industries. For many farmers, quad bikes and SSVs are affordable and used almost every day for weed spraying and checking livestock and fences. They are also becoming increasingly popular in recreational and sporting settings.

114 deaths in Australia were attributed to quad bikes between 2011–2017[1] and four deaths were attributed to SSVs. Approximately 2100–2500 injuries were recorded by hospital emergency departments and over 650 hospitalisations occur every year across Australia as a result of quad bike and SSV related injuries.[2] Deaths frequently involved adults between the ages of 46 and 75 years, whilst operating a general-use model quad bike on an incline on a farm or rural property and experiencing a rollover.

Almost half the deaths occurred during work related activities (47 per cent) and the 54 workers who died were almost exclusively employed in agriculture or rural based businesses and incidents occurred mostly on rural properties. Similarly, many of the non-work related deaths also occurred on rural properties. Children below the age of 16 years accounted for approximately 15 per cent of all recorded quad bike deaths over the same period and the majority involved a child operating an adult size quad bike and experiencing a rollover incident. [3,4]

The frequency and causes of quad bike related deaths and injuries suggests that the current design of quad bikes sold in Australia does not ensure an appropriate level of safety for their marketed uses in Australia.

Product safety best practice involves manufacturers adopting a precautionary approach when assessing the safety of consumer products and precludes a lack of full scientific certainty from being used as a reason for postponing risk reduction measures. Manufacturers should make design modifications to eliminate hazards caused by products associated with injuries at the design stage.[5]

Australian Model Work Health and Safety legislation and regulations require that risk be managed in accordance with the recognised Hierarchy of Risk Control Framework (HORC framework). The HORC framework assists in considerations for the management of identified hazards and risk through six approaches of possible interventions: elimination, substitution, isolation, engineering controls, administrative controls and the use of personal protective equipment.

Quad bikes and SSVs are 'experience goods' which means that consumers cannot fully assess the key characteristics of the product until after they have purchased and used the vehicle. Consumers require accurate and sufficient information about a vehicle, including its safety, in order to make an informed purchasing decision and to reduce the risk of

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1 Safe Work Australia 2017, Australian Government, viewed 12 October 2017.

2 See section 4.1 in this Consultation RIS.

3 Safe Work Australia 2017, Australian Government, viewed 12 October 2017.

4 Australian Centre for Agricultural Health and Safety, *Australian Farm Deaths & Injuries Media Monitors Snapshot: January 1 – June 30, 2015*, The University of Sydney, viewed 12 October 2017.

5 Standard Consumer Product Safety – Guidelines for Suppliers (AS ISO 10377:2017) – Section 3.6.

subsequent death or injury. However, the Australian market does not provide consumers with clear, consistent and sufficient vehicle safety information at the point of sale. This information asymmetry often results in consumers receiving conflicting and confusing information, which prevents them making informed decisions about whether a quad bike, SSV or other vehicle is more appropriate for their intended use and creates uncertainty regarding the safety of aftermarket operator protection devices fitted to quad bikes.

The ACCC has conducted an investigation to develop a long-term solution that reduces fatal and non-fatal injuries attributed to the operation of quad bikes and SSVs in Australia. The data and information reviewed by the ACCC indicates that in addition to prevalent market information asymmetry, the design of quad bikes, particularly those marketed as utility quad bikes in Australia, does not adequately address risks associated with the foreseeable use and misuse of these vehicles in the Australian environment.

There have been efforts aimed at alleviating safety risks to quad bike operators by Commonwealth and state and territory governments. These efforts have focused on work health and safety initiatives, funding research and testing, providing safety information and incentivising quad bike owners to substitute to a safer vehicle, and to attend training and wear protective equipment. Industry efforts to mitigate the operational risks of quad bikes have in the main part focused on the lowest level of the HORC framework, for example by promoting the use of personal protective equipment rather than through the development of appropriate engineering controls aimed at reducing these risks.

The ACCC has reviewed a number of options, including design solutions to improve the stability and handling of quad bikes in the Australian environment and considers that the lower level HORC framework interventions should be pursued to supplement this approach.

The ACCC has prepared this Consultation Regulation Impact Statement (Consultation RIS) to examine the case for government intervention to reduce the risk of death and injury associated with the use of quad bikes and SSVs in Australia.

Five options are being proposed:

- **Option 1**: take no action at all (status quo)
- **Option 2**: make a mandatory safety standard in relation to quad bikes and SSVs that:
  - adopts the ANSI/SVIA 1–2017 US Standard for quad bikes
  - requires post manufacture testing for quad bikes and SSVs in accordance with the requirements of a safety star rating system and the disclosure of the star rating at the point of sale
  - requires an additional warning on quad bikes alerting the operator to the risk of rollover
- **Option 3**: make a mandatory safety standard that satisfies all of the requirements of option 2, and in addition requires general-use model quad bikes to be fitted with an operator protection device
- **Option 4**: make a mandatory safety standard that satisfies all the requirements of option 2, and in addition requires general-use model quad bikes to meet minimum performance tests for mechanical suspension, stability and dynamic handling. It also requires that all wheels be able to rotate at different speeds
- **Option 5**: make a mandatory safety standard that satisfies all of the requirements of Options 2, 3 and 4.

The ACCC considers that **Option 5** is likely to prevent more deaths and injuries to quad bike operators than all of the other options by significantly reducing the frequency of incidents and mitigating the severity of injury when an incident occurs. It also best addresses information asymmetry issues that create product safety risks for quad bike and SSV operators.

As part of a holistic approach to mitigate the safety risks of quad bikes and SSVs, the ACCC notes that appropriate complementary regulatory measures should be considered by other jurisdictions and agencies. For example, a ban on children from operating adult quad bikes and SSVs and mandating the use of personal protection equipment, such as helmets, for operators and passengers of quad bikes and SSVs.

2. Introduction

This Consultation RIS has been prepared by the ACCC to develop long-term solutions to reduce fatal and non-fatal injuries associated with the operation of quad bikes and SSVs. The outcome of this process is to advise the Hon Michael Sukkar MP, Assistant Minister to the Treasurer (minister) on the implementation of a safety standard for quad bikes and SSVs under the Australian Consumer Law (ACL).

The ACCC released an Issues Paper on Quad Bike Safety (Issues Paper) on 13 November 2017, which invited responses and comments from interested stakeholders. The Issues Paper posed a range of questions relating to the current use of quad bikes and SSVs within Australia, perceived safety risks, the existing regulatory environment, international regulatory standards, consumer information and vehicle design.

The ACCC received 56 submissions from a broad range of stakeholders, including industry representative bodies, quad bike manufacturers and retailers, individual farmers and consumers, academics, hospitals and health professionals, quad bike tourism operators and government agencies.

Following the release of the Issues Paper the ACCC has continued its investigation, analysing new and updated data and has identified key factors that may contribute to quad bike related deaths and injuries including:

- design features that contribute to making the vehicle unstable and more likely to cause the operator to lose control (e.g. rollover or rider displacement)
- the absence of operator protection devices (OPDs)
- limited key operational and functional safety information to consumers at the point of sale to enable them to make informed purchasing decisions.

The options set out in this Consultation RIS have been developed from the results of the investigation conducted by the ACCC and in consideration of the views expressed by stakeholders in their submissions made in response to the Issues Paper.

3. Have your say

The ACCC invites interested parties to provide information and comment on this Consultation RIS on or before **4 May 2018**.

Submissions can be lodged

Online:	ACCC consultation hub at consultation.accc.gov.au/
By email or post:	Director Quad Bikes Taskforce Consumer Product Safety Branch Australian Competition and Consumer Commission GPO Box 3131 CANBERRA ACT 2601 qbtaskforce@accc.gov.au

Contacts

Project leader:	Mr Davin Phillips Director Quad Bikes Taskforce Consumer Product Safety Branch Australian Competition & Consumer Commission GPO Box 3131 CANBERRA ACT 2601 Phone: +61 2 6243 4930 Email: qbtaskforce@accc.gov.au
Website:	productsafety.gov.au/

All submissions will be treated as public documents and published on the ACCC website, productsafety.gov.au, unless otherwise requested. Parties wishing to submit confidential information are requested to:

- clearly identify the information that is the subject of the confidentiality claim – the identified information must be genuinely of a confidential nature and not otherwise publicly available; and
- provide a non-confidential version of the submission in a form suitable for publication – this public version should identify where confidential information has been redacted.

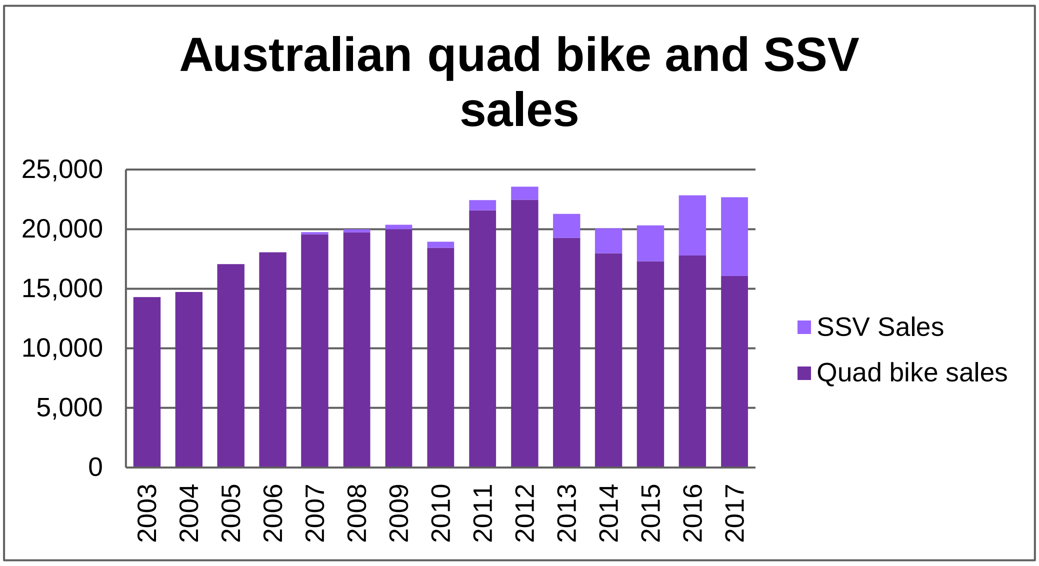
The ACCC will not disclose the confidential information to third parties, other than advisors or consultants engaged directly by the ACCC, except where permitted or required by law. See the ACCC & AER information policy: collection and disclosure of information publication for more information. For further information, see the ACCC's Information Policy (June 2014).

4. Why is government action needed?

4.1. What is the problem the government is trying to solve?

Submissions in response to the Issues Paper advised that depending on what purpose the vehicle is being used for, its lifespan could range from two to up to 30 years with an average age of 10 years before it is retired. Based on a 10-year lifespan, there are approximately 190,000 quad bike vehicles currently in operation in Australia.

Figure 1: Australian quad bike and SSV sales[6]



The estimated breakdown of quad bike sales is:

- approximately 76 per cent are general-use models
- approximately 7 per cent are sports models
- approximately 17 per cent are youth models.[7]

Since 2011, there have been 114 recorded deaths associated with quad bike incidents in Australia.[8] This is an average of 16 deaths per year. Seventeen of the deaths since 2011 were of children below the age of 16 years.

Over the same period, four deaths in Australia were associated with SSVs, with two of these deaths children below the age of ten years.

An estimated six Australians present to a hospital emergency department (ED) every day for quad bike and SSV related injuries and approximately one third of them (two people per day) are admitted to hospital for more serious injuries attributable to these vehicles.

Deaths

Deaths associated with quad bike incidents frequently involved adults between the ages of 46 and 75 years, operating general-use model quad bikes on an incline on a farm or rural

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[6] Polaris Industries submission to ACCC Quad Bike Safety: Issues Paper, p. 3 and correspondence with the FCAI.

[7] Queensland Coronial Inquest into nine (9) deaths caused by Quad Bike accidents, Coroners Court, Brisbane, delivered on 3 August 2015 by John Lock, Deputy State Coroner.

[8] Safe Work Australia 2017, Australian Government, viewed 12 October 2017.

property and experiencing rollovers. In addition, there have also been recorded deaths that occurred on grass and flat terrain. [9]

Table 1: Breakdown of deaths caused by quad bikes 2011–2017

	Sex		Operator/Passenger		Cause of death		
Total deaths (114)	Male	Female	Operator	Passenger	Rollover	Collision	Unknown
Number	95	19	108	6	66	34	14
Percentage	83	17	95	5	58	30	12

Table 2: Breakdown of quad bike death locations and vehicle types 2000–2012[10]

	Location		Quad bike type		
Total deaths (109 location, 72 vehicles type recorded)	Farm	Other	General-use quad	Sports quad	Youth quad
Number	82	27	57	11	4
Percentage	75	25	79	15	6

Children below the age of 16 years accounted for approximately 15 per cent of all recorded quad bike deaths between the years 2011 to 2017. These deaths most frequently involved a child operating an adult sized quad bike and experiencing a rollover incident.

Table 3: Breakdown of children (under the age of 16) deaths 2011–2017[11]

	Operator/Passenger		Quad bike type			Cause of death		
Child Deaths (17)	Operator	Passenger	Adult	Youth[12]	Unspecified	Rollover	Collision	Unknown
Number	12	5	12	1	4	15	1	1
Percentage	71	34	71	6	23	88	6	6

In the same period, four deaths were attributed to SSVs. These deaths most frequently involved a child operating a SSV and experiencing a rollover incident.

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9 Safe Work Australia 2017, Australian Government, viewed 12 October 2017.

10 R Grzebieta, G Rechnitzer, A McIntosh, R Mitchell, D Patton, K Simmons, University of New South Wales Transport and Road Safety Research Unit, *Supplemental Report: Investigation and Analysis of Quad Bike and Side by Side Vehicle (SSV) Fatalities and Injuries,* provided to WorkCover Authority of New South Wales January 2015 p 1-2 and Appendix A: ATV details. Quad bike models attributed to deaths are detailed at Attachment C.

11 Safe Work Australia 2017, Australian Government, viewed 12 October 2017.

12 The Safe Work Australia website reports two deaths attributable to youth quad bikes. Under the definitions in the US Standard, one of the recorded vehicles is defined as an adult quad bike.

Table 4: Breakdown of SSV deaths 2011–2017[13]

	Child/Adult		**Sex**		**Cause of death**	
Total Deaths (4)	Child	Adult	Male	Female	Rollover	Unknown
Number	3	1	3	1	3	1
Percentage	75	25	50	50	75	25

Injuries

The ACCC has estimated the number of injuries sustained as a result of the operation of quad bikes and SSVs from a number of sources. There is uncertainty associated with the estimates quoted below, as the ACCC has not been able to source a compilation of Australia-wide injury data for the most recent years.

The Centre for Automotive Safety Research at the University of Adelaide examined Australian hospitalisation data for incidents involving quad bikes and SSVs over the period 1 July 2002 to 30 June 2013.[14] Discounting cases that are unlikely to have involved the use of a quad bike or SSV, a total of 7194 hospitalisations occurred over the 11 year period (average of 654 per year or nearly two people per day).

The number of ED presentations associated with quad bike and SSV injuries has been extrapolated from New South Wales[15] and Queensland[16] data. The result is an estimate of 2100–2500 ED presentations per year in Australia (average of six people per day).

ED data for Queensland indicates the most common cause of injury was falling from the vehicle (over 40 per cent) and fractures accounted for approximately half of the hospitalisations. Rollovers accounted for 17.5 per cent of ED presentations and 34.8 per cent of ambulance attendances.

A number of these injuries result in a permanent disability. The majority of these injuries are likely to be traumatic brain injuries and a small number are likely to be spinal cord injuries that result in paraplegia or quadriplegia. Further, a number of injury related amputations are attributed to incidents involving the use of these vehicles.

It is difficult to measure the physical, emotional and social harm and disruption caused by deaths and injuries. However, this cost can be regarded as substantial with a broader impact beyond the injured vehicle operator, including families, friends, workplaces and the broader Australian community.

Consumer Information

[13] Data provided through correspondence with Safe Work Australia.

[14] LN Wundersitz, SD Doecke, SJ Raftery, J Harrison, *Quad bikes in South Australia. An investigation of their use, crash characteristics and associated injury risks*, Centre for Automotive Safety Research, University of Adelaide, 2016, for SafeWork SA, viewed January 2018.

[15] R Grzebieta, G Rechnitzer, A McIntosh, R Mitchell, D Patton, K Simmons, University of New South Wales Transport and Road Safety Research Unit, *Supplemental Report: Investigation and Analysis of Quad Bike and Side by Side Vehicle (SSV) Fatalities and Injuries,* provided to WorkCover Authority of New South Wales January 2015, Attachment 2.

[16] K Vallmurr, A Watson, J Catchpoole, Centre for Accident Research and Road Safety – Queensland, *Quad bike-related injuries in Queensland: Final Report*, August 2017, viewed 19 February 2018.

Consumers are not provided with clear and sufficient vehicle safety information at the point of sale. This information asymmetry often results in consumers receiving conflicting and confusing information, which prevents them making an informed decision whether a quad bike, SSV or other vehicle is more appropriate for the intended use. This means consumers cannot properly evaluate safety until after they have purchased and used a vehicle. This lack of safety awareness has potentially tragic consequences.

Additionally the ACCC notes consumer comments received in submissions to the Issues Paper regarding quad bike manufacturer's active campaign against safety innovation, specifically the fitting of ROPS on quad bikes. Feedback from state jurisdictions was that the campaign by manufacturers against the fitting of ROPS creates uncertainty regarding the safety of these devices.

4.2. Does the government have the capacity to intervene successfully?

Quad bikes and SSVs are not designed or manufactured in Australia. They are consumer goods subject to the consumer guarantees legilsated under the ACL, but otherwise the supply of quad bikes and SSVs in Australia is un-regulated. Specifically:

- there are no design standards that are required to be met as a pre-condition for the sale of these vehicles,
- these vehicles are not classified as 'road vehicles' under the *Motor Vehicle Standards Act 1989* (Cth), and are not required to comply with the Australian Design Rules for vehicle safety, and
- there are no uniform requirements for the registration of quad bikes or SSVs in Australia under existing road transport rules.

The ACCC conducted its investigation into quad bike and SSV safety to determine whether a mandatory safety standard for these vehicles should be made under the ACL.[17]

Under section 104 of the ACL, a safety standard may impose certain requirements in relation to consumer goods of a particular kind that 'are reasonably necessary to prevent or reduce risk of injury to any person arising from the use of consumer goods of a particular kind. A safety standard under the ACL could include requirements for:

- the performance, composition, contents, method of manufacture or processing, design, construction, finish or packaging of consumer goods
- the testing of consumer goods during or after the completion of manufacture or processing
- the form and content of markings, warnings or instructions to accompany consumer goods.

It should be noted that under this legislation, a safety standard for quad bikes and SSVs cannot:

- impose user age restrictions
- mandate passenger restrictions
- mandate speed limits
- impose an obligation to wear personal protective equipment

[17] The ACL is set out in Schedule 2 to the *Competition and Consumer Act 2010* (CCA) and is applied as a law of the Commonwealth (CCA Part XI) and as a law of the states and territories (through the enactment of legislation in each state or territory that applies the ACL as a law of its jurisdiction).'Consumer goods' are broadly defined in section 2 of the ACL and includes quad bikes.

- impose an obligation on users to receive training or a licence for the operation of these vehicles.

However, this does not preclude other jurisdictions and agencies from pursuing these requirements as supplementary risk controls.

4.3. Government measures so far to address the problem

The Commonwealth and state and territory governments have implemented numerous initiatives to increase quad bike safety awareness. In particular:

- In 2012, the Australian Government (via Safe Work Australia) launched ‘QuadWatch’, a website dedicated to providing work health and safety information, relevant data and guidance about managing risk associated with quad bikes. It also sets out the existing initiatives in the jurisdictions and contact details for state and territory regulatory bodies. Safe Work Australia has also published guidance material for quad bike use, for example on managing the risks of machinery in rural workplaces.
- In 2012, the Heads of Workplace Safety Authorities (HWSA) commissioned UNSW TARS to examine design solutions to improve the safety of quad bikes. Funding was provided by the WorkCover Authority of New South Wales and also supported by the New South Wales state government, HWSA and the ACCC. The final research results were released in August 2015.
- Since 2013, the ACCC has been promoting quad bike safety through a number of initiatives including a summer awareness campaign and the release of a YouTube video ‘Quad bike safety – would you risk it?’ This video highlights the risks to riders of not wearing adequate personal protective equipment, the dangers associated with children operating adult-sized quad bikes and the risks posed to riders attempting to navigate unsafe terrain.
- In 2013, the ACCC commissioned the CARRS-Q to examine recreational quad bike related injury patterns and trends in Australia. In the same year, the ACCC also commissioned Colmar Brunton to undertake a survey on the behaviours and attitudes of Australian recreational quad bike users.
- In July 2016, SafeWork NSW introduced a quad bike safety improvement program that offers NSW farmers and small businesses quad bike safety rebates and training packages. Rebates are offered for approved alternate vehicles or for fitting of OPDs to existing quad bikes. Farmers and farm workers are also offered a rebate towards the purchase of compliant helmets and are provided free with an eligible training course. In May of this year NSW launched a communication campaign across regional NSW involving television, print, radio and social media to raise awareness of safety issues and the rebate scheme.
- WorkSafe Victoria introduced a quad bike safety rebate scheme in October 2016. Under the scheme, farmers can apply for a rebate for the purchase of an alternate vehicle or for fitment of OPDs to existing quad bikes. WorkSafe Victoria also accepts OPDs fitted to a quad bike as part of the solution to controlling the risk to operators in the event of a rollover. Victoria has also launched a communication campaign across regional Victoria involving television, print, radio and social media to raise rebate awareness. WorkSafe Victoria also attends regional field days and engages directly with farming communities.
- SafeWork SA sponsored a study by the University of Adelaide's Centre for Automotive Safety Research in 2016: ‘Quad bikes in South Australia: an investigation of their use, crash characteristics and associated injury risks’. The study examined the circumstances of fatal and non-fatal quad bike incidents in South Australia.
- Workplace Health and Safety Queensland has a ‘State-wide Plan for Improving Quad Bike Safety in Queensland 2016–2019’. A major part of this plan is the

'Ride Ready' awareness campaign, which aims to raise awareness of the risks associated with the operation of quad bike and improve operator safety skills.

- In late 2016, a Tasmanian Inter-Departmental Taskforce was established to investigate methods of improving safety outcomes for quad bike users. In early 2017, the Taskforce released an Issues Paper for consultation: 'Quad Bike Safety in Tasmania'. The Issues Paper received 22 public submissions.
- WorkSafe Tasmania and the Department of Primary Industries, Parks, Water and the Environment (DPIPWE) run a joint initiative, the Safe Farming Tasmania Program, to provide training and educational resources to farmers including the safe use of quad bikes. On 12 October 2017, a suite of worker induction materials, including videos and handbooks were released as part of the Safe Farming initiative.

4.4. Why have previous government measures not worked?

For many farmers and farm businesses, quad bikes and SSVs are affordable and useful equipment that are used for daily work purposes. Tour operator businesses also use quad bikes and SSVs in their daily operations and they are becoming increasingly popular for personal recreational and sporting uses.

Despite the previous efforts to improve safety by the Commonwealth, state and territory governments, industry representative bodies, quad bike manufacturers, and aftermarket innovators, deaths and injuries associated with quad bike and SSV use continue to occur at a high rate.

To reduce risk, product safety is best addressed when the product is at the design stage. At the design stage, best practice involves manufacturers considering the reasonably foreseeable decisions and actions of consumers when purchasing, assembling, using, storing and maintaining the consumer product. Considering these matters at the design stage enables manufacturers to design products with their likely use or misuse in mind, enabling design improvements to be practical and safe for each of these foreseeable decisions and actions. Implementing this approach at the design stage ensures continual improvement in product safety design[18] and is more economically viable than after-market design modifications.

This approach to product safety is aligned with the HORC Framework. The HORC Framework provides a model for addressing hazards with the ideal situation being to eliminate the hazard, and the next best options being to substitute, isolate or reduce the risks through engineering controls or exposure (Figure 2). The lowest level control approach in the hierarchy is to use personal protective equipment (Figure 2).[19]

Manufacturers should also provide information to consumers on the safety features of the consumer product. This may include labelling or advertising that provides information about the product use, including safety hazards.[20]

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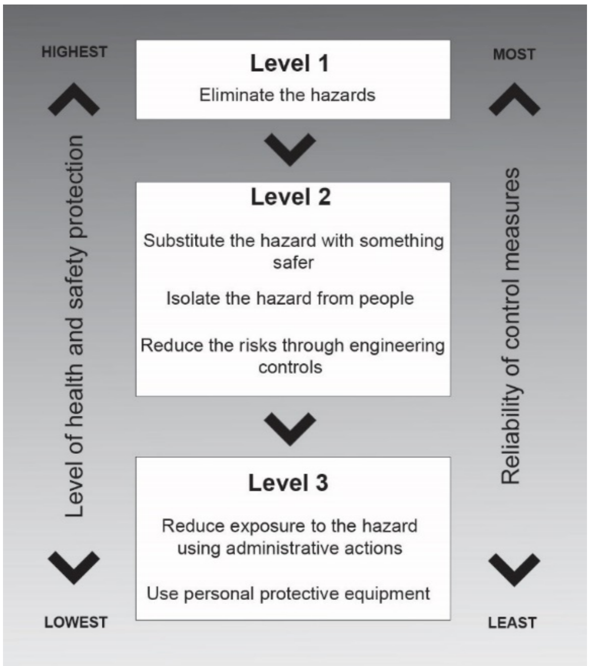
[18] ASO ISO 10377:2017.

[19] Safe Work Australia, *Model Code of Practice: How to manage work health and safety risks*, Safe Work Australia, December 2011, viewed 24 January 2018.

[20] Ibid

Figure 2 The HORC Framework



The Australian Standard Consumer Product Safety – Guidelines for Suppliers (AS ISO 10377:2017), supports the application of the HORC Framework to quad bikes and SSVs. The HORC framework is also consistent with the Australian government *Work Health and Safety Strategy 2012–22,* as safety in design is one of the priorities.[21] The Safe Systems Approach to Road Safety[22] implies that the design of vehicles should be such that the consequence of minor errors and lapses of attention is not death or serious injury, and this is equally applicable to quad bikes and SSVs.

From the information and data available to the ACCC, quad bikes present the least safety risk when operated at a low speed on flat surfaces. However, part of the marketed utility of quad bikes is their ability to operate at higher speeds and on uneven terrain, for example when mustering cattle. However, from the information provided to the ACCC, at these high speeds and/or on uneven terrain, the design limitations of quad bikes result in serious safety risks, especially if the operator's concentration is divided between riding and other tasks.

Quad bike and SSV manufacturers have largely focussed safety efforts on operator behaviour such as the use of personal protective equipment and active riding, which is categorised within the lowest level on the HORC framework. The FCAI has also opposed Level 2 controls such as OPDs. Active riding cannot compensate for vehicle safety design limitations particularly as some operators are unable to engage in active riding and because this technique is not feasible for those involved in prolonged periods of quad bike operation.

In August 2012, the then Federal Minister for Employment and Workplace Relations stated 'for over 20 years the focus on quad bike safety in Australia has been on other approaches like training and education, awareness raising and helmet use to address the high number of fatalities and serious injuries sustained by quad bike riders. The time has come to focus on design and engineering controls for improving quad bike safety'. Manufacturers have not heeded this advice from government and have not improved the safety of quad bike design.

21 Comcare, 5 July 2017, viewed 29 January 2018.

22 National Road Safety Strategy, 1 November 2017, viewed 29 January 2018.

4.5. Support for government action

The National Farmers Federation (NFF) has called for a comprehensive strategy to improve quad bike safety, including safety improvements such as fitting Crush Protection Devices (CPDs). The NFF supports an initiative for better safety information being provided to consumers through a safety star rating system. The Country Women's Association of NSW has also been a vocal advocate for a national consumer safety star rating system for these vehicles and the Australian Centre for Agricultural Health and Safety has also voiced its support for regulatory change to improve the safety of quad bikes.

The Royal Australasian College of Surgeons (RACS) has called for action to address child deaths associated with quad bike incidents. The RACS supports measures that include prohibiting children under the age of 16 from operating adult quad bikes, improving vehicle stability, design improvements to increase protection from rollovers and the introduction of a safety star rating system for quad bikes. A number of other hospital and health bodies support the introduction of prohibitions on children under the age of 16 riding quad bikes, including: the Royal Children's Hospital; Ambulance Victoria; KidSafe; and the Australian Medical Association.

There have been three major coronial inquests into deaths arising from the use of quad bikes and SSVs in Australia. In each of these, the coroners made findings that supported the implementation of a safety star rating system and the development of a safety standard for quad bikes. The Queensland and Tasmanian coroners also recommended using the ANSI/SVIA 1–2010 as a starting point towards the development of an appropriate safety standard for quad bikes in Australia.

The FCAI has also indicated its support for the government to consider adopting the US Standard for quad bikes to ensure that a minimum standard is applicable for these vehicles sold in Australia.

An Inter-Departmental Committee (IDC) has been established by the Australian Government to identify and develop national initiatives to improve quad bike safety. WorkSafe New Zealand has recently has joined the IDC as an observer. The IDC is chaired by the Department of Jobs and Small Business.

The work of the IDC is supported by the Australian Ministers for Consumer Affairs who, on 31 August 2017, agreed to 'support all steps necessary to expedite the regulatory impact assessment process and any other safety measures necessary to introduce a consumer safety quad bike rating system and a safety standard'.[23]

4.6. Alternatives to government action

Industry safety initiatives to date have focused on low-level risk management administrative controls such as advocating the use of personal protective equipment, which have overall been ineffective in reducing deaths and injuries. Manufacturers have so far not implemented design solutions that sufficiently improve overall vehicle safety.

Information provided by manufacturers, distributors and retailers to quad bike and SSV consumers on the relative safety of the vehicles is limited and in some cases not consistent causing confusion. The ACCC does not consider it has been effective in reducing the information asymmetry.

No other stakeholders have presented the ACCC with any alternative strategies that are able to be developed into an appropriate long-term solution that is capable of reducing the fatal

[23] Australian Consumer Law, Meeting of Ministers for Consumer Affairs 31 August 2017, viewed 8 March 2018.

and non-fatal injuries attributed to the operation of these vehicles in Australia. Consequently, the ACCC has concluded government must intervene.

4.7. The objective of government action

Government action may be needed where the market fails to provide the most efficient and effective solution to a problem.

The objective of a safety standard, if made under the ACL, is to prevent or reduce the risk of death and injury caused by quad bikes and SSVs in Australia.

4.8. Cost of no government action

Government action will incentivise manufacturers to improve the design of quad bikes and reduce information asymmetries. Thus, there is a strong likelihood that the high risk of fatal and non-fatal injuries associated with the use of these vehicles will continue if no government action is taken.

The estimated minimum economic cost of deaths and injuries associated with the use of quad bikes and SSVs is approximately $208.1 million per year.[24] This figure excludes intangible costs associated with deaths and injuries, including but not limited to, the pain and suffering of family and friends, and costs to emergency workers and affected communities.

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[24] See Option 1 in Section 9.3 of this Consultation RIS.

5. International standards, approaches and initiatives

5.1. International standards and regulations

There are a number of international standards and regulations covering the design features of quad bikes, including those in:

- the United States (US)
- the European Union (EU)
- Israel.

United States

In 1987, the United States Government commenced a series of legal actions against major quad bike manufacturers, contending that quad bikes constituted an ‘imminent hazard’ to consumers within the meaning of the US *Consumer Product Safety Act 1972.* In 1988, these actions were settled by negotiation in the form of consent decrees entered into between the United States Department of Justice and the representatives of the quad bike industry.

Pursuant to the consent decrees the quad bike industry agreed to:

- cease production and sale of new 3-wheeled version quad bikes (but not to recall existing models already in the market);
- implement a free national rider-safety training program available to all quad bike purchasers and their families;
- implement a major public awareness campaign on the operation of quad bikes;
- implement age recommendations for operating quad bikes to prevent children from riding wrong sized quad bikes;
- implement quad bike labelling and the provision of owner’s manuals to consumers and other point of purchase materials to effectively inform consumers about the hazards of quad bike operation and the available safety options; and
- develop a voluntary standard to make quad bikes safer to operate.

The consent decrees expired in 1998, at which time the majority of quad bike manufacturers agreed to an All-Terrain Vehicle Action Plan which included not marketing or selling 3-wheeled quad bikes, or adult-size quad bikes for use by children below the age of 16 years. Manufacturers also agreed to promote training and conduct safety education campaigns.

The American National Standards Institute (ANSI) developed a voluntary quad bike standard, which was adopted as a mandatory quad bike standard into section 42 [15 U.S.C. §2089] of the *Consumer Product Safety Act 1972*. It includes mandatory requirements for the design and construction, security, provision of information at point of sale and labelling of quad bikes in the United States. The ANSI issued a revised edition of its standard in June 2017 (the ANSI/SVIA 1–2017). The US Consumer Product Safety Commission (CPSC) has issued a final rule to amend the CPSC's mandatory quad bike standard to reference ANSI/SVIA 1–2017 and this rule will become effective as of 1 January 2019[25].

[25] The United States Federal Register: The Daily Journal of the United States Government, *All-Terrain Vehicles: A Rule by the Consumer Product Safety Commission on 02/27/2018*, The United States National Archives and Records Administration, viewed 6 March 2018.

The United States dominates the global quad bike market and most quad bikes are designed and manufactured to satisfy the US standard. The ACCC understands that it is estimated that approximately 95 per cent of quad bikes imported into Australia meet the US standard.[26]

In the United States there is also a voluntary standard for recreational off-highway vehicles (ROHVs) (which is inclusive of SSVs), ANSI/ROHVA 1–2016. This standard covers design, configuration and performance aspects of ROVs, including requirements for Rollover Protective Structures (ROPSs), accelerator, clutch and gearshift controls and lateral and pitch stability.

The European Union (EU)

The European quad bike safety standard (CEN EN 15997:2011 *All-terrain vehicles (ATVs - Quads) - Safety requirements and test methods)* is based on the ANSI/SVIA 1–2010.

EU Regulation 168/2013 (EU Regulation) details requirements for the approval and market surveillance of two- or three-wheel vehicles and quadricycles[27]. The EU regulation applies to vehicles that are intended to travel on public roads. It does not apply to vehicles that are primarily intended for off-road use and designed to travel on unpaved surfaces. Annex VIII of the EU Regulation lists enhanced functional safety requirements. This includes (amongst other things) that L-category vehicles, which are defined to include quad bikes, have wheels that can rotate at different speeds at all times for safe cornering on hard-surfaced roads. It requires that if the vehicle is equipped with a lockable differential, it must be designed to be normally unlocked.

Israel

Israel has regulations that require quad bikes to be registered and riders to be licensed before the vehicle may be operated.[28] One of the conditions of registration is that a Rear Safety Frame must be installed on each vehicle.[29] The Rear Safety Frame is subject to a specific design standard that, among other things, mandates attachment mechanisms and materials, minimum dimensions and requirements for the frame to withstand loads without residual deformation.[30] Welding of a Rear Safety Frame may only be carried out by manufacturers licensed by the Ministry of Transport.[31]

Ireland

On 27 February 2018, Fianna Fail (Irish Republican Party) announced its intention to introduce new legislation in the Dail (Lower House of the Irish Legislature) which could see anti-roll bars and mandatory headgear made compulsory on all quad bikes. The proposed legislation coincides with a call by a coroner has called for anti-roll bars to be made mandatory on quad bikes in Ireland.[32]

5.2. International approaches

There are regulatory approaches to managing quad bike safety in a number of international jurisdictions (Canada, NZ, UK and others). Regulations vary across jurisdictions and include:

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26 Submission by Australian Centre for Agricultural Health and Safety for the Consultation Paper on *Motor Vehicle Standards Act 1989*.

27 Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles.

28 *Transport Regulations Amendments 2014* (Israel).

29 Ibid.

30 Manufacturing and Installation of Safety Frames for Quad Bikes Code – 72, Specifications Document No.3876 (2005).

31 Ibid.

32 Fianna Fáil The Irish Republican Party, *FF move to improve Quad bike safety – Calleary,* Media Release, 25 February 2018.

- the ability to be lawfully used on public roads
- the ability to be regulated through transport laws
- registration requirements
- licensing requirements
- requirements depending on the intended use of the vehicle
- age restrictions for riders
- requirements for personal protective equipment.

5.3. International safety research and initiatives

Submissions to the Issues Paper identified a number of international research activities and initiatives undertaken in various countries to improve quad bike safety including:

- A joint strategy on quad bike safety in effect for the years 2014–2020,[33] in Sweden seeks to harmonise safety strategies undertaken across the country through improved cooperation between stakeholder groups.
- A research team from the Public University of Navarra in Spain is currently developing a CPD known as 'Air-Rops' for quad bikes.

[33] The Swedish Transport Administration, *Better Safety on Quad Bikes Joint strategy version 1.0 for the years 2014-2020*, December 2013.

6. Quad bikes and SSVs

6.1. Quad bikes

In Australia, quad bikes are used for various purposes, including agriculture and forestry, recreation, sport, tourism and commercial hire. Quad bikes sold in Australia are generally marketed for the uses of adult recreational and utility (work and non-work), sports and youth (children's quad bikes). All categories of quad bikes can be used for recreational purposes.

General-use model quad bikes are primarily purchased for off-road operation in the farming and forestry industry but these vehicles are also used in non-working environments by individuals and in the recreation and tourism industry. General-use model quad bikes are typically the heaviest of the three types, with greater towing and lifting capacities.

Sports quad bikes are lightweight, have a lower centre of gravity and produce a higher rate of acceleration than general-use model quad bikes.

Youth quad bikes are specifically designed for young riders between the ages of 6 and 15 years and are comparatively less expensive, lighter weight and smaller compared to adult quad bikes.

Quad bike design also varies according to the number of people they are designed to carry. Some quad bikes are manufactured for use only by a single operator without any passengers.[34] Other quad bikes are manufactured for use by an operator and a single passenger, and are equipped with a designated seating position located behind the operator.[35]

6.2. SSVs

Similar to quad bikes, SSVs are used in Australia primarily for utility purposes (including farming and forestry) and for recreational purposes (sporting and tourism).

SSVs are designed so that the operator remains seated and controls the vehicle by using a steering wheel. SSVs are capable of carrying one or more passengers (depending on the vehicle design). They are larger vehicles than quad bikes and have a longer wheelbase, a wider track width and usually include an occupant restraint system (seat belts) and ROPS.

Since entering the Australian market in 2007, sales of SSVs have increased steadily. Rebate schemes in Victoria and New South Wales have provided incentives for farmers to purchase a SSV. Such initiatives are resulting in SSVs progressively being used in the agriculture as a substitute for quad bikes.

If the sales of SSVs continue to increase in Australia, it is anticipated that the rate of injuries associated with SSV use will also increase. However, it is also anticipated that injuries will occur at a much lower rate than is the current quad bike incident rate. This is because SSVs have additional design features that provide the vehicle with greater stability, better dynamic handling and increased occupant protection relative to current quad bike design.

[34] These quad bikes are classified at Type I ATVs in the US, see ANSI/SVIA 1-2017, approved by the American National Standard Institute 8 June 2017.

[35] These quad bikes are classified at Type II ATVs in the US, see ANSI/SVIA 1-2017, approved by the American National Standard Institute 8 June 2017.

7. Submissions in response to the Issues Paper

On 13 November 2017, the ACCC released an Issues Paper to help inform the development of this Consultation RIS. The Issues Paper posed a range of questions relating to the current use of quad bikes and SSVs in Australia, including: safety risks, existing regulatory framework, international regulatory standards, consumer information and design.

In response, the ACCC received 56 submissions from a broad range of stakeholders including manufacturers, representative bodies, individual farmers and businesses, academics, hospitals, health professionals and government agencies. All submissions are available on the ACCC Consultation Hub.

The following is a high-level summary of observations arising from the submissions:

- approximately 77 per cent supported the introduction of a safety standard of some kind but perspectives on what should be included in the standard varied. Manufacturers, recreational/sport users and some individuals believe there is no need for regulation (except in some circumstances there was support for adopting the US Standard). Government agencies, the agricultural sector, medical, research, technical experts and some individuals support regulation
- of those submissions that commented on a transition period, associated with the introduction of a standard, the majority supported having a transition period, while a number stated a safety standard should commence as soon as possible
- the majority of submissions that commented on whether the safety standard should apply to second hand vehicles were not in favour of it doing so
- there were mixed views as to whether the standard should apply to SSVs
- the majority of submissions that commented on the US Standard were in favour of its adoption but stated that it is not sufficient as a stand-alone measure to improve quad bike safety
- there were mixed reactions to a star rating system. Of those that commented on this issue approximately 80 per cent supported implementation of a safety star rating system
- the proposals for design solutions attracted the highest response (approximately 84 per cent) and suggestions included:
    - fitting of OPDs
    - open rear wheel differential with the option of being locked
    - independent rear suspension
    - lowering the centre of gravity of quad bikes
    - solutions to prevent children riding adult quad bikes
    - solutions to prevent passengers being carried on quad bikes designed for operation by a single rider only, and
    - audible warning systems
- some submissions expressed the view that insufficient and inconsistent information is provided at the point of sale, particularly concerning alternative vehicle options and the benefits of devices designed to increase safety, such as CPDs.
- a number of submissions commented that the provision of warnings and consumer information are not sufficient on their own and are not effective measures to address safety risks and proposed these matters should form only part of broader measures to improve the safety of quad bikes

- a number of stakeholders expressed the view that to be effective, any proposed safety standard must be accompanied by a range of complementary measures including:
  - mandating helmets
  - providing training
  - promoting alternate vehicles
  - banning children from riding adult quad bikes.

8. Informing Policy Options

8.1. Adoption of US Standard ANSI/SVIA 1–2017 in Australia

The US Standard ANSI/SVIA 1–2017 addresses vehicle design, configuration and performance (a summary is at Attachment B) and imposes requirements including, but not limited to, the following:

- mechanical suspension
- throttle, clutch and gearshift controls
- engine and fuel cut off devices
- lighting
- tyres and parking brake mechanisms
- operator foot environments
- pitch stability
- owners' manual, hang-tags and compliance certification labelling.

The Queensland, Tasmanian and New South Wales coronial inquiries included recommendations that work commence to develop an Australian Standard based on the US Standard.

The Issues Paper asked stakeholders to provide comment on whether Australia should adopt a mandatory safety standard similar to the US Standard. The majority of those stakeholders who commented on this issue supported the adoption of the US Standard either in part or in its entirety. However, more than half of these stakeholders expressed concerns that the US standard did not sufficiently address all quad bike safety issues. In particular, a number of submissions highlighted that the US standard only requires testing for rear pitch stability, not forward or lateral stability or dynamic handling.

Approximately 95 per cent of the quad bikes in Australia already conform to the US Standard.[36]

Noting the above, the ACCC is of the view that adopting the US standard will be beneficial in aligning Australia with other global markets, and will ensure the applicability of a minimum safety standard to all new quad bikes sold in Australia.

8.2. Safety Star Rating System

A safety star rating system is likely to be effective in improving the information available to consumers about the safety of quad bikes and SSVs.

The work of the University of New South Wales Transport and Road Safety Quad Bike Performance Project 2015 (UNSW TARS Project) involved research aimed at improving the safety of quad bikes. The project included the development of a safety star rating system for quad bikes and SSVs.

The safety star rating system developed by the UNSW TARS Project applies a higher star rating to vehicles that present a higher resistance to rollover and improved operator protection in the event of a rollover incident. The star rating system was developed by evaluation, research and testing of vehicle engineering and design features including static

[36] Submission by Australian Centre for Agricultural Health and Safety for the Consultation Paper on *Motor Vehicle Standards Act 1989.*

stability, dynamic handling and crashworthiness and operator protection devices and accessories.

The dynamic handling tests measure the likelihood of the operator losing control of the vehicle when operating in stressed conditions. The static stability tests measure the likelihood of the vehicle rolling over in the event of such a loss of control. The crashworthiness test measures the likelihood of the operator suffering a fatal or non-fatal injury in the event of a rollover.

The UNSW TARS Project's research and physical test program involved over 1000 tests carried out at a Crashlab facility in New South Wales and included the examination and analysis of 109 coronial case files collected from around Australia and workplace injury and hospital admissions data. As part of the project, the safety star rating model was applied to 16 quad bikes and SSVs on sale at the time in Australia. From its findings, the UNSW TARS Project made a number of recommendations to improve quad bike safety beyond a star rating system.

A Technical Reference Group (TRG) formed in late-2017 by the IDC is currently conducting a review of the star rating system developed by the UNSW TARS Project. The TRG will provide its recommendations to the IDC, which will then provide its assessment of the star rating system to the ACCC. The ACCC will consider the IDC's advice and submissions in response to this Consultation RIS in its final recommendation to the minister, and is presently of the view that a safety star rating system will provide key information about vehicle safety to better inform consumers at the point of sale. The ACCC is seeking feedback on the merits and limitations of the safety star rating system proposed by the UNSW TARS project, the details of which are summarised in Attachment A.

8.3. Design solutions

The ACCC supports the use of personal protective equipment, rider education and training and compliance with manufacturer recommendations. However, these measures are categorised in the lowest level of the HORC Framework. It is apparent from the investigation conducted by the ACCC that these measures alone are not sufficient to mitigate the risk of deaths and injuries caused by the foreseeable use and misuse of quad bikes in the Australian environment.

From the information provided to the ACCC, the majority of deaths are associated with the use of general-use model quad bikes, and the safety of these types of quad bikes has been the focus of public research and testing. At present, the ACCC does not have adequate information to recommend to the minister that additional design solutions are reasonably necessary to reduce the number of injuries attributed to SSVs, sports and youth model quad bikes.

Therefore the ACCC is not proposing to mandate additional design solutions for SSVs, sports and youth quad bikes. However, the ACCC is seeking feedback on their exclusion.

Manufacturers are well placed to consider the hazards posed by quad bikes in the design stage and could act to ensure quad bikes are safe to operate in reasonably foreseeable circumstances. It is the view of the ACCC that the current safety related design features of quad bikes, particularly those marketed as general-use model quad bikes, do not adequately address reasonably foreseeable use and misuse in the Australian environment. For example, farmers operating quad bikes while spraying weeds (an activity widely undertaken using quad bikes) may have their attention shared between operating the vehicle and weed spraying and may be less likely to observe a rock or branch in the grass that could trigger a rollover if impacted. Such an event may result in a death.

From the information presented to the ACCC there appears to be specific design solutions that can effectively mitigate the operational risks associated with general-use model quad bikes. The benefits of these design changes would be significant in Australia. Examples would be designs that improve the dynamic handling and stability of the vehicle and protect operators in the event of a rollover.

Operator Protection Devices (OPDs)

OPDs have proved to be effective in reducing the number of deaths and serious injuries resulting from vehicle rollovers. For example, in the period between the years 2003 to 2011 there was an annual decrease of approximately 87 per cent in fatalities caused by tractor rollovers after the introduction of ROPS.[37]

Australian data indicates that approximately 50 per cent of quad bike-related deaths occur as a result of rollovers of general-use model quad bikes, resulting in the operator being pinned underneath the vehicle, with crush asphyxiation identified as one of the major causes of death.

Some concern has been expressed that OPDs can cause injuries to quad bike operators. The UNSW TARS Project testing found that OPDs could potentially contribute to operator injury in certain circumstances but concluded that overall, aftermarket OPDs currently available would reduce harm.

The European Commission has stated that it is monitoring the market to consider whether the requirement for roll over protection should be adopted as a requirement for all quad bikes operated on roads.[38] The Irish Republican Party has announced that it will introduce a Bill into the Lower House of the Irish Legislature that make anti-roll bars compulsory on all quad bikes, as well as mandating the wearing of helmets.[39]

There are a number of OPDs currently available for quad bikes and SSVs which can broadly be categorised as ROPS or CPDs.

Rollover Protective Structures (ROPS)

ROPS are structures that enclose the rider and are to be used in conjunction with occupant retention systems (seatbelts or harnesses). Examples of smaller vehicles that are sold with ROPS fitted as a standard feature include SSVs, Polaris Ace® and golf carts. Many larger vehicles such as tractors, earthmovers, road rollers, front-end loaders and bobcats also have ROPS fitted as standard.

The US voluntary standard for SSVs (ANSI/ROHVA 1–2016) includes the requirement that SSVs be fitted with ROPS and an occupant retention system.

A study conducted by Monash University Accident Research Centre in 2003 used a simulation program to assess the impact of a proposed ROPS system. These simulations without a ROPS present predicted a high probability of potential injury for an incident at 7 km/h and likely death in the two higher speed incident simulations. With the addition of the ROPS structure and rider restraints the predicted injuries were found to be significantly

37 InterSafe submission to ACCC Quad Bike Safety: Issues Paper, p. 13.

38 Bienkowska on behalf of the Commission, 4 July 2017 in response to a written question posed by Mairead McGuinness on 5 May 2017, viewed 5 February 2018. Question available on the European Parliament website.

39 Fianna Fáil The Irish Republican Party, *FF move to improve Quad bike safety – Calleary*, Media Release, 25 February 2018.

reduced. No fatalities were predicted in the three simulated incidents where the ROPS was fitted.[40]

Crush Protection Devices (CPDs)

Another option for operator protection is CPDs. These are mounted onto a quad bike to minimise the risk of the operator being crushed by the vehicle in the event of a rollover. CPDs do not enclose the rider, but instead aim to prevent the weight of the upturned vehicle coming to rest on the rider by holding the upturned vehicle off the ground and creating in effect a 'crawl out' space.

There are a number of innovative CPD designs currently available or being developed and manufacturers have already integrated CPDs on certain models.

Aftermarket CPDs have been available in Australia and New Zealand for over a decade, with examples including the Quadbar and ATV Lifeguard.

The Quadbar is a rigid hairpin shaped hoop mounted on the quad bike behind the rider. It is a bolt on attachment to the tow bar and rack. The ATV Lifeguard is a segmented roll bar, which is flexible and yielding and is designed to absorb and deflect the force of impact around and away from the operator's body. It is fitted by clamping to a metal rear carrier.

Quadbar ®

ATV Lifeguard ®

An automatic rollover protection device known as an 'Air ROPS' is being developed in Spain to provide crush protection for agricultural machinery including general-use model quad bikes. The Air-ROPS system operates in a similar manner to automatic rollover protections systems used in convertible motor vehicles, being activated when the vehicle exceeds a specific pitch angle.[41]

The Victorian and New South Wales governments began rebate schemes in July 2016 to encourage the adoption of quad bike safety measures. The rebates directly subsidise

40 G Rechnitzer, L Day, R Grzebieta, R Zou, S Richardson, Monash University Accident Research Centre, *All Terrain Vehicle Injuries and Deaths*, 2003, cited in S Wordley, B Field, Department of Mechanical and Aerospace Engineering, Monash University, *Quad Bike Safety Devices: A Snapshot Review,* provided to WorkSafe Victoria 3 February 2012, p. 18.

41 University of Navarre submission to ACCC Quad Bike Safety: Issues Paper, p.11.

farmers for the cost of fitting CPDs to quad bikes or purchasing an alternate vehicle and the Victorian rebate scheme alone has contributed to the installation of 1580 CPDs.[42]

Both rebate schemes require farmers or farm businesses to contribute between $0–$926 (subject to location and the type of CPD) of the cost of purchasing an eligible CPD.

Feedback on OPDs

The majority of submissions in response to the Issues Paper that commented on OPDs supported their use, commenting on their beneficial effect in reducing the number of deaths and serious injuries.

The FCAI states that the position of their members is that there is no scientific evidence available which proves that OPDs are a suitable means to reduce the risk of injury in the event of a quad bike rollover.[43] The Australasian Off Road Vehicle Association (AORVA) opposes the mandating of OPDs on quad bikes and commented that there are currently alternative vehicles that have factory fitted ROPS. Additionally a number of stakeholders who oppose OPDs identified operator behaviour as the main cause of incidents.

Several submissions to the Issues Paper, including from the Department of Emergency at the University of Iowa and the UNSW TARS Project reported that CPDs have a net benefit of increasing the health and safety of quad bike riders. They stated that where injuries had been sustained from CPDs, they were often less severe than would have occurred had a CPD not been fitted to the vehicle.

The submission of the Australian Centre for Agricultural Health and Safety indicated there had been no recorded quad bike deaths in Australia or New Zealand caused by a CPD. In the one recorded death in Australia where a CPD was fitted to a quad bike and the rider was ejected from the vehicle (not a rollover) the CPD was reported to have played no part in the injuries sustained by the operator.

Evidence supporting regulation

The ACCC has considered the following evidence to inform its position on OPDs.

- 58 per cent of fatalities associated with the use of quad bikes result from rollovers. McIntosh and Patton (2015) reported that amongst the 55 deaths of riders who were pinned under a quad bike as the result of an incident, the chest was the injured body region in the majority of cases (34/55 cases). Consistently, the mechanism of death was asphyxiation (caused by crushing of the rider) in a majority of cases (28/55 cases)[44]
- Between the years 2003 to 2011 there was an annual decrease of approximately 87 per cent in fatalities caused by tractor rollovers after the introduction of tractor ROPS.
- The US Standard for SSVs (ANSI/ROHVA 1–2016) includes the requirement that ROPS be fitted to the SSV.
- The UNSW TARS Project:

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42 McCubbing G, 'Get quad bike protection' *The Telegraph,* 24 November 2017, accessed 6 February 2018.

43 Federal Chamber of Automotive Industries, *Fitment of Operator Protective Devices to All Terrain Vehicles*.

44 R Grzebieta, G Rechnitzer, A McIntosh, R Mitchell, D Patton, K Simmons, University of New South Wales Transport and Road Safety Research Unit, *Supplemental Report: Investigation and Analysis of Quad Bike and Side by Side Vehicle (SSV) Fatalities and Injuries,* provided to WorkCover Authority of New South Wales January 2015, Attachment 1.

- Reviewed 53 quad bike related deaths that were the subject of coronial inquests and identified that an OPD could have assisted in reducing the rider's injuries or prevent asphyxiated in approximately half of these incidents.[45]
- Found that rollover crash tests indicated that CPDs increase survivability by creating a 'crawl out' space (clearance) and changing the crush loads applied to the operator under certain rollover circumstances. The baseline rollover crash tests demonstrated how the full weight of the quad bike without an OPD could rest on top of the rider in lateral, rearward and forward pitch rolls, whereas when the vehicle was fitted with an OPD the vehicle's full weight did not rest on the rider.
- Reported that installing an OPD would not significantly impact dynamic handling of the vehicle. A quad bike tested with the Quadbar and Lifeguard fitted showed only a minor change in the limit of lateral acceleration which was a significantly lower impact than that caused by loading a general-use model quad bike with cargo up to the maximum specified cargo weights allowed on front and rear carry racks.[46]
- Undertook sub-studies as part of its survey on quad bikes used in the workplace.[47] The first study, involved a quad bike tour company that fitted its quad bikes with an after-manufacture CPD in an attempt to reduce the number of major injury incidents. It found that despite a significant increase in its operation size, the annual number of reported incidents remained the same, resulting in a major proportionate reduction in both the number and severity of injuries by a factor of at least 6 to 10 times.
- The purpose of the second sub-study was to identify if fitting OPDs to quad bikes caused serious injury in rollover incidents in a workplace environment. The survey reported that there were no incidents involving a death or serious injury (to the head or chest) caused by the use of the Quadbar or Lifeguard CPDs. The results indicated that the two CPDs reduced the risk of riders suffering serious chest injuries in rollovers.

- Currently the New South Wales and Victorian governments offer rebates for aftermarket fitting of eligible CPDs.
- Research on the effectiveness of OPDs using computer simulations has been conducted by Dynamic Research Inc (DRI) and Delta–V Experts:
  - DRI tests found that the effect on injuries and fatalities of adding a Quadbar to a quad bike was small and not statistically significant.[48]
  - Delta-V assessed the effect of an OPD on the frequency of mechanical asphyxiation resulting from rollovers. Nine thousand simulations were performed and a reduction in the percentage of asphyxiations was reported when OPDs were fitted. Results varied from a 55 per cent reduction to a 100 per cent reduction in asphyxiation, depending on the type of OPD installed.[49]
- The majority of submissions in response to the Issues Paper that commented on CPDs supported their use, commenting on their beneficial effect in reducing the number of deaths and serious injuries.

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45 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Rollover Crashworthiness Test Results: Report 3*, provided to WorkCover Authority of New South Wales January 2015, p. 20.

46 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Dynamic Handling Test Results: Report 2*, provided to WorkCover Authority of New South Wales January 2015.

47 University of New South Wales Transport and Road Safety Research Unit, *Quad Bike and OPD Workplace Safety Survey Report: Results and Conclusions*, provided to SafeWork NSW 31 May 2017.

48 J W Zellner, S A Kebschull, R M Van Auken, Dynamic Research Incorporated, *Updated Injury Risk/Benefit Analysis of Quadbar Crush Protection Device (CPD) for All-Terrain Vehicles (ATVs)*, 3rd Rev, 8 August 2016.

49 S Richardson, A Sandvik, T Gaffney, N Josevski, W P (T) Pok, B Winter, presentation by Shane Richarson, Delta-V Experts, for FarmSafe 2014 in Launceston, Tasmania on 15 and 16 October 2014, *Simulation and analysis of quad bike rider risk of being traumatically or mechanically asphyxiated as a result of a rollover*.

- There is also international support for OPDs. A study of deaths and injuries associated with quad bikes conducted in the United States in 2014 reported that overturning and rollover incidents were the highest causes of deaths (approximately 60 per cent) between1982 – 2014 and also caused approximately 60 per cent of non-fatal injuries.[50] The study reported that at least 13,617 deaths were associated with quad bikes over the same period and commented that CPDs have the potential to prevent deaths and serious injuries associated with quad bike rollovers.
- Honda previously supplied the Israeli Defence Force with a quad bike fitted with a CPD as standard issue which was later adapted to civilian use.[51] As noted previously, since the early 1990s, Israel has mandated the fitting of CPDs to all quad bikes as a condition of registration. A number of the major quad bike brands continue to supply quad bikes to Israel.
- Polaris supplies the US Army with quad bikes fitted with rollbars[52] and these are also available to United States' state and local government agencies through approved schemes.[53]

US Army Polaris Sportsman ® MV850

- After-market OPDs are classified as safety components in the EU and require CE marking and can be voluntarily retrofitted to quad bikes. The ATV Lifeguard has been awarded a CE marking.[54]

Conclusion

An OPD will not prevent a rollover from occurring. However, the data indicates that there is a strong likelihood that OPDs fitted to general-use model quad bikes will reduce the risk of injury caused by a rollover and decrease the severity of injury and risk of death.

8.4. Stability and dynamic handling

The ACCC is proposing performance tests that will improve the stability and dynamic handling of general-use model quad bikes to reduce the number of incidents involving these vehicles. This outcome will be best achieved by setting minimum performance requirements

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[50] M L Myers, H P Cole, International Society for Agricultural Safety and Health, Paper No. 16-02, *Crush Prevention Device Safety for ATVs Paper*, June 2016 p.1 and 6.

[51] University of Navarre submission in response to the ACCC Quad Bike Safety: Issues Paper, p. 6.

[52] Ibid.

[53] Polaris, Government and Defense*, How to buy*.

[54] Correspondence with ATV Lifeguard and ATV Lifeguards Twitter, 12 January 2018, accessed 15 January.

that general-use model quad bikes must satisfy, allowing innovation by manufacturers to select the best ways to meet these requirements.

Stability

The overall stability of a mobile four wheel drive vehicle is determined by its dynamic stability characteristic which is dependent on its suspension and steering. Track width and height of centre of gravity are key factors which affect lateral (or rollover) static stability. The static stability factor of a vehicle governs its fundamental stability. [55]

The UNSW TARS Project conducted static stability tests to determine the rollover resistance characteristics of quad bikes and SSVs as rollover (lateral roll, rear pitch roll and forward pitch roll) was identified from the fatality data as a dominant cause of deaths and injuries. A series of tests were conducted for lateral rollover and forward and rearward pitch rollover based on tilt table tests with and without a rider and with combinations of maximum cargo loads positioned on the front and rear of the vehicle. The effects of a selected sample of OPDs on static stability were also tested.

It was noted that fundamental engineering principles recognised stability as an essential criterion for stationary and mobile systems and the defining characteristics for static stability followed the laws of physics and the actions of bodies subjected to the force of gravity. As such, for a stationary body to achieve a static equilibrium it must have a sufficient footprint to provide an opposing static force capable of overcoming any lateral overturning forces acting upon it to avoid rolling over.[56]

One of the quad bikes tested was a prototype quad bike that was modified. This vehicle incorporated increased track width (around 150mm added to either side compared to the Honda-TRX700XX, for example), an open and lockable rear differential, and modified suspension design (independent suspension and shock absorber tuned for spring and damping) aimed at significantly improving stability and dynamic handling.

The intention of testing this vehicle was to demonstrate that the rollover resistance and dynamic handling of quad bikes can be significantly improved.

The UNSW TARS Project found that all the quad bikes and SSVs tested would satisfy the respective static stability requirements of the ANSI/SVIA 1–2010 and ANSI–ROHVA 1–2011 for SSVs, which the authors stated was an indication the requirements in these standards were possibly set too low.[57] The relatively low lateral static stability values of all the tested commercially available general-use model quad bikes were found in many cases to be incompatible with traversing steeper slopes while fully loaded in a work environment and on the terrain on which these vehicles were being used, particularly on farms.

The static stability tests indicated that if the tested quad bikes were to be used to carry various loads such as hay bales or liquids in spray tanks they would have a lower resistance to rollover than any of the tested SSVs. In comparison to quad bikes, SSVs demonstrated a higher lateral Table Tilt Ratio (TTR) of up to 40 to 60 per cent, which suggested that the use of quad bikes should be restricted to relatively low slopes and lower turning speeds for safe operation. The increased use of SSVs on farms and workplaces in place of quad bikes was noted.[58]

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55 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Static Stability Test Results: Report 1*, provided to WorkCover Authority of New South Wales January 2015.

56 Ibid.

57 The US and EN Standards stipulate only a rearward pitch stability and do not define forward pitch or lateral roll stability requirements.

58 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Static Stability Test Results: Report 1*, provided to WorkCover Authority of New South Wales January 2015.

The ACCC has been informed that one possible reason why quad bikes are generally designed to be less than 50 inches wide is because in the United States there are rules imposed by the Forest Service of the federal Department of Agriculture that place restrictions on the use of off-highway vehicles, including quad bikes that are in excess of certain widths in designated areas. The ACCC has not been able to verify the validity of this claim. It should be noted that Australia does not have such limits.

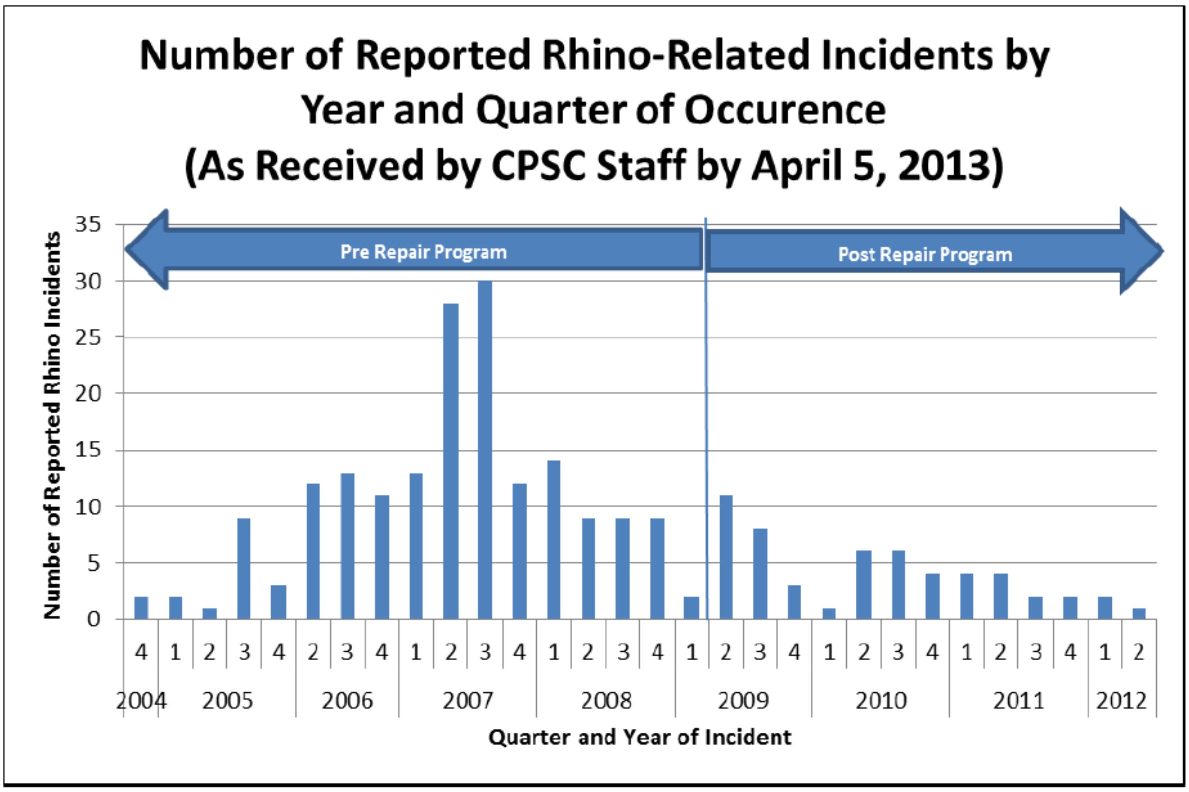
Evidence supporting regulation

The ACCC has considered the following evidence to inform the position on improving the stability of general-use model quad bikes:

- In the majority of cases, deaths occur as a result of lateral pitch rollover and to a lesser extent forward and rearward pitch rollover.
- The static stability factor of a quad bike is a key characteristic that significantly influences the stability of the vehicle during use. Principal static stability characteristics are the vehicle's fundamental geometric properties of centre of gravity height, wheel base and track width.
- In response to a significant number of incidents in the United States with the Yamaha Rhino (SSV), including 46 deaths (consisting of either the fatality of an operator or passenger), a repair program for the vehicle was undertaken. The repair consisted of the addition of 50-mm spacers on the rear wheels to increase the track width, and the removal of the rear stabilizer bar to effect understeer characteristics. The result of the repairs was a significant decrease in the number of incidents (see Figure 3 below).[59] This example illustrates how improvements to static stability contributes to improving the operational safety of a vehicle.

[59] The United States Federal Register: The Daily Journal of the United States Government, *Safety Standard for Recreational Off-Highway Vehicles (ROVs): A Proposed Rule by the Consumer Product Safety Commission on 11/19/2014*, The United States National Archives and Records Administration.

Figure 3: Rhino-Related Incidents Pre and Post Repair Program



- Results of tests conducted by the UNSW TARS Project and SEA Limited (SEA) (2017, 2018) indicate that better static stability lowers the risk of tip-up and subsequent rollover, which may occur during cornering. [60] [61] [62]
- The wider track prototype quad bike tested by UNSW TARS Project was found to have a much higher lateral TTR (on average 50 per cent higher) than all of the other quad bikes tested and was comparable with some of the SSVs tested.[63]
- The ANSI/SVIA ROHVA 1–2016 Standard stipulates minimum requirements for the lateral stability and rearward and forward pitch stability of SSVs.

Conclusion

The above evidence demonstrates a direct relationship between increased static stability and increased rollover resistance, which reduces the risk of lateral, forward and rearward rollovers.

The best outcome will be achieved by setting minimum stability requirements rather than prescribing specific design solutions to allow manufacturers to choose the best design solutions to achieve those requirements.

See Attachment D for detailed testing criteria.

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60 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Dynamic Handling Test Results: Report 2*, provided to WorkCover Authority of New South Wales January 2015.

61 G Heydinger, SEA Vehicle Dynamics Division, *Vehicle Characteristics Measurements of All-Terrain Vehicles: Results from Tests on Twelve 2014-2015 Model Year Vehicles*, provided to the United States Consumer Product Safety Commission January 2017.

62 G Heydinger, SEA Vehcile Dynamics Division, *Effects of ATV Vehicle Characteristics of Rider Active Weight Shift: Results from Tests on Twelve 2014-2015 Model Year Vehicles*, provided to the United Sates Consumer Product Safety Commission January 2018.

63 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Static Stability Test Results: Report 1*, provided to WorkCover Authority of New South Wales January 2015.

Dynamic Handling

The tests performed as part of the UNSW TARS Project related to vehicle control and handling characteristics that were likely to improve the operator's path control and the vehicle's resistance to rollover. Following its review of coronial investigations into quad bike related deaths where rollover was identified as the most significant cause of fatal crashes, the UNSW TARS Project focussed its testing on riding and handling characteristics that can potentially cause loss of control on firm ground, including unsealed roads, or paddocks and/or after striking an obstacle.

The UNSW TARS Project considered:

- understeer/oversteer characteristic and the steering response time to determine vehicle controllability.
- suspension system response to a bump or single obstacle impact which could cause the rider to be displaced and fall from the saddle or result in a rollover

It was found that there was a distinct relationship between fundamental vehicle control characteristics and the occurrence and consequence of certain de-stabilising events.

Tests demonstrated that a light understeer characteristic for quad bikes resulted in a more forgiving vehicle with enhanced dynamic stability and better responsiveness to operator control. In contrast, test results demonstrated that vehicles exhibiting oversteer characteristics had reduced rollover resistance.

The UNSW TARS Project also referred to the Yamaha Rhino 450, 660 and 700 model ROVs recall in the United States by the CPSC to address stability and handling issues with these models. It was noted that there was a significant reduction in the number of deaths following modifications to increase lateral stability and to change the handling characteristics from oversteer to understeer. In its September 2014 report proposing a Safety Standard for ROHVs, the CPSC stated:

> *the commission believes that improving lateral stability (by increasing rollover resistance) and improving vehicle handling (by correcting oversteer to understeer) are the most effective approaches to reducing the occurrence of ROV rollover incidents.*[64]

The ACCC is recommending in Option 4 and 5 that general-use model quad bikes meet performance requirements for dynamic handling, including understeer characteristics. The test for this requirement is a procedure modelled on ISO 4138:2012; Passenger Cars - Steady state circular driving behaviour - Open-loop test methods[65] which has been modified to suit the physical and dynamic characteristics of quad bikes.

The dynamic handling characteristics of a vehicle form a very important part of vehicle active safety, especially so for a vehicle that offers little or no crash protection, making crash avoidance ever more important. A quad bike travelling at a moderate rate of 25 km/hr will cover almost 7 metres of ground every second. A vehicle that is slow to respond or that responds differently in similar circumstances, or that has responses that change over time independent of operator actions, is an unpredictable and difficult to control vehicle.

A vehicle that has an oversteer characteristic will also have a Critical Speed, which is the speed at which the vehicle will become dynamically unstable. Critical Speed is a function of both the oversteer gradient and the wheelbase. Short wheel-based vehicles (such as a quad

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64 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Final Project Summary Report: Quad Bike Performance Project Test Results, Conclusions, and Recommendations: Report 4*, provided to WorkCover Authority of New South Wales January 2015, p. 39.

65 ISO 4138:2012, Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods.

bike) can have a Critical Speed within speed ranges that average riders would consider to be safe speeds. Vehicles that have an understeer characteristic do not have a Critical Speed.

See Attachment D for test criteria.

Mechanical suspension

Quad bikes typically have either a rigid or an independent suspension system. In a rigid suspension system, the wheels are joined by a rigid single axle with either one or two shock absorbers and when one wheel traverses over an object, the other wheel is also affected.

In an independent suspension system, the wheels are connected to the central frame by two independent axles, so that when one wheel traverses an object, the other wheel is largely unaffected.

Rigid suspension systems are generally cheaper to manufacture and are more commonly fitted to less expensive quad bike models. Independent suspension systems are comparatively more expensive to manufacture and are more commonly fitted to higher-end quad bike models.

Evidence supporting regulation

The ACCC has considered the following evidence to inform its position on mechanical suspension:

- Rough ground can contribute to rollovers and result in deaths and injuries from an operator being ejected or falling off the vehicle. Among the fatalities examined by UNSW TARS Project, loss of control caused by an object alone or with another factor (slope or turning) is reported to be the initiator of a significant number of rollovers resulting in deaths.
- Independent rear suspension systems are already commonly fitted to higher-end quad bike models, so designs are already in widespread use.
- The UNSW TARS Project:
    - Found the dynamic handling of quad bikes can be improved where the suspension is designed to avoid rider displacement off the seat when one side of the wheels traverse (asymmetrically) over a bump of a height of approximately 100-150 cm.
    - Eleven quad bikes with a test dummy were subjected to a bump obstacle test. It was found that the four quad bikes where the test dummy exhibited the lowest displacement were fitted with an independent rear suspension.
- The ACCC notes that stakeholders who commented on design solutions broadly supported designs with an independent rear suspension

Conclusion

The above evidence demonstrates that better designs for rear suspension (e.g. independent rear suspension) will improve the safety of general-use model quad bikes, particularly when the vehicle collides with a hidden object or encounters an unexpected change in terrain.

It is the ACCC’s view that the best outcome will be achieved by setting testing criteria for mechanical suspension rather than prescribing a specific design to allow manufacturers to choose the best design solutions.

See Attachment D for detailed testing criteria

Rear differential

The type of wheel differential also affects stability and handling, particularly when a general-use model quad bike is operated on different types of terrain and in varying weather conditions.

An open differential allows the wheels to rotate at different speeds so that the outer wheel, which travels a greater distance, rotates at a faster rate than the inner wheel during cornering. On firm ground, this type of differential provides for greater control while cornering by producing an understeer characteristic, where the front wheels slip and the front end of the vehicle pushes towards the outside of a corner so that the vehicle changes direction less than it would based on input provided by the operator.

A locked differential forces the wheels to rotate at the same speed, which may lead to a loss of control of the vehicle and subsequent rollover as cornering speed increases by producing an oversteer characteristic. This can cause the rear wheels to slip and push in the opposite direction to the turn so that the vehicle steers or turns more sharply than the input provided by the operator.

The UNSW TARS Project found that most of the test quad bikes had a fixed or locked rear differential. In the steady state circular driving behaviour tests, all vehicles were tested in 2WD mode only and quad bikes with a locked rear differential demonstrated oversteer characteristics, which are not favourable for riding on firm flat surfaces.[66] In contrast, most SSVs included as part of the test had an open rear differential (or allowed the operator to choose an open or locked rear differential) and exhibited light understeer handling characteristics.[67]

For off-road operation on rough or uphill surfaces with low friction, it is essential that the differential be lockable to provide acceptable traction and handling on such surfaces.[68]

The EU Regulation requires open differentials to be fitted on all quad bikes that are intended to be used on public roads and that where they have lockable differentials, the default setting is required to be open to enhance the functional safety of the quad bike.

From the information presented to the ACCC, most quad bike models on the market do not have the option to use an open rear differential, irrespective of whether they are operating in 2WD mode or 4WD mode if it is available. The exception is the Polaris Sportsman 570 X2 EPS with VersaTrac (turf mode), which allows the use of both an open and locked rear differential.

Evidence supporting regulation

The ACCC has considered the following evidence to inform its position on rear differentials.

- Deaths examined by UNSW TARS Project found that speed and turning capability were contributing factors to loss of control.
- In the UNSW TARS Project, 72, steady state circular driving behaviour tests were undertaken on asphalt and grass surfaces, with all vehicles tested in 2WD mode. Most SSVs and the prototype quad bike had open rear differentials, while all other quad bikes

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66 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Dynamic Handling Test Results: Report 2*, provided to WorkCover Authority of New South Wales January 2015 and R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Final Project Summary Report: Quad Bike Performance Project Test Results, Conclusions, and Recommendations: Report 4*, provided to WorkCover Authority of New South Wales January 2015.

67 Ibid.

68 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Dynamic Handling Test Results: Report 2*, provided to WorkCover Authority of New South Wales January 2015.

had locked rear differentials. Vehicles with open rear differentials generally maintained favourable light understeer characteristics as the speed increased. When the inside wheel eventually lifted off the ground, the drive transferred to the free wheel causing it to spin up, resulting in a slight loss of vehicle speed and the inside wheel returned to the ground. For most vehicles with locked rear differentials, as the speed increased the vehicle experienced a change from understeer to oversteer characteristics and when the threshold lateral acceleration was reached, the inside wheels lost contact with the ground and the vehicle tipped onto the outside wheels.

- The benefits of open differentials on hard surfaces are further reinforced by the requirements of EU Regulation. This applies to vehicles that are intended to travel on public roads and does not apply to vehicles that are primarily intended for off-road use and designed to travel on unpaved surfaces. Under this regulation, quad bikes must have wheels that can rotate at different speeds at all times for safe cornering on hard-surfaced roads.
- In considering whether the addition of an open rear differential option may lead to increased operating complexity and subsequent adverse consequences, it is noted that operators of high-end models already have three options to choose from; 2WD, 4WD and 4WD with lockable front differential modes. There is no evidence that having these choices available causes operator confusion leading to problems in practice.

Conclusion

Available evidence from testing indicates that quad bikes that have the capacity for the rear wheels to spin at different speeds with the option of being locked will be safer to operate across the full range of operating conditions and surfaces encountered in Australia, than quad bikes that do not have this feature.

The ACCC recommends that general-use model quad bikes be designed in such a way that each of the wheels can rotate at different speeds, in order to allow safe cornering on hard surfaces and if it is equipped with a lockable differential, it must be designed to be normally locked.

8.5. Youth quad bikes

Between 2011 and 2017, in cases in which the type of quad bike was recorded, one child was found to have died while riding a youth quad bike and 12 died while riding an adult quad bike.[69]

Injury data from CARRS-Q indicates that between 2009 and 2013 more than 27 per cent of all hospital ED presentations and 23 per cent of all hospitalisations in Queensland involved children below the age of 14 years. The type of quad bike involved in these incidents was generally not recorded.

From the information currently available, it is difficult for the ACCC to accurately ascertain the magnitude of risk that children are exposed to while operating youth quad bikes.

The US Standard defines a youth model quad bike as a vehicle of an appropriate size, which is intended for recreational use under adult supervision by an operator below the age of 16 years. The appropriate size is determined by the age of the operator by reference to three specific age group categories, 6 years and above, 10 years and above and 12 years and above. The standard also provides for an appropriate size 'transitional model' of youth quad bike that is intended for recreational use by an operator aged 14 years or above with adult supervision or by an operator aged 16 years or above. All categories of youth model quad bikes are required to comply with stipulated requirements including:

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69 Safe Work Australia 2017, Australian Government, viewed 14 March 2018.

- maximum unrestricted speed capability
- maximum speed limit, and
- an appropriate speed limiting device delivered from the manufacturer.

The ACCC understands that industry has implemented these required maximum speed capabilities by the integration of speed control systems that limit the maximum speed achievable on youth quad bikes.

The ACCC notes that some youth quad bike manufacturer operator manuals contain a safety message stating that:

- a child under the age of 6 years should never operate a quad bike with engine size greater than 50cc
- a child under the age of 12 years should never operate a quad bike with engine size greater than 70cc
- a child under the age of 16 years should never operate a quad bike with engine size greater than 90cc

The ACCC is aware of at least one case in Australia where a quad bike with an engine displacement volume of 110cc is marketed as ‘a great entry level machine for kids to learn on’. A headline representation of this kind may lead consumers to believe that the bike is appropriate for children below the age of 16 years. This particular model of quad bike was involved in the death of a 7-year-old child in 2017.

There is currently no regulation of Youth quad bikes in Australia and suppliers can market them to any age group. However, the ACL provides that a person engaged in trade or commerce must not engage in misleading or deceptive conduct, or in conduct that is liable to mislead the public about the characteristics or the suitability of goods for their purpose.

The adoption of the US Standard will, as a minimum, require suppliers of youth quad bikes to correctly identify the appropriate age group for which the Youth quad bike is suitable.

The ACCC intends to keep a close watch on marketing practices of quad bike suppliers to ensure that they are not engaging in misleading or deceptive conduct and will continue to monitor the safety hazards posed to children by Youth quad bikes.

8.6. Additional Labelling and Information

The risk of rollover

The US Standard for quad bikes does not require the provision of information warning consumers of the risks of rollovers. This is important information that consumers should be made aware of. The ACCC is recommending that a label be affixed to all quad bikes and information be contained within their respective operation manuals alerting operators of the risk of rollovers. The ACCC is not recommending this for SSVs because the ANSI/ROHVA 1–2016 standard already imposes a similar requirement.

Differential

A vehicle equipped with a lockable differential should have appropriate advice provided to consumers in the Instruction Handbook advising that the rear differential should be locked before attempting more demanding off-road manoeuvres and when travelling on an incline or on loose, low friction or rough surfaces. Quad bikes should also have a notice affixed near the differential lock selection control advising the rider when to lock the differential.

8.7. Second hand vehicles

A safety standard requires compliance of the goods at the time they are supplied. Goods supplied prior to the existence of the safety standard are not required to comply with the standard. However, if a good is not subject to the safety standard at the time of initial supply, but is subsequently re-supplied (a second hand good), it must comply with the standard, and failure to do so would contravene section 106 of the ACL.

Safety standards can be made in relation to “goods of a particular kind”. In specifying the consumer goods to which the particular safety standard applies, the standard can expressly exclude second hand goods. An example of this is provided by the Consumer Protection Information Standard Care Labelling for Clothing and Textile Products (*Consumer Protection Notice No.25 of 2010*) which specifically exempts second hand clothing from the goods subject to the Standard.

The majority of submissions in response to the Issues Paper suggested that any standard should not apply to second hand vehicles. Introducing regulation must be proportionate and not place any unnecessary burden on impacted parties. As such, the ACCC is proposing to exempt second hand (used) vehicles from the proposed safety standard.

8.8. Implementation

The Issues Paper asked a range of questions relating to the internal workings of a standard, including: the vehicles it should apply to, when the standard should commence, whether there should be a transitional period and whether it should have an expiry date. The responses received from stakeholders have informed the below considerations.

Transition period

Implementation of a new standard for quad bikes would need careful planning to ensure that any new requirements are achievable, well designed and do not cause additional safety issues.

Submissions to the Issues Paper generally supported the need for a transition period and various suggestions were made as to how the transition period should operate. Industry stakeholders noted the adoption of the existing US Standard could occur quickly and would not require a long transition period. Other stakeholders suggested that if any additions were made to the design requirements beyond the US Standard, the transition period would need to be longer to allow industry to respond to the new requirements.

Based on this feedback, the ACCC is proposing to recommend that if a standard has multiple requirements, some more complex than others, it should allow for a phased transition period over 24 months from the date of its commencement.

EXAMPLE FOR ILLUSTRATIVE PURPOSES

Phase 1 (6 months):

- Quad bikes required to meet the US Standard; and
- Quad bikes required to display any additional warnings or instructions.

Phase 2 (12 months):

- Vehicles are required to be tested to certain criteria in accordance with a safety star rating system;
- Vehicles required to display the awarded safety star rating at the point of sale.

Phase 3 (24 months)

- General-use quad bikes must meet specific design requirements.

A transition period does not preclude parties bound by the standard from adopting its requirements early. The ACCC is seeking feedback as to the best approach.

Review of the standard

The Issues Paper asked whether a standard for quad bikes should have an expiration date. The majority of stakeholders who responded to this question were of the view that a standard should have a review date, but not an expiration date.

The ACCC may review the standard before the end of the period of five years after its commencement and may consider:

- the extent to which the standard addresses any safety issues with quad bikes supplied in Australia
- the level of compliance with the standard by manufacturers, importers and retailers
- whether there are any further measures that would improve the safety of quad bikes
- whether there has been any developments on international standards
- whether the standard should continue or be repealed.

9. What policy options are being considered?

9.1. Policy Focus

As stated above product safety best practice includes consideration of product safety at the design stage. However, rather than develop design solutions through engineering controls at the design stage manufacturers have focussed their efforts primarily towards managing product risk through administrative controls such as promoting the use of personal protective equipment and safety campaigns.

The design solutions proposed in Options 3, 4 and 5 do not extend to SSVs, youth or sport model quad bikes, which have different performance and handling characteristics.

The main options the ACCC is considering are:

- the adoption of the US Standard ANSI/SVIA 1–2017 to ensure that all quad bikes on sale in Australia conform to a minimum industry standard
- a requirement that all quad bikes and SSVs are tested to a safety star rating system to encourage safer design. It will also provide key information about quad bike and SSV safety characteristics to consumers to better inform their purchase decisions.
- The requirement for the integration of OPDs in the design of general-use model quad bikes
- The requirement of minimum performance criteria that will improve the stability, dynamic handling and mechanical suspension of general-use model quad bikes.

9.2. Preliminary position

The ACCC currently prefers Option 5. Option 5 includes measures to best address each of the design and information asymmetry issues that create product safety risks for quad bike and SSV operators. Option 5 thus provides the greatest benefit in terms of reducing the risk of death and injury.

9.3. Detailed Policy Options

For a proposed regulation that aims to achieve improved safety and reduce deaths or injuries, a difficulty arises in attempting to attribute a cost to the loss of a life or an injury. The following analysis uses guidance provided by the Australian Government on this question, solely for the purpose of enumerating and comparing probable costs and benefits arising from different policy options. The ACCC acknowledges that in reality, it is not possible to allocate a value to the life of a person.

Option 1

Take no action

Description

Under this option, there would be no additional regulation of the supply of quad bikes and SSVs.

Suppliers would still need to comply with the consumer protection provisions of the ACL. The ACL provides consumers with specific protections, known as consumer guarantees, which are enforceable each time a consumer purchases goods or services. One of those guarantees is that goods will be of acceptable quality, defined in the ACL as being as safe, fit for purpose and free from defects as a reasonable consumer would regard as acceptable in the circumstances.

Under this option, manufacturers and retailers of quad bikes and employers would also need to continue to comply with other Commonwealth and state and territory laws relating to quad bikes.

The ACCC does not favour this option as it considers that regulation targeted specifically at improving the safety of quad bikes and SSVs is essential to provide the necessary impetus to manufactures to implement design changes and provide better vehicle safety information. In turn these are likely to prevent and reduce the number of deaths and injuries attributable to the operation of quad bikes and SSVs in Australia.

Deaths

Guidance is published by the Office of Best Practice Regulation on how to treat the benefits of regulations designed to reduce the risk of physical harm or death. This guidance uses an estimate of $4.2 million (2014) based on empirical evidence for the value of a statistical life. Escalated to December 2017 dollars, this figure becomes $4.45 million.

Over the period 2011–17, there was an average of 17 deaths per year in Australia associated with the operation of quad bikes and SSVs.

- Cost of lives lost per year = value of a statistical life x average number of deaths per Year ($4.45 million x 17 deaths)

The total cost of lives lost per year is $75.7 million.

Injuries

The cost of an injury can vary greatly depending on its severity. In estimating the total cost of injury and for the purposes of this Consultation RIS, the costs associated with the following descriptions of injuries have been considered:

- disabling injuries that require hospitalisation and which result in long term impairment
- serious injuries that require hospitalisation but which do not result in long term impairment
- minor injuries that require Emergency Department presentation only and do not result in hospitalisation

The OBPR uses an estimate of $182 000 (2014 value) for the value of a statistical life year. Updated to December 2017 dollars, this figure becomes $191 400 per year.

The OBPR suggests the use of a Disability Adjusted Life Year (DALY) which provides a measure of the level of disability associated with an injury, where a weight of 1 represents one year of healthy life lost[70].

The cost of an injury is calculated below.

Cost of Injury = DALY weight x value of statistical life year x average duration of injury

As there is no repository for quad bike and SSV injuries data in Australia, the average range of cost of the different types of injuries attributed to quad bikes and SSVs in each injury category has been estimated from the data available as set out in Table 5.

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70 The DALY ranges from 0 to 1 depending on type and severity of injury.

Table 5: Summary of average injury cost estimates[71] [72] [73] [74] [75] [76]

Injury severity	Minor (ED)	Hospitalisations	Disabling
Range of average cost estimates	$1 000–$19 400	$39 800–$352 800	$351 200–$4 117 400

Given the range of estimates, and the uncertainty of the number of injuries that involve a permanent impairment, it is difficult to assess the average cost of an injury. The ACCC has referred to a number of data sources to provide an estimate of $176 800 as the average cost of a hospitalised injury. This estimate was derived from:

- data provided by CARRS-Q[77] to determine the nature and severity of injuries (Table A5.1, hospitalised injuries)[78]
- the OBPR value of a statistical life year
- Bureau of Transport Economics[79] and Safe Work Australia[80] estimates on community and workplace costs
- ambulance attendance data and aero recovery data.[81] [82]

The estimated total annual cost of injuries is calculated by combining the cost of each injury category.

Average cost of hospitalised injury x average number of hospitalised injuries per year) + (average cost of a minor injury x number of ED injuries not hospitalised)

= ($176 800[83] x 654) + ($10 200[84] x 1646[85])

The estimated total cost of injuries per year is $132.4 million.

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71 Safe Work Australia, *The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13*, November 2015, viewed 28 February 2018.

72 Department of Infrastructure and Regional Development, Early Assessment: Regulation Impact Statement, *Advanced Motorcycle Braking Systems for Safer Riding*, April 2017, viewed 7 February 2018.

73 IDC Technical Reference Group submission in response to the ACCC Quad Bike Safety: Issues Paper.

74 ACCC estimates, including an analysis of quad bike injury severity.

75 InterSafe submission in response to the ACCC Quad Bike Safety: Issues Paper.

76 For consistency, the costs have been adjusted (where necessary) to December 2017 values using the ABS CPI Inflation Calculator.

77 K Vallmurr, A Watson, J Catchpoole, Centre for Accident Research and Road Safety – Queensland, *Quad bike-related injuries in Queensland: Final Report*, August 2017, viewed 19 February 2018.

78 Permanent injury cases were estimated from the fraction of spinal cord injuries reported (0.4%) and traumatic brain injuries (10.8%, which excludes open wound cases). In its submission to the Issues Paper, InterSafe estimated the cost of injury assuming 6%-7% of (1400) cases result in permanent impairment, and using an estimated average whole body impairment of 5%.

79 Bureau of Transport Economics, *Road Crash Costs in Australia: Report 102*, 2000, viewed 19 Feburary 2018.

80 Safe Work Australia, *The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13*, November 2015, viewed 28 February 2018.

81 R Franklin, submission in response to the ACCC Quad Bikes Safety: Issues Paper, K Vallmurr, A Watson, J Catchpoole, Centre for Accident Research and Road Safety – Queensland, *Quad bike-related injuries in Queensland: Final Report*, August 2017, viewed 19 February 2018.

82 Ibid.

83 ACCC estimate, including an analysis of quad bike injury severity.

84 Mid-point of the minor injury average cost estimates (Table 5).

85 Mid-point of the estimated injuries presented to ED and not hospitalised per year.

Total costs of deaths and injuries

The total annual cost of quad bike and SSV deaths and injuries in Australia is estimated to be approximately $208.1 million (2017 dollars).

This estimate does not cover the full impact of deaths and injuries and only takes the number of recorded injuries into consideration. As such, it is likely that a significant number of injuries that were not presented to hospital were not recorded. Additionally the estimate does not include intangible costs associated with deaths and injuries, including but not limited to, the pain and suffering of family and friends, costs to emergency workers and affected communities.

Benefits

Under Option 1, it is likely that manufacturers will continue to supply the current makes and models of quad bikes, therefore consumer choice would not be restricted.

Allowing quad bikes and SSVs to remain unregulated would mean they are less likely to increase in price as there will be no additional regulatory costs imposed on manufacturers or passed onto consumers.

Limitations

Given the current number of deaths and injuries associated with the use of quad bikes in Australia, a decision not to impose additional regulatory intervention to improve the safety of quad bikes is likely to result in an ongoing intolerable number of deaths and injuries suffered by consumers.

In addition, in the absence of regulation there would be no impetus for manufacturers to take any steps to improve the safety of quad bikes and SSVs.

Net Benefits

The ACCC will assess the net benefits of the other policy options against this option of no additional regulation, which is estimated to currently impose an annual cost on the Australian economy of $208.1 million.

Option 2

Make a mandatory safety standard that:

- adopts the ANSI/SVIA 1–2017 US Standard for quad bikes
- requires post manufacture testing for quad bikes and SSVs in accordance with the requirements of the safety star rating system and the disclosure of the star rating at the point of sale
- requires an additional warning on quad bikes alerting the operator to the risk of rollover.

Description

This option requires that all quad bikes sold in Australia comply with ANSI/SVIA 1–2017 (the US Standard for quad bikes). The US Standard stipulates a number of design, configuration and performance specifications including the provision of consumer information in the form of warning labels, an owner's manual, hang tags and a compliance certification label. A detailed summary of the US Standard is provided at Attachment B.

Option 2 also requires an additional warning label alerting riders to the risk of rollover should be affixed to all quad bikes. The owner's manual will be required to provide information alerting consumers to the risk of rollovers, including when the risk of rollover is increased (e.g. on inclined terrain, whilst carrying a load, when there are hidden objects on the ground, wet or slippery surfaces) and how to best operate the vehicle safely in higher risk conditions.

Figure 4 – proposed warning label

! WARNING !

HIGH RISK OF ROLLOVER DEATH AND INJURY EVEN ON FLAT TERRAIN

AVOID STEEP INCLINES

AVOID RIDING ACROSS SLOPES

PLAN YOUR RIDE

Option 2 further requires quad bikes and SSVs should be tested post-manufacture according to a safety star rating system and that the resulting safety star rating be displayed at the point of sale. This requirement is intended to provide consumers with more information about the safety of different quad bike models, allowing them to make more informed choices. Quad bikes and SSVs will be compared together under the safety star rating system to inform consumers of the relative safety of each of these types of vehicles.

Table 6: Summary of Option 2

Proposed change	Proposed requirements
US Standard	All quad bikes on sale in Australia shall comply with the requirements in the US Standard ANSI–SVIA 1–2017
Rollover warning	All quad bikes on sale in Australia shall have the rollover warning label (above) affixed to the vehicle in a prominent position.

	Additionally the owner's manual shall provide information alerting consumers to the risk of rollovers, when the risk of rollover is increased (e.g. on inclined terrain, whilst carrying a load, when there are hidden objects on the ground, wet or slippery surfaces) and how to best operate the vehicle safely in higher risk conditions.
Safety star rating testing and display at point of sale and affixed to vehicle	All quad bike and SSV models supplied in Australia shall undergo testing in accordance with the criteria in Attachment A and shall have a safety star rating awarded to each model. The awarded star rating must be displayed as a hangtag at the point of sale.
Testing requirements	A summary of the current UNSW TARS testing criteria is at Attachment A. It is possible that the testing criteria could change upon the ACCC's consideration of the IDC's recommendation of the safety star rating model.

Benefits

Adopting the US Standard will ensure all new quad bikes sold are subject to a minimum safety standard and will enable the enforcement of matters where there has been a departure from this minimum standard. This option will also provide key information about vehicle safety characteristics to consumers to better inform their purchase decisions.

Extending minimum safety standards to all new quad bikes will also help to reduce the number and cost of quad bike related deaths and injuries, as older, less safe vehicles are retired.

The ACCC notes that as approximately 95 per cent of the quad bikes sold in Australia already comply with the US Standard, and compliance cost of this requirement will present little or no burden on manufacturers whose models already comply

Fifty eight per cent of all deaths involving quad bikes are attributed to rollovers. The requirement for an additional rollover warning label and the inclusion of information on rollovers in the owner's manual will highlight the risk of rollovers and ensure consumers are aware of the dangers posed by these vehicles.

The testing of quad bikes and SSVs according to the proposed safety star rating system and requirement to display the resulting star rating at the point of sale is likely to reduce the information asymmetry and assist consumers in choosing a vehicle that reduces the risk of injury for their specific needs. The ACCC anticipates that implementation of a star rating system may encourage some consumers to purchase a safer quad bike, while some may instead prefer to purchase an SSV. Regardless, the ACCC expects that better consumer information will help to reduce the number and cost of quad bike related deaths and injuries.

In the longer term, a safety star rating system may generate innovation amongst quad bike manufacturers. Consumers will be able to easily compare not only the price, but also the safety rating of different vehicles and models in the market. However, this option will have less impact on driving safety-related changes than the design-based requirements included in Options 3, 4 and 5.

The ACCC notes that after the introduction of the Australasian New Car Assessment Program (ANCAP) for cars, safety became the third most important consideration of consumers when making purchasing decisions after price and the vehicle's operational costs. Safety features also became more innovative, for example the sales of new cars fitted with airbags jumped from 30 per cent to 50 per cent in the four years following the introduction of the ANCAP.[86]

Limitations

A mandatory safety standard may increase some quad bike production costs to ensure compliance with the US Standard (if not already the case). Additionally, there may be a small increase in post-production costs because of the testing requirements to be performed in accordance with the safety star rating system.

The ACCC notes that as approximately 95 per cent of the quad bikes sold in Australia already comply with the US Standard, and compliance cost of this requirement will present little or no burden on manufacturers whose models already comply.

The TRG has estimated an increase in unit price of $50 per vehicle (a price rise of typically 0.5 per cent –1 per cent, depending on quad bike model) arising from the average cost of testing required for the safety star rating system.

An increase in costs to manufacturers may lead to an increase in the retail price of quad bikes as manufacturers seek to pass the costs of compliance onto consumers.

Net benefits

This option will ensure a minimum standard of safety for all quad bikes sold in Australia and will also provide key information about quad bike and SSV vehicle safety characteristics to consumers to better inform their purchase decisions. However, it is unlikely on its own to result in a significant reduction in the number of deaths and injuries attributed to the operation of quad bikes in Australia as it will not directly bring about quad bike design improvements to reduce the number of deaths and injuries.

Option 3

Make a mandatory safety standard that adopts all requirements in Option 2, and requires general-use model quad bikes to be manufactured with an integrated operator protection device

Description

In addition to the requirements of Option 2, Option 3 requires all general-use model quad bikes sold in Australia to be manufactured with an OPD, which could be either a CPD or ROPS. The fitting of OPDs to general-use model quad bikes is not expected to reduce the number of incidents occurring. The aim of fitting an OPD is to protect the safety of a rider in the event of a rollover, by reducing the risk of death and serious injury.

The proposed definition of an OPD is sufficiently broad to ensure designs are not restricted to only one specific OPD design. Quad bike manufacturers and designers are well placed to assess the most beneficial and innovative OPD design for each of their individual models with minimum regulation. This approach is supported in several submissions received in response to the Issues Paper as it provides different design opportunities. For example, an OPD could be designed so that in the event of a rollover it:

- holds the quad bike off the ground to create a ‘crawl space’
- prevents the vehicle resting on the rider and hence prevents the weight of the vehicle crushing the rider

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[86] M Case, M Griffiths, J Haley, M Paine, *International NCAP Programs in Review*, viewed December 2017.

- facilitates the rider extracting themselves from under the vehicle
- tips the quad bike back onto its four wheels.

The OPD could be integrated into the vehicle by the design considered most appropriate and safe by quad bike manufacturers. Two after-market devices currently available in Australia demonstrate some design possibilities for OPDs, as do those mandated in Israel and supplied to the US Army. Looking to the convertible car industry, it appears to the ACCC that OPD design research and development could drive innovation, so that new and improved devices could be introduced on an ongoing basis as a standard feature of new quad bike models.

Allowing manufacturers to develop appropriate OPDs addresses a fundamental objection to OPDs by providing for the design of OPDs to be considered within the original production specifications of the vehicle.[87]

The ACCC is seeking feedback on an effective minimum OPD design standard. Relevant minimum OPD design considerations include OPDs that are:

- consistent with the specifications and intended use of the vehicle and have a minimal impact on the vehicle's stability (low weight and low centre of gravity)
- rigorously tested by manufacturers
- effective in protecting the rider in rear and side overturns, as well as front and rear overturns
- a safe distance away from the rider to minimise impact with the rider in the event of an overturn, or alternatively not protrude from the vehicle during normal operation.

Additionally, OPDs should not:

- affect driver visibility
- catch overhead branches
- restrict access and egress from quad bikes
- be able to be crushed during incidents and must therefore be able to withstand the weight of the vehicle.

A minimum OPD design standard could require:

- the device to provide a high enough clearance to enable a survival space in the upside-down position
- the device to provide a high enough clearance to provide a 'crawl out' space in the upside-down position
- that any forces on the operator from the mass of the upturned vehicle are minimised
- the chance of the operator being pinned or speared by the vehicle to be minimised.

The ACCC has formed a preliminary view that to encourage innovation, only a minimum requirement for energy absorption should be prescribed, and is seeking feedback on this issue.

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87 KE McBain-Rigg, RC Franklin, GC McDonald, SM Knight, 'Why quad bike safety is a wicked problem: an exploratory study of attitudes, perceptions, and occupational use of quad bikes in northern Queensland, Australia' *Journal of Agricultural Safety and Health,* January 2014, 20(1) p. 44.

Table 7: Summary of Option 3

Proposed change	Proposed requirements
US Standard	As above at Option 2
Warning and safe use labels and owner's manual	As above at Option 2
Safety star rating testing and display at point of sale and affixed to vehicle	As above at Option 2
Testing requirements	As above at Option 2
Integration of an OPD	All general-use model quad bikes sold in Australia shall have a device that ensures, in the event of a rollover, the impact on the operator is minimised and the device is able to absorb the energy of 1.75 times the mass of the vehicle (CPD Absorbed Energy = 1.75 x vehicle mass[88,89]

Benefits

In addition to ensuring that a minimum safety standard is applied to all quad bikes sold in Australia and that key information about quad bike and SSV vehicle safety characteristics is provided to consumers, Option 3 will reduce the number of deaths and severity of injuries attributed to the operation of general-use model quad bikes in Australia. This is because OPDs will prevent a significant number of deaths and reduce the severity of injury associated with rollover events.

The UNSW TARS Project reported that from 2000 to 2012 asphyxiation was identified as the cause of death in 29 of 109 general-use model quad bike incidents (27 per cent)[90] and estimated that 77 percent of these incidents were survivable if the operator had not been pinned underneath the vehicle.[91] Even if an integrated OPD prevented only asphyxiation deaths, this would result in an estimated 20 per cent reduction in the total number of deaths by saving approximately 3 lives every year.

Limitations

Manufacturers of general-use model quad bikes will be required to integrate an OPD into the design of all vehicles of this type sold in Australia.

The retail costs of currently available OPDs on the market is:

- Quadbar: $599 (including GST and delivery)[92]

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88 This has been adopted from ISO 3471, AS 1636.2 2294, SAE J1040.

89 The Health and Safety Executive in 2006 found this formula may result in a 15–17% energy over-estimate for the lowest mass vehicles considered (~ 300 kg).

90 All asphyxia cases were included except asphyxia-drowning cases, which were excluded. R Grzebieta, G Rechnitzer, A McIntosh, R Mitchell, D Patton, K Simmons, University of New South Wales Transport and Road Safety Research Unit, *Supplemental Report: Investigation and Analysis of Quad Bike and Side by Side Vehicle (SSV) Fatalities and Injuries,* provided to WorkCover Authority of New South Wales January 2015, Table 1-36 in Attachment 1.

91 R Grzebieta, G Rechnitzer, A McIntosh, University of New South Wales Transport and Road Safety Research Unit, *Rollover Crashworthiness Test Results: Report 3*, provided to WorkCover Authority of New South Wales January 2015, p. 12.

92 QuadBar Industries, *Online Store*, viewed February 2018.

- ATV Lifeguard: $1240+GST & delivery.[93]

This option may impose additional costs on manufacturers who would have to ensure that general-use model quad bikes include an integrated OPD. Manufacturers may seek to pass on some or all of these costs to consumers. The ACCC will have a better understanding of the impact on consumers after quad bike manufacturers provide feedback on their predicted costings.

Net benefits

This option will prevent more deaths and be more effective in reducing the severity of injuries suffered by operators of general-use model quad bikes than Option 2 and the baseline case but will not prevent the occurrence of rollover incidents.

Option 4

Make a mandatory safety standard that satisfies all of the requirements of Option 2, and in addition requires all wheels on general-use model quad bikes to be able to rotate at different speeds at all times and meet minimum performance tests for:

- static stability
- mechanical suspension
- dynamic handling

Description

In addition to the requirements of Option 2, Option 4 requires general-use model quad bikes on sale in Australia to meet minimum performance tests for static stability, mechanical suspension and dynamic handling. The test requirements are summarised in Table 8 and ultimately relate to increasing the safety of general-use model quad bikes by reducing the likelihood of the driver losing control of the vehicle, and decreasing the likelihood of the vehicle rolling over.

Option 4 also requires all wheels of general-use model quad bikes to be able to rotate at different speeds at all times and if it is equipped with a lockable differential, it must be designed to be normally unlocked. Further, general-use model quad bikes should have appropriate advice provided to operators in the owner's handbook that the rear differential should be locked before attempting more demanding off-road manoeuvres and when travelling on loose, low friction or rough surfaces and on inclines. Under this option, quad bikes should have a notice affixed near the differential lock selection control advising the rider when to lock the differential.

Quad bike manufacturers and designers are well placed to assess the best design solutions to meet the minimum performance requirements for each of their individual models. This will facilitate innovative design opportunities, for example, designing models that can have rear differentials that lock or open without input from the operator.

The ACCC engaged the services of a technical consulting firm, KND Consulting, to develop the performance tests and the minimum performance requirements in Option 4.

93 ATV Lifeguard, *ATV Lifeguard*, viewed February 2018.

Table 8: Summary of Option 4

Proposed change	Proposed requirements
US Standard	As above at Option 2
Warning and safe use labels and owner's manual	As above at Option 2, and a vehicle equipped with a lockable differential shall have appropriate advice provided to riders in the owner's manual that the rear differential should be locked before attempting more demanding off-road manoeuvres, and when travelling on loose, low friction or rough surfaces and on inclines. General-use model quad bikes shall have a notice affixed near the differential lock selection control advising the rider when to lock the differential.
Safety star rating testing and display at point of sale and affixed to vehicle	As above at Option 2
Safety Star Rating Test Requirements	As above at Option 2
Minimum Stability Test Requirements	Stability of general-use model quad bikes is measured using a tilt table using a 50th Percentile Adult Male (PAM) Hybrid III (H3) Anthropormorphic Test Dummy (ATD) as a simulated rider positioned in a standardised seating position, as described in Annex E Stability Test Procedure. The coefficient of stability for each direction (forward or rearward pitch, and lateral roll) is calculated as Tan (Tilt Table Angle at two wheel lift). The measured Tilt Table Ratios (TTR) for stability in Forward (TTRpf) and Rearward (TTRpr) pitch and in Lateral Roll (TTRst) shall comply with the minimum requirements identified below: • Rearward Longitudinal stability (rearward pitch): The Tilt Table Ratio for rearward pitch (TTRpr) measured with a 50 PAM H3 ATD shall be equal to or greater than 1.0. • Forward Longitudinal stability (forward pitch): The Tilt Table Ratio (TTR) for forward pitch (TTRpf) measured with a 50 PAM H3 ATD shall be equal to or greater than 1.10 • Lateral Stability (lateral roll): The Tilt Table Ratio (TTR) for Lateral Roll stability (TTRst) measured with a 50 PAM H3 ATD shall be equal to or greater than 0.80 • For Sport and Youth quad bikes, the stability requirements stipulated in US ANSI/SVIA 1–2017 Section 9, Pitch Stability shall apply.
Minimum Mechanical Suspension Test Requirements	General-use model quad bikes shall be fitted with a mechanical suspension system suitable for the machine to perform its intended function of driving in a variety of terrain types and provide appropriate bump attenuation for the rider and passenger. The minimum wheel articulation shall be 150 mm for all wheels. This articulation is to be centred about (approximately half available for compression and half for rebound) the suspension

	position when the articulation is measured with a 50th PAM H3 ATD seated on the saddle in a normal riding position. General-use model quad bikes shall achieve a bump response of less than 2.0g when tested in accordance with the Bump Response Test Procedure in Attachment D Springing and damping properties shall be provided by components other than the tyres. For Sport and Youth quad bikes, the mechanical suspension requirements stipulated in US ANSI/SVIA 1–2017 Section 4.3 shall apply.
Vehicle Handling Test Requirements	The fundamental handling characteristics of general-use model quad bikes are to be determined using the Dynamic Test procedures described Attachment D, Quad Bike Dynamic Handling Test Procedure. Performance Requirements. The understeer gradient obtained from the testing shall be positive for values of ground plane lateral acceleration from 0.10 g to 0.50 g[94]. Negative understeer gradients (oversteer) shall not be exhibited by the vehicle in the lateral acceleration range specified. Sport and Youth quad bikes are not subject to this requirement.
Safe Cornering Device	General-use model quad bikes shall be constructed such that each of the wheels can rotate at different speeds at all times, in order to allow safe cornering on hard-surfaces. If a vehicle is equipped with a lockable differential, it must be designed to be normally unlocked. The differential lock selection device shall be “self-explaining”, in that the rider shall be able to readily determine if the switch is in the “locked” or “open” position. Sport and Youth quad bikes are not subject to this requirement.

Benefits

The ACCC anticipates that by improving the key safety-related design features of general-use model quad bikes there will be a reduction in the number of incidents across a wide range of terrains and operating conditions in Australia.

Option 4 is significantly different to Option 3 in that it seeks to improve the design of safety-related characteristics of quad bikes and prevent incidents from occurring, compared with Option 3 which aims to reduce the severity of injuries arising from an incident. This is likely to have quite different net benefits.

The UNSW TARS Project tested a prototype quad bike. This vehicle incorporated increased track width, an open and lockable rear differential, and a modified suspension designed to significantly improve the stability and dynamic handling of the vehicle. The results were:

- no inside wheel tip-over or transition from understeer to oversteer characteristics in steady state circle tests, and
- a much higher lateral tilt table ratio (on average 50 per cent higher) than all of the other quad bikes tested and was comparable with some of the SSVs tested.

94 Or up to the maximum lateral acceleration reached for the quad bike, if the cornering speed is limited by operation of an open rear differential.

An examination of crash initiators e.g. loss of control caused by an object, speed, while turning, through collision or on slopes [95] suggests that the proposed design improvements may have reduced the risk of incidents occurring in over 90 per cent of incidences (where the initiator was known).

It is anticipated that Option 4 will reduce the likelihood of incidents occurring:

- from most incident initiators, e.g. loss of control caused by an object, speed, while turning, through collision or on slopes,
- on all types of operating terrain, and
- across different types of incidents, including rollovers, collisions and riders falling from the quad bike.

There are a number high end quad bike models sold by a range of manufacturers that are currently available in the Australian market which include an independent rear suspension. The ACCC understands that of models currently sold in Australia, only one model has an open rear differential option. Quad bikes typically have a width less than 50 inches.

In response to a significant number of incidents in the United States with the Yamaha Rhino (SSV), including 46 deaths (consisting of either the fatality of an operator or passenger), a repair program for the vehicle was undertaken. The repair consisted of the addition of 50 mm spacers on the rear wheels to increase the track width, and the removal of the rear stabilizer bar to effect understeer characteristics. In the three years before the repair program there were 163 incidents reported to CPSC, while in the three years post program there were 53 incidents. Thus there were 110 less incidents reported over the three years post repair program, a 67 per cent reduction. Noting that this improvement was for SSVs and not quad bikes, it nevertheless demonstrates the potential for improvements in safety arising from improved static stability and dynamic handling.

Costs associated with the enforcement of the safety standard, if introduced, are anticipated to be minimal.

Limitations

The additional costs to manufacturers for implementing the required design features will vary depending on the particular model of quad bike involved. Some currently available quad bike models satisfy certain of the required design features but only to varied and limited extents. For a number of models, the costs to implement Option 4 are likely to be higher than the cost of installing an OPD in Option 3.

Examples of retail cost information relating to the proposed design requirements are:

- The Honda FourTrax Rancher quad bike model, which includes an independent rear suspension, has a $625 higher retail price than the same model with a rigid rear axle
- The Polaris Sportsman 570 X2 EPS which includes an open rear differential, has a retail price of $12 366, while the Sportsman Touring 570 EPS has a retail price of $10 978[96]. The Sportsman 570 X2 EPS model includes VersaTrac (with open rear differential option) and some additional features, including Active Descent Control

The retail price of quad bikes may increase as manufacturers seek to pass on to consumers increased production costs associated with this Option.

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95 R Grzebieta, G Rechnitzer, A McIntosh, R Mitchell, D Patton, K Simmons, University of New South Wales Transport and Road Safety Research Unit, *Supplemental Report: Investigation and Analysis of Quad Bike and Side by Side Vehicle (SSV) Fatalities and Injuries,* provided to WorkCover Authority of New South Wales January 2015, Table 1-19.

96 Based on pricing from US website.

The QB Industries submission[97] in response to the Issues Paper reported it would cost approximately AUD$100 (USD$80) to import a lockable open rear differential from China, which would add approximately AUD$200 to the retail cost of the quad bike.

Adding the requirements of Option 4 may reduce consumer choice, as it will remove quad bikes without the required attributes (generally cheaper) from the Australian market.

The ACCC does not have data on which to base a reliable quantitative estimate of the number of deaths and injuries that may be prevented through this option and seeks feedback on this matter.

Net benefits

Option 4 is likely to result in a significant reduction in the number of deaths and injuries attributed to the operation of quad bikes in the Australian environment.as it is likely to prevent a substantial number of incidents from occurring.

Option 5

Make a mandatory safety standard that incorporates all the requirements of Options 2, 3 and 4

Description

Option 5 requires all of the following:

- all quad bikes sold in Australia to comply with the US Standard ANSI/SVIA 1–2017
- all quad bikes and SSVs to be tested post-manufacture according to a safety star rating system and display the resulting safety star rating
- all quad bikes to have affixed an additional warning label alerting riders to the risk of rollover, with further information provided in the owner's manual
- general-use model quad bikes to have OPDs fitted
- all wheels of general-use model quad bikes to be able to rotate at different speeds at all times and if it is equipped with a lockable differential, it must be designed to be normally unlocked.
- appropriate advice provided to riders in the owner's manual that the rear differential should be locked before attempting more demanding off-road manoeuvres, and when travelling on includes and on loose, low friction or rough surfaces. Additionally quad bikes shall have a notice affixed near the differential lock selection control advising the rider when to lock the differential.
- general-use model quad bikes to meet certain minimum performance requirements for static stability, mechanical suspension and dynamic handling.

[97] QB Industries submission to ACCC Quad Bike Safety: Issues Paper.

Table 9: Summary of Option 5

Proposed change	Proposed requirements
US Standard	As above at Option 2
Safety star rating testing and display at point of sale and affixed to vehicle	As above at Option 2
Integration of an OPD	As above at Option 3
Warning and safe use labels and owner's manual	As above at Option 4 (rollovers and differential lock selection)
Minimum test requirements	As above at Option 4 (static stability, mechanical suspension and dynamic handling)
Safe cornering device	As above at Option 4

Benefits

Option 5 will:

- ensure a minimum safety standard is applied to all quad bikes sold in Australia
- provide key information about vehicle safety characteristics to better inform consumer purchase decisions for quad bikes and SSVs
- improve the dynamic handling, static stability and mechanical suspension of general-use model quad bikes , reducing the likelihood of rollovers, collisions and other causes that can lead to quad bike-related death and injury, and
- significantly increase the safety of general-use model quad bike operators in rollover events.

Option 5 involves improving design-related safety characteristics of general-use model quad bikes, and promotes use of a combination of control approaches across the hierarchy of controls framework including substitution (choice of the right quad bike or SSV), engineering controls and administrative controls to significantly reduce the risk of death or injury.

Limitations

Option 5 is anticipated to have the highest cost impact to business and consumers. This option may increase manufacturer production costs which manufacturers may seek to pass to consumers through higher retail prices for quad bikes.

Under Option 5, manufacturers will incur the combined costs of complying with Options 3 and 4. The reduction in deaths and injuries will be incremental, as with design improvements (Option 4) in place to improve static stability, dynamic handling and mechanical suspension, less incidents are anticipated, and therefore OPDs are unlikely to save as many lives as would be the case if they were required to be installed without the design improvements (Option 3).

Net benefits

Option 5 is expected to prevent the most deaths and injuries to quad bike operators of all the options by a significant degree, through significantly reduced incident frequency and by mitigating the impact on operators or passengers when incidents occur.

10. Next steps

The questions set out in the beginning of this Consultation RIS identify the policy options that the ACCC is reviewing to develop a Final Recommendation to the minister. A consolidated list of these questions is included at the beginning of the Consultation RIS. The ACCC encourages you to respond to any or all of the questions and to raise any additional issues that you consider relevant.

Submissions will inform the ACCC's development of a Final Recommendation which will be provided to the minister by mid-2018.

Attachment A: UNSW TARS Safety Star Rating Testing Criteria

The UNSW TARS safety star rating system is comprised of three major test components, divided into further tests. The three major components are:

- Static Stability
- Dynamic Handling
- Rollover Crashworthiness

Static Stability

The Static Stability tests measures the tilt angle at which the uphill or ‘high side’ tyres lost contact with the load cell (ground). Each of the vehicles were tilted in three different directions:

- Lateral roll – tilting about the longitudinal axis of the vehicle (sideways)
- Forward pitch – tilting over the front axle of the vehicle (nose towards the ground)
- Rearward pitch – tilting over the rear axle of the vehicle (rear towards the ground)

The load cell and angle data of each tilt test was analysed to determine the angle of lift-off of each tyre and the quasi-static rollover angle of the vehicle.

Further, ‘tilt table tests’ were conducted using an adult sized dummy and youth sized dummy (‘operator’) respectively for the adult and youth model vehicles.

The vehicles were also tested with the following different load configurations (dependant on what the vehicle was designed for):

- unloaded;
- with operator;
- with operator and front cargo load;
- with operator and rear cargo load; and
- with operator, front cargo load and rear cargo load.

Three different CPDs were also fitted to the appropriate vehicles and tested in the abovementioned load configurations and tilt directions.

Dynamic Handling

Following on from the Static Stability test program, the Dynamic Handling program provides the second arm of the assessment and rating of production vehicles for stability and handling.

The Dynamic Handling test program consists of different dynamic tests series all relating to vehicle control and handling characteristics which are likely to improve a driver’s/rider’s vehicles path control and the vehicle’s resistance to rollover. The tests include:

Steady-state circular driving behaviour dynamic tests

- This test was to determine each vehicle’s limit of lateral acceleration and the understeer/oversteer characteristics.

Lateral transient response dynamic tests

- This test determined the time taken for each vehicle to respond to steering manoeuvres

Bump obstacle perturbation tests

- This test was to determine each vehicle's response characteristics while riding over asymmetric bumps in terms of change in steering direction or displacement and lateral and vertical acceleration of the test dummy. This represents the ability of each vehicle to ride over ground obstacles that could in some circumstances precipitate loss of control and consequential rollover.

Rollover Crashworthiness

The Rollover Crashworthiness test program provides the third arm of the overall assessment. The rollover crashworthiness test program consists of the following four different areas all relating to vehicle rollover crashworthiness characteristics:

Quad bike ground contact load tests

- This consisted of measurement of resting ground contact forces to determine the load distribution of a typical work farm quad bike and what potential load could be expected to transfer to the rider in an incident of a vehicle rollover both on its side and when inverted.

SSV occupant retention systems test results

- During this testing, two inter-related characteristics were assessed:
  1. Occupant Retention Systems Zone Restriction
     - This is a largely inspection-based evaluation of the SSVs. The SSV is divided into four retention zones leg/foot, shoulder/hip, arm/hand and head/neck.
     - The retention devices, including operator warning labels, were inspected and components tested where required in order to assess whether the SSV complied with the American National Standard for Recreational Off-Highway Vehicles (ANSI/ROHVA 1–2011).
  2. Occupant Retention Systems Performance
     - These tests consisted of using the Motorcycle ATD (MATD) as the rider/driver and placing the vehicle on a single axis tilt table, tilting about its longitudinal axis. This test included a focus on how far the torso extended outside the plane of the vehicle width and took into account the use of a seat belt.

Quad bike and SSV rollover tests

- The MATD was also used in these tests as the quad bike/SSV rider/driver and subjected to rollover tests in nine (3 x 3 matrix) configurations comprising of:
  - Roll direction (lateral roll, rearward pitch and forward pitch); and
  - OPD (none, Lifeguard OPD and Quadbar OPD).

SSV ROPS load strength assessment

- This measures whether the ROPS will yield and deform when it holds the required load in the event of a rollover.
- Each vehicle's ROPS were tested by applying a uni-axial load to the top of the structure sequentially in three different directions. The load directions in order were lateral, vertical and longitudinal.

Attachment B: Summary of US Standard ANSI/SVIA 1–2017

The US Standard ANSI/SVIA 1–2017 established minimum requirements for four wheel all-terrain vehicles and becomes effective beginning with 2019 model year vehicles.

The US standard defines an ATV as a motorised off-highway vehicle designed to travel on four low pressure or non-pneumatic tyres, having a seat designed to be straddled by the operator and handlebars for steering control.

The definition is further categorised into two types, Type I and Type II:

Type I ATVs

- Type I ATVs are intended for use by a single operator and no passenger.
  - Category G (General Use Model) ATV that is intended for recreational and/or utility use by an operator, age 16 or older
  - Category S (Sports Model) ATV that is intended for recreational use by an experienced operator, age 16 or older
  - Category Y (Youth Model) ATV is of an appropriate size that is intended for recreational use under adult supervision by an operator under age 16. Further categorisation in terms of ages is applied encompassing Y (year) 6+, Y10+ and Y12+
  - Category T (Transitional Model) ATV is of an appropriate size that is intended for recreational use by an operator aged 14 or older under adult supervision, or by an operator aged 16 or older

Type II ATVs

- Type II ATVs are intended for use by an operator or an operator and a passenger. They are equipped with a designated seating position behind the operator designed to be straddled by no more than one passenger.
  - Category G (General Use Model) ATV that is intended for recreational and/or utility use by an operator aged 16 or older.

The standard addresses design, configuration and performance aspects of ATVs, which include:

- Brakes
- Mechanical Suspension
  - Each wheel shall have a minimum wheel travel of 50 mm (2 in). Springing and damping properties shall be provided by components other than the tyre
- Engine Stop Switch
- Manual Clutch Control and Additional Clutch Control for ATVs
  - All ATVs equipped with a manual clutch shall have a clutch lever, which is located on the left side of the handlebar and operable without removing the hand from the handlebar
  - All ATVs with a power take-off (PTO) or other device requiring fixed engine or vehicle speed and a clutch control for engagement and disengagement of the PTO or other device, shall have the control located convenient to the operator
- Throttle Control
  - All ATVs shall be equipped with a throttle control, however, different requirements are applicable to ATVs with PTO or Other Device

- Drive Train Controls
    - Manual transmission control, foot and hand gearshift control and gear selection
- Neutral and Reverse Indicator
- Electric Start Interlock
    - To prevent the ATV from starting unless the clutch is disengaged, the transmission is in neutral or park, or brake is applied
- Handlebars and Passenger Handholds
    - Handholds are applicable to all Type II ATVs
- Flag Pole Bracket
- Manual Fuel Shutoff Control
- Foot Environment
    - Footrests or other design features for the operator and passenger (e.g. footpegs)
    - Note, test procedures and clearances apply
- Lighting and Reflective Equipment
    - Headlamp, conspicuity light, tail lamp, stop lamp and reflex reflector
- Spark Arrestor
- Tyres
    - Pneumatic tyres (air inflated), non-pneumatic tyres, tyre pressure gauge and tyre markings (including vehicle label for operating pressure)
- Security
    - All ATVs shall have a key-operation or equivalent system (with a minimum of 300 exclusive combinations) except Category Y ATVs may use a security system without multiple exclusive combinations
- Owner's Manual
    - All ATVs shall be provided with a manual in paper form at the point of sale, which may be supplemented at the manufacturer's option in electronic for viewable on a display on the ATV or other device.
- ATV Identification Number
- Labels
    - For example, labels in relation to durability, tyre pressure warning, overloading warning, capacity and limitation, certification, age recommendation, passenger warning.
- Hang Tags
    - For example, providing the appropriate age recommendation and information on the category of intended usage.
- Maximum Speed Capability Measurement
- Category Y and T ATV Speed Capability Requirements
- Service Brake Performance
- Pitch Stability
- Electromagnetic Compatibility with EU Standard

- Sound Level Limits and Test Procedure

Annex A of the US standard contains a description of the rationale for the requirements of the standard, including but not limited to: ATV categories, mechanical suspension, flag pole bracket and foot environment.

Warning labels include:

- Age use requirements
- Safe operation and use, such as:
  - personal protective equipment should be worn
  - not to operate under the influence of alcohol or drugs
  - the appropriate tyre pressures
  - the risk of overloading
  - speed adjustment to suit the terrain
  - the risk of riding on roads and paved surfaces
  - use proper riding techniques
  - a warning outlining that passengers should never be carried (for Type I ATVs and for Type II ATVs, warnings regarding the safe carriage of passengers).

Attachment C: Vehicle models involved in Australian deaths 2000 – 2012

Vehicle	Make	Model	Size [cc]	Year	Type
QB	Barossa	Unknown	50	Unknown	Youth
QB	Bombardier	800 HO	800	2007	General-use model
QB	Bombardier	Outlander 800	800	Unknown	General-use model
QB	Bombardier	Rotax	640	2001	Unknown
QB	E-Ton	Challenger CXL-150	Unknown	Unknown	General-use model
QB	Honda	400EX Quad Runner	400	Unknown	Sport model
QB	Honda	Big Red	Unknown	Unknown	General-use model
QB	Honda	Big Red 300R TRX300FW	300	Unknown	General-use model
QB	Honda	Foreman	500	Unknown	General-use model
QB	Honda	Foreman 400	400	Unknown	General-use model
QB	Honda	Foreman ES	500	Unknown	General-use model
QB	Honda	Fourtrax	Unknown	Unknown	General-use model
QB	Honda	Fourtrax AT	Unknown	Unknown	General-use model
QB	Honda	FourTrax ES (TRX350 FE)	350	Unknown	General-use model
QB	Honda	Fourtrax Foreman ES 450SE	450	Unknown	General-use model
QB	Honda	Fourtrax TRX400 FX	400	1999	General-use model
QB	Honda	Fourtrax TRX400EX	400	Unknown	General-use model
QB	Honda	TRX 250	Unknown	Unknown	General-use model
QB	Honda	TRX300	300	1997	General-use model
QB	Honda	TRX350FWM	350	Unknown	General-use model
QB	Honda	TRX350TEY	350	Unknown	General-use model

QB	Honda	TRX400	400	Unknown	Sports model
QB	Honda	TRX400fa	400	Unknown	General-use model
QB	Honda	TRX420FM7	420	Unknown	General-use model
QB	Honda	TRX450R	450	2005	Sports model
QB	Honda	Unknown	650	Unknown	Unknown
QB	Honda	Unknown	350	Unknown	Unknown
QB	Honda	Unknown	Unknown	Unknown	Unknown
QB	Honda	Unknown	Unknown	Unknown	Unknown
QB	Kawasaki	KFX 400	Unknown	Unknown	Sports model
QB	Kawasaki	KLF 300	Unknown	Unknown	General-use model
QB	Kawasaki	KVF Workhorse 360	360	Unknown	General-use model
QB	Kawasaki	KVF360	360	2003	General-use model
QB	Kawasaki	Unknown	400	Unknown	Unknown
QB	Kawasaki	Unknown	Unknown	Unknown	Unknown
QB	Kawasaki	Workhorse 300	300	Unknown	General-use model
QB	Kawasaki	Workhorse 400	400	Unknown	General-use
QB	Kawasaki	Workhorse 400	400	Unknown	General-use model
QB	Kazumi Kazuma	Mini	Unknown	Unknown	Youth model
QB	Motoworks	Unknown	Unknown	Unknown	Unknown
QB	Polaris	3400	400	1996	Unknown
QB	Polaris	Magnum 325	325	Unknown	General-use model
QB	Polaris	Magnum 425	425	Unknown	General-use model
QB	Polaris	Sportsman	Unknown	Unknown	General-use model
QB	Polaris	Sportsman X2 500	500	2006	General-use model
QB	Polaris	Trail Boss 330	330	Unknown	General-use model
QB	Polaris	Twin Sportsman	Unknown	Unknown	General-use model

QB	Polaris	Unknown	325	1999	Unknown
QB	Polaris	Unknown	500	Unknown	Unknown
QB	Suzuki	275 RVG	500	Unknown	Unknown
QB	Suzuki	Kin Quad 750AXI	750	Unknown	General-use model
QB	Suzuki	KingQuad	750	Unknown	General-use model
QB	Suzuki	KingQuad	300	Unknown	General-use model
QB	Suzuki	KingQuad LT-A700c	Unknown	Unknown	General-use model
QB	Suzuki	LT 250F	250	Unknown	General-use model
QB	Suzuki	LTF 250K Quad Runner	250	1989	General-use model
QB	Suzuki	Quad Master 300	300	1996	Unknown
QB	Suzuki	Quad Runner	500	2000*	General-use model
QB	Suzuki	Quad Runner 160	Unknown	Unknown	General-use model
QB	Suzuki	Quad Sport	80	Unknown	Youth model
QB	Suzuki	Twin Quad 300	300	Unknown	Unknown
QB	Suzuki	Unknown	500	Unknown	Unknown
QB	Suzuki	Unknown	450	Unknown	Unknown
QB	Yamaha	250YFM225	250	Unknown	Unknown
QB	Yamaha	Banshee	350	Unknown	Sports model
QB	Yamaha	Banshee 350	350	Unknown	Sports model
QB	Yamaha	Banshee 350	Unknown	Unknown	Sports model
QB	Yamaha	Bear Tracker	250	Unknown	General-use model
QB	Yamaha	Bear Tracker	250	2001	General-use model
QB	Yamaha	Big Bear	250	Unknown	General-use model
QB	Yamaha	Big Bear	350	Unknown	General-use model
QB	Yamaha	Big Bear	350	Unknown	General-use model
QB	Yamaha	Big Bear	350	Unknown	General-use model

QB	Yamaha	FZ450	450	2004	Sports model
QB	Yamaha	Grizzly	Unknown	Unknown	General-use model
QB	Yamaha	Kodiak	400	Unknown	General-use model
QB	Yamaha	Kodiak	Unknown	Unknown	General-use model
QB	Yamaha	Kodiak	400	Unknown	General-use model
QB	Yamaha	Kodiak	400	2003	General-use model
QB	Yamaha	Kodiak Ultramatic	Unknown	Unknown	General-use model
QB	Yamaha	Kodiak YFM 400F	400	2002*	General-use model
QB	Yamaha	Moto 4	225	1987	General-use model
QB	Yamaha	Moto 4	250	Unknown	General-use model
QB	Yamaha	Moto 4	Unknown	Unknown	General-use model
QB	Yamaha	Raptor	90	Unknown	Youth model
QB	Yamaha	Raptor	700	Unknown	Sports model
QB	Yamaha	Timber Wolf	200	Unknown	Unknown
QB	Yamaha	Ultramatic Grizzly	350	Unknown	General-use model
QB	Yamaha	Unknown	Unknown	Unknown	Unknown
QB	Yamaha	Unknown	350	2005	Unknown
QB	Yamaha	Unknown	450	Unknown	Unknown
QB	Yamaha	Unknown	250	Unknown	Unknown
QB	Yamaha	Unknown	Unknown	1991*	Unknown
QB	Yamaha	Unknown	350	Unknown	Unknown
QB	Yamaha	Unknown	Unknown	Unknown	Unknown
QB	Yamaha	Warrior 4	350	Unknown	Sports model
QB	Yamaha	YFZ	350	Unknown	Sports model
6x6	Polaris	Sportsman	500	2000	6x6
SSV	Kawasaki	Mule	600	Unknown	SSV
SSV	Yamaha	Rhino 700	700	Unknown	SSV

Source: R Grzebieta, G Rechnitzer, A McIntosh, R Mitchell, D Patton, K Simmons, University of New South Wales Transport and Road Safety Research Unit, *Supplemental Report: Investigation and Analysis of Quad Bike and Side by Side Vehicle (SSV) Fatalities and Injuries,* provided to WorkCover Authority of New South Wales January 2015, Appendix A.

Results:

General-use models	57 deaths
Sport models	11 deaths
Youth models	4 deaths
SSV models	2 deaths
6x6 models	1 death
Unknown models	25 deaths

Attachment D: Option 4 Test Procedures

QUAD BIKE - BUMP RESPONSE TEST PROCEDURE

1. Introduction

1.1. The purpose of this procedure is to provide a methodology by which the accelerations that will be imparted to the rider by a disturbance created by a bump obstacle input can be measured. Analysis of Australian fatal crash data involving quad bikes[98] indicates a significant proportion of fatal and serious injury crashes occur consequent to a rider striking a small bump type obstacle at low to moderate speeds. These impacts may result in the quad bike rolling onto the rider or the rider being otherwise thrown from the vehicle and striking another hazard.

1.2. The dynamic handling characteristics of a vehicle form a very important part of vehicle active safety, especially so for a vehicle that offers little or no crash protection, making crash avoidance ever more important. Any individual vehicle, together with its rider and environment will form a unique closed loop system. It is impossible to measure the performance of every vehicle and rider in every circumstance. By establishing a standardised test procedure, the characteristic results for different vehicles can be determined.

1.3. Bounce response to a bump is a function of the suspension geometry and spring and shock absorber design. In order to handle bumps well and minimise disturbance to the rider, the vehicle suspension must have adequate travel in both bump and rebound directions and also must provide appropriate ride stiffness and damping. Part of the ride stiffness includes the stiffness of the tyre. Due to the low pressure typically used in quad bikes, the tire is able to absorb small bumps simply through deformation with little disturbance to the vehicle and rider. Slightly larger bumps will involve both tyre and suspension reactions and will disturb the vehicle and its rider. The consequent vertical and lateral accelerations that are transferred to the rider by the perturbed quad bike are measured, to allow measurement of the vehicle's safe bump obstacle performance.

2. Scope

2.1. This test procedure specifies the open-loop test method for determining the bump obstacle response behaviour of quad bikes. It is applicable to both Type I Category G and Type II quad bikes. This test procedure does not apply to Sport or Youth model quad bikes.

3. References

3.1. This test procedure was developed in response to identified circumstances associated with fatal and serious injury crashes involving quad bikes. Recognised International Standards such as those listed below are used to describe the vehicle and general test arrangements:

3.1.1. ISO 8855, Road Vehicles – vehicle dynamics and road holding ability – Vocabulary, and

3.1.2. ISO 1176, Road Vehicles – Masses – Vocabulary and codes

3.1.3. SAE J963, SAE Recommended Practice: Anthropomorphic Test Device for Dynamic Testing, Society of Automotive Engineers, June 1968

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[98] McIntosh A., and Patten D.; Quad Bike Fatalities in Australia: Examination of Crash Circumstances and Injury Patterns; UNSW 12 December 2013

4. General

4.1. The test speeds and bump obstacle height have been chosen to be representative of a rider (may be a worker whose primary concentration is likely to be on something other than the riding task) operating at a moderate speed and impacting an unseen or unexpected bump obstacle hazard on one side of the vehicle only. While a wide variety of input speeds and obstacle configurations are possible, this sample is generally representative of the circumstances for at least a proportion of fatal and serious injury quad bike crashes that have occurred in the agricultural workplace in Australia[99]. The rider in this circumstance is often not engaged in an active riding style, (which would otherwise improve the outcome of the obstacle impact), hence a neutral rider (inactive) has been used for the test methodology.

4.2. The primary aim of this test is to determine the resultant of vertical and lateral accelerations that will be imparted to the rider by a vehicle that strikes a bump obstacle. Characteristic values will provide an indication of how significantly a rider, (who is not prepared for the bump and hence not riding so as to minimise the effect of the bump, ie. they are inert at the time of impact) will be disturbed by the bump obstacle impact.

5. Test Method

5.1. The obstacle is engaged by the q along each side of the vehicle separately. The approach/impact speed is set at 25km/hr and three passes are made on each side. The results of the three passes are analysed and the resultant of lateral and vertical accelerations experienced at the Anthropomorphic Test Dummy (ATD) pelvis are then averaged.

5.2. The test is repeated for the opposite side of the vehicle and the highest average response (left or right side) is reported as the Vehicle Bump Response. The Vehicle Bump Response provides an indication of how severely a rider sitting in a neutral riding position (non active riding) would be perturbed by the bump obstacle.

6. Reference System

6.1. The reference system specified in ISO 15037–1 applies as closely as practicable (given ISO 15037 is for passenger cars and includes references to driver and passenger etc).

6.2. The location of the origin of the vehicle axis system (X,Y,Z) is the reference point and therefore should be independent of the loading condition. It is fixed in the longitudinal plane of symmetry at half the wheelbase and at the height above the ground of the centre of gravity (CG) of the vehicle when loaded at rider only test mass (see 8.1).

7. Determining Variables

7.1. The following variables shall be determined during the test:

7.2. Vertical and Lateral acceleration imparted to the ATD when seated at the 'seat reference position' (see 9.2 below), and

7.3. Lateral displacement of the ATD from the centreline.

7.4. Vehicle roll may be measured.

8. Measuring Equipment

8.1. Data recording must be capable of a rate of at least 100 Hz and higher of possible. Minimum sampling rates and accuracy of the various parameters are shown in Table 1 below:

Table 1: Parameter sampling rate, range and accuracy

Parameter	Sensor Range	Resolution	Accuracy
Longitudinal Velocity	0–40 km/hr	0.2 km/hr	± 0.25% of full range
Lateral Acceleration	± 5g	≦ 0.01g	≦ 1% of full range
Vertical Acceleration	± 5 g	≦ 0.01 g	≦ 1% of full range
ATD Lateral Displacement	± 0.2mm	≦ 0.05 mm	
Roll Angle *	± 45 deg	≦ 0.01 deg	± 2 deg

* If measured

9. Vehicle and Anthropomorphic Test Dummy Preparation and Conditions

9.1. **Vehicle Loading.**

9.2. The vehicle shall be in standard configuration without any accessories fitted.

9.2.1. Tests shall be carried out at the 'rider only' configuration test mass. Rider only test mass is the unloaded tare mass of the vehicle with all fluids at recommended level and the fuel tank filled to its rated capacity, plus the mass of the appropriate ATD for the Quad Bike Type as follows:

9.2.2. Type I Category G and S and for Type II quad bikes, use the 95%ile male ATD (nominal mass 101 kgs) clothed in form fitting cotton clothing and shoes equivalent to those specified in MIL-S13192 rev P

9.2.3. Additional attachment device / straps to hold the hands on the handlebar should not exceed 1kg.

9.2.4. The mass of any installed sensor and data acquisition system is to be compensated for by removing the quad bike battery and/or fuel from the fuel tank, until the rider only test mass is achieved. Care should be taken to minimise disturbance of the CG position of the system.

9.3. **ATD Setup and Seat Reference Position.**

9.3.1. The ATD is to be set up with vertical and lateral accelerometers installed in the instrument cavity of the pelvis. The test vehicle is parked on smooth flat ground. A 95%ile ATD 'rider' is positioned on the saddle, such that the hands fully grasp the handlebars with the web between the thumb and forefinger pushed against the inboard handgrip stops. The ATD hands are to be secured to the handgrips by way of tie-down strap or similar. The ATD shoes are adjusted into position so that the leading edge of the heel is positioned up against the rider foot peg rear edge. The shoes are not secured in this position for the bump obstacle test.

9.3.2. With the ADT elbows locked straight, the pelvis is positioned centrally on the saddle, then adjusted forward or aft until the upper torso spine box or rib attachment plate is vertical (± 0.5 °). A reference mark is placed on the saddle vertically below the 'vee' formed at the rear of the ATD pelvis flesh, directly below the instrument cavity. This mark is the seat reference position and identifies the position the ATD pelvis must be in prior to conduct of each test run.

9.3.3. A measurement may be taken from the ATD to the quad bike frame for easy repositioning. ATD thighs and calves are to be pressed against the cowling. The ATD may have targets affixed to the rear of the pelvis to assist video analysis of the pelvis displacement.

9.3.4. The x and z positions of the Hip reference point (H Point) should be measured, relative to the rear edge of the foot peg.

9.3.5. The ATD head roll angle is positioned using the head gauge tool to be as close to horizontal as possible (0.0° ±0.5°).

9.3.6. ATD elbows are then to be splayed to 10° (set by using a marked Delrin bushing at the elbow joint).

9.3.7. A reference mark shall be placed centrally on the dashboard or instrument cluster and a measurement taken from the tip of the ATD nose to that reference mark. The set-up of the ATD for each test run should be within ±5mm of the original set-up measurement.

9.3.8. The ATD may be tethered at the pelvis so to allow free movement left and right to a maximum of 200mm travel, in order to minimise the risk of it falling off the quad bike during the test.

10. Instructions for vehicle set-up.

10.1. The quad bike is to be fitted with instrumentation to measure forward speed, vehicle roll angle and ATD displacement. Instrumentation and ballasting (addition or removal) should be distributed so as to minimise the effect on overall vehicle CoG.

10.2. Tow vehicle / cable and guide cable (if used) arrangements can be varied to suit available test location.

11. Tyres and Suspension

11.1. Tyres should be close to new condition. Tyres shall be inflated to manufacturers recommended pressures. Where more than one pressure is specified, the lowest value for this load condition shall be used.

11.2. Adjustable suspension components shall be set to the values specified at the point of delivery by the dealer.

12. Vehicle Conditioning

12.1. The quad bike is towed through the bump obstacle test, hence no vehicle warm up is required. The vehicle should be conditioned in ambient temperatures between 10 and 30 degrees C for at least 2 hours prior to the test.

13. Drive Train

13.1. The quad bike drive train should be set to its most open setting. For example, two wheel drive shall be used instead of four wheel drive and if a lockable differential is fitted, it shall be in the unlocked, or "open" configuration. The quad bike transmission is to be in neutral.

13.2. **Test Surface and Ambient Conditions**

13.3. **Test Surface**

13.3.1. The test surface shall be constructed of concrete or asphalt having a friction coefficient of at least 0.75. The slope of the surface shall be less than 1 degree (1.7%).

13.3.2. The test surface shall be dry and kept free from debris and substances that may affect test results during vehicle testing.

13.3.3. A semi-circular (half pipe), smooth surfaced rigid step obstacle at least 400 mm long, with a maximum height above the test surface of 150mm (±5mm) is to be used for the bump obstacle test. The obstacle is to be secured to the test surface so as to ensure there is no significant movement when impacted.

13.3.4. **Ambient Conditions**

13.3.4.1. Testing should be conducted within an ambient temperature range of 10 degrees to 30 degrees Celsius.

13.3.4.2. Testing should not be conducted when wind speed (constant wind or gusts) exceed 15 km/hr (at this wind speed a flag will stir up to 45 degrees from a flagpole but will not fully extend)

13.4. **Test Procedure**

13.4.1. The vehicle is towed in a straight line at a test speed of 25 km/hr ±1 km/hr and the obstacle engaged at 90 degrees, with the tires of the vehicle striking approximately mid-point of the step obstacle. Tow vehicle is to reduce power/brake immediately prior to front wheel impact and the quad bike is to pass over the obstacle purely due to its own momentum. As a minimum, data is to be acquired from a point immediately prior to the front wheel impact, until 5 seconds after the rear wheel bump obstacle impact.

14. Data Analysis

14.1. **Data Smoothing**

14.1.1. Data obtained is to be smoothed by use of a 10 step moving average filter process, to remove some of the inherent noise. (the knobbly type high mobility tires and imperfect ground surface, among other sources, can all contribute minor accelerations to the system which need to be smoothed by filtering).

14.2. **ATD Lateral Displacement**

14.2.1. The ATD lateral displacement measured with the string-pot potentiometer is to be used as a first order check to ensure the test run results are consistent. (Variations in results can occur from variables such as the tyres striking the bump at one end of the obstacle instead of the middle, the ADT feet raising from the foot platform or foot pegs during lead-in, variation in ATD joint stiffness or positioning and more.) Three successful test runs are to be arithmetically averaged and each of the three test results should lie within ± 10% of the mean displacement distance (measured in mm).

14.3. **Vertical and Lateral Acceleration.**

14.3.1. The peak resultant vertical and lateral accelerations are measured at the ATD pelvis. The three (or more) test run results are to be averaged to produce a 'rider acceleration' for that test speed on that side of the vehicle. The largest average resultant produced from the left and right test runs is to be recorded as the vehicle bump obstacle response.

Appendix:

1. Vehicle Test Report - General Data

Appendix 1

Test Report

General Data

Vehicle Identification			
Make:	Model:	Year:	Type:
VIN or Manufacturer Serial Number:			
Steering Type:			
Suspension Type:	Front:	Rear:	
Engine Size:			
Tyres:	Make:	Model:	Size:
Tyre Pressures:	Front: kPa	Rear: kPa	
Wheelbase:			
Track	Front: mm	Rear: mm	
Other:			
Vehicle Loading			
Tare Mass	Left Front: kgs	Right Front: kgs	Sum: kgs
	Rear: kgs	Rear: kgs	Sum: kgs
	Sum: kgs	Sum: kgs	Total: kgs
Rider Only Test Mass (Tare + 103 kgs)	ATD and Test Eqpt: kgs	Fuel Removed: (less) kgs	Test Mass: kgs
Test Personnel			
Testing Officer			
Observer			
Comments			

Quad Bike Step Obstacle

Test Results Sheet

Test Speed	Peak Vertical and Lateral Resultant Acceleration at 25 kph	Comments
Left Side First Pass		
Left Side 2		
Left Side 3		
Left Side Bump Response	Average Resultant	
Right Side First Pass		
Right Side 2		
Right Side 3		
Right Side Bump Response	Average Resultant	

STABILITY TEST PROCEDURE

1. General

1.1. Static Stability of a Type I, Category G or Type II quad bike is to be measured using a tilt table or tilting platform, with a 50th%ile male ATD simulated rider positioned in a standardised seating position as described below.

1.2. The coefficient of stability for each direction (forward or rearward pitch, or lateral roll) is calculated as Tan (Tilt Table Angle at two wheel lift).

2. Tilting Table or Platform

2.1. Adjustable slope single plane tilt-table structure, range of 0° to 80° from horizontal.

2.2. Surface shall be rigid, flat and large enough to support all four wheels.

2.3. Surface shall support a load cell under each of the four vehicle wheels

2.4. A high friction surface is to be installed on the top surface of the downhill side load cells to prevent the low side tyres from slipping (anti slip tape or expanded mesh may suit)

2.5. Tilt rate of nominally less than 1.0 degree per second (for at least the last 20 degrees before tyre lift-off)

3. Test Vehicle Set-up

3.1. Vehicle is to be prepared to kerb mass ie. all standard equipment fitted and vehicle fluids to be filled to maximum capacity (engine oil, transmission and differential fluids, coolant, brakes and fuel)

3.2. Tyres are to be inflated to the manufacturers recommended pressures. Where more than one pressure is specified, the lowest pressure is to be used.

3.3. Adjustable suspension is to be set at the value specified at dealer delivered configuration.

4. Anthropormorphic Test Device (ATD)

4.1. For Type I Category G and for Type II quad bikes, use the 50%ile adult male (PAM) ATD (nominal mass 78 kgs) clothed in form fitting cotton clothing and shoes equivalent to those specified in MIL-S13192 rev P

4.2. ATD is to be secured to the seat so as to prevent independent movement.

4.3. The ATD pelvis is to remain parallel with the plane of the rider seat during tilting. (nominally,this is achieved by securing each leg downward toward the footrest. Hands are to be secured to the hand grips)

4.4. ATD is to be positioned such that each hand is gripping the hand controls with the web of the hand in contact with the inner ridge of the hand grip. The arms are to be fully extended, the pelvis is centred laterally on the seat and located longitudinally such that the back angle (measured flat from the spine box) is vertical (±2.5°); the head roll angle is to be horizontal (±0.5°). The thighs are to be in contact with the fuel tank / cowling and the feet are to be positioned on the footrest with the leading edge of the heel in contact with the rear edge of the footrest.

4.5. The ATD Pelvis angle and H point dimensions are to be recorded relative to the rear upper edge of the footrest (vertical (y) and horizontal (z) dimensions)

4.6. ATD limb joint stiffness is to be set at 1g.

NOTE: If the HIII 50 PAM ATD cannot straddle the cowling, a pedestrian sit/stand pelvis may be required to be fitted to the device.

5. Determination of Centre of Gravity (CG) Location

5.1.1. Record vehicle wheelbase and track width (front and rear). Check against manufacturer documentation to confirm sample vehicle is within manufacturer tolerances.

5.1.2. In test condition, weigh the vehicle on flat, level surface to obtain the four individual wheel masses and calculate the vehicle longitudinal CG and lateral CG position.

6. Tilt Test Procedure

6.1.1. **Lateral Roll.**

6.1.1.1. Position test vehicle on Tilt Table with each wheel centred on a load cell.

6.1.1.2. Quad Bikes are to be tested so that the lateral offset of the CG position is located on the downhill direction of tilt.

6.1.1.3. Align the test vehicle so that a line passing through the outer edges of the two downhill tyres is parallel to the line of the tilt axis of the table or platform.

6.1.1.4. Set the steering mechanism in the straight ahead position.

6.1.1.5. Apply park brake or park mechanism to stop the vehicle from rolling.

6.1.1.6. Affix two catch straps (of less than 1 kg mass) between the vehicle and the tilt platform with sufficient slack to allow full decompression (extension) of the uphill suspension and minimal wheel lift at tip over.

6.1.1.7. Raise tilt platform until both uphill tyres have lost contact with the ground (ie. both uphill load cells show no load).

6.1.1.8. Record the tilt platform angle at moment of second uphill wheel lift (tip over).

6.1.1.9. Return the tilt platform to the horizontal position.

6.1.1.10. The static rollover threshold of the vehicle in g's of lateral acceleration (1g = acceleration due to gravity), often referred to as the Tilt Table Ratio (TTR) is calculated as Tan of tilt platform angle at second wheel lift (Tan Ø). The TTR is approximately equal to the Static Stability Factor (SSF) with variation due to CG displacement due to vehicle body roll and suspension articulation, compliance in steering and suspension joints and deformation of the wheels and tyres.

6.1.2. **Pitch**

6.1.2.1. Quad Bikes are to be tested in both forward and rearward pitch directions.

6.1.2.2. Position test vehicle on Tilt Table with each wheel centred on a load cell.

6.1.2.3. Align the test vehicle so that a line passing through the centreline of the contact patches of the two downhill tyres is parallel to the line of the tilt axis of the table or platform.

6.1.2.4. Set the steering mechanism in the straight ahead position.

6.1.2.5. Apply park brake or park mechanism, or fix the wheel or the brake assembly (if required) to stop the vehicle from rolling.

6.1.2.6. If the low side tyres slip on the load cell surface prior to uphill wheel lift, affix a ratchet strap over each low side wheel such that the line of action of the strap passes through the contact patch of the tyre and the axle centreline, whilst still allowing the tyre to roll about the contact patch when the vehicle tips.

6.1.2.7. Affix two catch straps (of less than 1 kg mass) between the vehicle and the tilt platform with sufficient slack to allow full decompression (extension) of the uphill suspension and minimal wheel lift at tip over.

6.1.2.8. Raise tilt platform until both uphill tyres have lost contact with the ground (ie. both uphill load cells show no load).

6.1.2.9. Record the tilt platform angle at moment of second uphill wheel lift (tip over).

6.1.2.10. Return the tilt platform to the horizontal position.

6.1.2.11. The static pitch-over threshold of the vehicle in g's of lateral acceleration (1g = acceleration due to gravity), often referred to as the Tilt Table Ratio (TTR) is calculated as Tan of tilt platform angle at second wheel lift (Tan Ø). The TTR is approximately equal to the Static Stability Factor (SSF) with variation due to CG displacement due to vehicle body pitch and suspension articulation, compliance in steering and suspension joints and deformation of the wheels and tyres.

7. Instrumentation

7.1.1. Four load cells with at least 700kg load capacity and resolution of at least 0.5kg.

7.1.2. Tilt angle sensor with a range of at least 80° and a resolution of at least 0.1°

7.1.3. Data acquisition system acquisition rate of at least 100 samples per second (100Hz)

7.1.4. Rear time videography (front 45° view)

8. Performance Standards

8.1.1. The measured Tilt Table Ratios (TTR) for stability in Forward (TTRp*f*) and Rearward (TTRp*r*) pitch and in Lateral Roll (TTRst) shall comply with the minimum requirements identified at Section 5.7 (reproduced below).

8.1.2. **Rearward Longitudinal stability (rearward pitch)** The Tilt Table Ratio for rearward pitch (TTRp*r*) measured with the appropriate ATD for Quad Bike type shall be equal to or greater than 1.0

8.1.3. **Forward Longitudinal stability (forward pitch)** The Tilt Table Ratio (TTR) for forward pitch (TTRp*f*) measured with the appropriate ATD for Quad Bike type shall be equal to or greater than 1.10

8.1.4. **Lateral Stability (lateral roll)** The Tilt Table Ratio (TTR) for Lateral Roll stability (TTRst) measured with the appropriate ATD for Quad Bike type shall be equal to or greater than 0.80

QUAD BIKE DYNAMIC HANDLING TEST PROCEDURE

QUAD BIKE - STEADY STATE CIRCULAR DRIVING BEHAVIOUR TEST METHOD

1. Introduction

1.1. The purpose of this procedure is to provide a methodology by which the steady state circular driving behaviour (understeer gradient) of a quad bike can be measured. This procedure is modelled on ISO 4138:2012; Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods[100] which has been modified to suit the physical and dynamic characteristics of quad bikes.

1.2. The dynamic handling characteristics of a vehicle form a very important part of vehicle active safety, especially so for a vehicle that offers little or no crash protection, making crash avoidance ever more important.

1.3. A quad bike travelling at a moderate rate of 25 km/hr will cover almost 7 metres of ground every second. A vehicle that is slow to respond or that responds differently in similar circumstances, or whose response will change over time with the driver doing nothing, is an unpredictable and difficult to control vehicle. A vehicle that has an oversteer characteristic will also have a Critical Speed, which is the speed at which the vehicle will become dynamically unstable. Critical Speed is a function of both the oversteer gradient and the wheelbase. Short wheel-based vehicles (such as a quad bike) can have a Critical Speed within speed ranges that average riders would consider to be safe travel speeds. Vehicles that have an understeer characteristic do not have a Critical Speed. A quad bike rider should not need to focus the bulk of their attention on the control of an unnecessarily unwieldy vehicle. The results of the tests described by this procedure provide a measure of the predictability of the vehicle response to rider steering input and its safe handling.

2. Scope

2.1. This test procedure specifies the open-loop test method for determining the steady state circular driving behaviour (understeer gradient) of quad bikes. It is

[100] ISO 4138:2012, Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods.

applicable to both Type I Category G and Type II quad bikes. This procedure does not apply to Sports or Youth model quad bikes.

3. References

3.1. The primary reference for this test procedure is ISO 4138:2012, Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods, including where applicable, the normative references used by that standard, such as:

3.2. ISO 8855:2011, Road Vehicles - vehicle dynamics and road holding ability - Vocabulary,

3.3. ISO 15037-1:2006, Road Vehicles - Vehicle dynamics test methods - Part 1 General conditions for passenger cars, and

3.4. Society of Automotive Engineers (SAE) J266 - Steady-State Directional Control Test Procedures For Passenger Cars and Light Trucks

NOTE The American National Standard for Recreational Off-Highway Vehicles, ANSI/ROHVA 1 - 2011[101] *was also referenced to develop this procedure.*

4. General

Note: The test is designed to be representative of a rider whose primary concentration is on something other than, or in addition to, the fundamental riding task, operating at a moderate speed and undertaking a typical steering manoeuvre.

4.1. While a wide variety of test speeds and steering inputs are possible, this sample is representative of the circumstances for a significant proportion of fatal and serious injury quad bike crashes that have occurred in the workplace in Australia[102]. The rider in the described circumstance is often not engaged in an active riding style, (which may alter the steady state response of the vehicle), hence a neutral rider (inactive) has been used for the test methodology.

4.2. The primary aim of this test is to determine the quasi-steady state circular driving behaviour of a quad bike. The measured understeer or oversteer and where relevant, the point of transition between these characteristics, when combined with other handling characteristics, will provide an indication of an average rider's ability to control the vehicle during expected and unanticipated steering manoeuvres. The results can also be used to determine if the vehicle has a Critical Speed and if so, what it is.

5. Test Method

5.1. This test determines a measure of understeer or oversteer and where relevant, the point of transition between these characteristics. The information is determined by driving on a constant radius circle and varying the vehicle speed, either in set increments or by constant acceleration, then measuring the steering (handlebar) angle required to maintain the constant radius turn. Other test methods are available and are explained in full in Reference i, ISO 4138:2012, Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods

6. Reference System

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[101] American National Standard Institute, American National Standard for Recreational Off-Highway Vehicles, (ANSI/ROHVA 1 - 2011), 11 July 2011.

[102] Lower T, Herde E, Fragar L. Quad bike deaths in Australia 2001 to 2010. *Journal of Health, Safety & Environment* 2012.

6.1. The reference system specified in ISO 15037-1 applies as closely as practicable (given ISO 15037 is for passenger cars and includes references to driver and passenger etc).

6.2. The location of the origin of the vehicle axis system (X, Y, Z) is the reference point and therefore should be independent of the loading condition. It is fixed in the longitudinal plane of symmetry at half the wheelbase and at the height above the ground of the centre of gravity (CG) of the vehicle when loaded at rider only test mass (see 9.1).

7. Measuring Variables

7.1. The following variables shall be determined during the test:

- handlebar angle
- Steered wheel angle
- lateral acceleration
- yaw velocity
- longitudinal velocity
- roll angle

7.2. The following variables may be recorded if the situation or resources permit:

- sideslip angle
- lateral velocity
- handlebar torque
- longitudinal acceleration

8. Data Measuring Equipment

8.1. Data recording must be capable of a rate of at least 100 Hz or more. Minimum sampling rates and accuracy of the various parameters are shown in Table 1 below:

Table 1: Parameter sampling rate, range and accuracy

Parameter	Sensor Range	Resolution	Accuracy
Longitudinal Velocity	0–40 km/hr	0.2 km/hr	± 0.25% of full range
Lateral Acceleration	± 2g	≦ 0.01g	≦ 1% of full range
Yaw Velocity	± 200 deg/sec	≦ 1 deg/sec	≦ 5% of full range
Handlebar or Wheel angle	± 80 deg or ± 25 deg	≦ 0.25 deg	± 0.25 deg
Roll Angle	± 45 deg	≦ 0.01 deg	± 2 deg

9. Vehicle Test Conditions

9.1. **Vehicle Loading.**

9.1.1. The vehicle shall be in standard configuration without any accessories fitted. Tests shall be carried out at the 'rider only' configuration. Rider only test mass is the curb mass of the vehicle with all fluids at recommended level and the fuel tank filled to its rated capacity, plus 103 kgs, consisting of:

- rider and his/her safety clothing and equipment;
- outrigger system;
- sensor and data acquisition system,
- plus any ballast required to achieve 103 kg total mass. (ballast is to be added in a saddle bag type device that applies the mass as closely as possible to the point of connection between the rider and the saddle when in a nominal upright seating position)

9.2. **Tyres and Suspension**

9.2.1. Tyres should be close to new condition. Tyres shall be inflated to manufacturers recommended pressures. Where more than one pressure is specified, the lowest value for this load shall be used.

9.2.2. Adjustable suspension components shall be set to the values specified at the point of delivery by the dealer.

9.3. **Warm Up**

9.3.1. Vehicle must be warmed up adequately by driving, including circling in both left and right hand directions to warm up the tyres. Engine should be in the normal operating temperature range. No specific warm up procedure is required, however an experienced rider will be able to tell when their vehicle is suitably warmed up to ensure correct and consistent responses to throttle, steering and brake inputs are achieved.

9.4. **Outriggers**

9.4.1. Test vehicles shall be fitted with outriggers on both sides of the vehicle. These outriggers shall be designed to minimally influence dynamic test results and constructed so as to be strong enough to resist vehicle rollover during the prescribed testing.

9.5. **Drive Train**

9.5.1. The quad bike drive train should be set to its most open setting. For example, two wheel drive shall be used instead of four wheel drive and if a lockable differential is fitted, it shall be in the unlocked, or "open" configuration.

10. Test Surface and Ambient Conditions

10.1. **Test Surface**

10.1.1.1. The test surface shall be constructed of concrete or asphalt having a braking friction coefficient of at least 0.75. The slope of the surface shall be less than 1 degree (1.7%)

10.1.1.2. The test surface shall be dry and kept free from debris and substances that may affect test results during vehicle testing.

10.2. **Ambient Conditions**

10.2.1. Testing should be conducted within an ambient temperature range of 10 degrees to 30 degrees Celsius. In addition to consistent test results, this will ensure rider comfort and safety from either wind chill or heat related stress or injury.

10.2.2. Testing should not be conducted when wind speed (constant wind or gusts) exceed 15 km/hr (at this wind speed a flag will stir up to 45 degrees from a flagpole but will not fully extend)

11. Test Procedure

11.1. General

11.1.1. The vehicle is driven at several speeds over a circular path of radius 7.6 metres[103]. The vehicle should remain on the desired path centreline, ± 0.2 m.

11.1.2. The directional control characteristics are determined from data obtained while driving the vehicle at successively higher speeds on the constant radius path. This procedure can be conducted in a very small area.

11.1.3. There are two variations of the constant radius test. In the first, the vehicle is driven on the circular path at discrete, constant speeds. Data are taken when steady state is attained and measured for at least 3 sec. In the second method, the vehicle remains on the circular path with a continuous, slow speed increase, during which data are continuously taken. When tested in this way, use a 5 second moving average to filter out the noise.

11.2. Procedure

11.2.1. The Ackerman Steering Angle for the desired turn radius can be determined from the formula:

Ackerman Angle = arc tan (wheelbase / turn radius)

Record the calculated Ackerman Steering Angle.

11.2.2. Drive the vehicle onto the desired circular path at the lowest possible speed. Record data with the steering and throttle positions fixed, then drive the vehicle at the next speed at which data are to be taken.

11.2.3. Increase the level of lateral acceleration by increasing speed until it is no longer possible to maintain steady state conditions. The test will end when the vehicle does one of:

- roll onto two wheels,
- spin the rear end out of the turn,
- plough the front end out of the turn, or
- vehicle cannot go any faster

11.3. With discrete test speeds

11.3.1. Drive the vehicle onto the circle at each test speed. After attaining steady-state, in which the desired circular path is maintained within ± 0.2 m, the steering and vehicle speed are to be held constant for at least 3 sec.

11.4. With continuous speed increase

11.4.1. Steadily increase the speed and record data continuously for as long as the vehicle remains on the desired circular path within ± 0.2 m. The maximum rate of increase of lateral acceleration should be $0.1 m/sec^2/sec$. If longitudinal velocity is

[103] Circle radius of 7.6 metres is specified by ANSI ROHVA 1: 2011 for testing SSV and generates lateral acceleration at or close to rollover limit at 25 km/hr or less (depending on vehicle).

used to control vehicle acceleration, the rate of increase should be 0.15 km/hr/sec or 0.045 m/sec/sec (approx 10 km/hr per minute)

Note: Lateral acceleration is a function of velocity squared, but over the range of speeds being tested (generally 0–25 kph) the above rate of longitudinal speed increase will provide meaningful results.

11.4.2. Regardless of the method chosen, tests must be conducted in both left and right hand circle directions and repeated at least 3 times in each direction.

11.5. **Rider Instructions.**

11.5.1. The rider must keep his/her coccyx located as close as possible to the 'seat reference point' on the saddle throughout the tests and only lean their upper body into the turn to counter the lateral acceleration being generated. Head and neck should remain in general alignment with the upper body.

11.5.2. **Seat Reference Point.** The seat reference point is established using a 95%ile male ATD (nominal mass 101 kgs) clothed in form fitting cotton clothing and shoes equivalent to those specified in MIL-S13192 rev P

11.5.3. The ATD is to be seated on the quad bike with each hand gripping the hand controls with the web of the hand in contact with the inner ridge of the hand grip. The arms are to be fully extended.

11.5.4. The pelvis is centred laterally on the seat and located longitudinally such that the back angle (measured flat from the spine box) is vertical (±0.5°); the head roll angle is to be horizontal (±0.5°)

11.5.5. The thighs are to be in contact with the fuel tank / cowling and the feet are to be positioned on the footrest with the leading edge of the heel in contact with the rear edge of the footrest.

11.5.6. A 'seat reference point' mark is placed on the saddle directly below the vee formed in the skin of the pelvis, below the instrument cavity.

11.5.7. Test riders are to position themselves with their buttocks on the saddle, with their coccyx positioned at the seat reference point. Hands are to grip the handgrips so the web of the hand in contact with the inner ridge of the hand grip and arms are to be kept as straight as possible, acknowledging the requirements of the riding task.

12. Data Analysis

12.1. **Steady State Values.**

12.1.1. The steady-state values can be established as the average values during any time interval of 1 to 3 sec during which steady state is maintained.

12.2. **Lateral Acceleration**

12.2.1. Theoretically, steady-state characteristics should be determined as functions of centripetal acceleration, which is measured perpendicular to the path. Traditionally, these characteristics have been expressed as functions of lateral acceleration, which is measured perpendicular to the vehicle's x-axis. At steady state, lateral acceleration and centripetal acceleration differ by the Cosine of the sideslip angle. In most cases, the vehicle side-slip angle will be small, so the difference between lateral acceleration and centripetal acceleration can be ignored. Where large side-slip angles are observed, centripetal acceleration may be corrected to obtain lateral acceleration using the formula specified in

Reference i, ISO 4138:2012, Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods, Section 9.2.

12.2.2. The data should also be corrected for roll angle. As roll increases, gravity contributes to the perceived lateral acceleration. Therefore roll angle must be recorded and then a correction applied to the measured lateral acceleration.

12.3. Data Presentation

12.3.1. Measured data shall be plotted directly against lateral acceleration in accordance with Figure 1-2 (and 1-3 if Roll rate measured) of Appendix 1.

12.3.2. A curve is to be fitted to the data set, using a mathematical routine. The method of curve fitting shall be described in the presentation of results. Since each resulting curve will be described by a mathematical expression, it can be differentiated mathematically to produce the gradient as a continuous function of lateral acceleration.

NOTE: It has been found that the characteristics of some vehicles have discontinuities in slope, which are not easily dealt with by standard curve fitting and differentiating techniques.

12.4. Evaluation of characteristic values

12.4.1. Derive the gradient of the curve fitted to the experimental points. The values of gradient obtained are then plotted against the independent variable (in this case, lateral acceleration) to give a response graph.

12.4.2. By this means, the derived gradients can be obtained and plotted as functions of lateral acceleration, The gradients are plotted against lateral acceleration using the conventions: lateral acceleration on the *x* axis, left turns positive, right turns negative, while the gradients on the *y* axis are plotted using the normal sign convention.

12.5. Steering (handlebar) angle gradient and Steering (handlebar) torque gradient

12.5.1. Both steering (handlebar) angle gradient and steering (handlebar) torque gradient can be derived using formula detailed in ISO 8855:2011, 12.3.2.

12.6. Normalisation of results — Comparison of results from different vehicles

12.6.1. The results obtained above are to be normalised, so that meaningful comparisons between vehicles can be made. Further information about normalisation is provided in Appendix 4.

12.6.2. Normalisation with respect to steering ratio

12.6.2.1. This technique is essential for comparing results from vehicles of similar wheelbase. The procedure for measuring the steering ratio is given in Appendix 2. This ensures the comparison is made between steered wheel angles and not handlebar angles.

12.6.3. **Understeer gradient.** This gradient is determined by dividing the handlebar angle gradient by the steering ratio: $\partial\delta_H/\partial a_y$ * $1/i_s$

12.6.4. **Normalisation with respect to wheelbase** — Stability factor

12.6.4.1. This technique yields response values that can be used to compare vehicles of widely different sizes. See ISO 8855.

12.6.4.2. The stability factor is determined by dividing the understeer gradient by the wheelbase.

Appendices:

1. Test Report and Presentation of Data
2. Determination of overall (static) steering ratio
3. General information — Theoretical basis for the test methods
4. Normalisation of Results

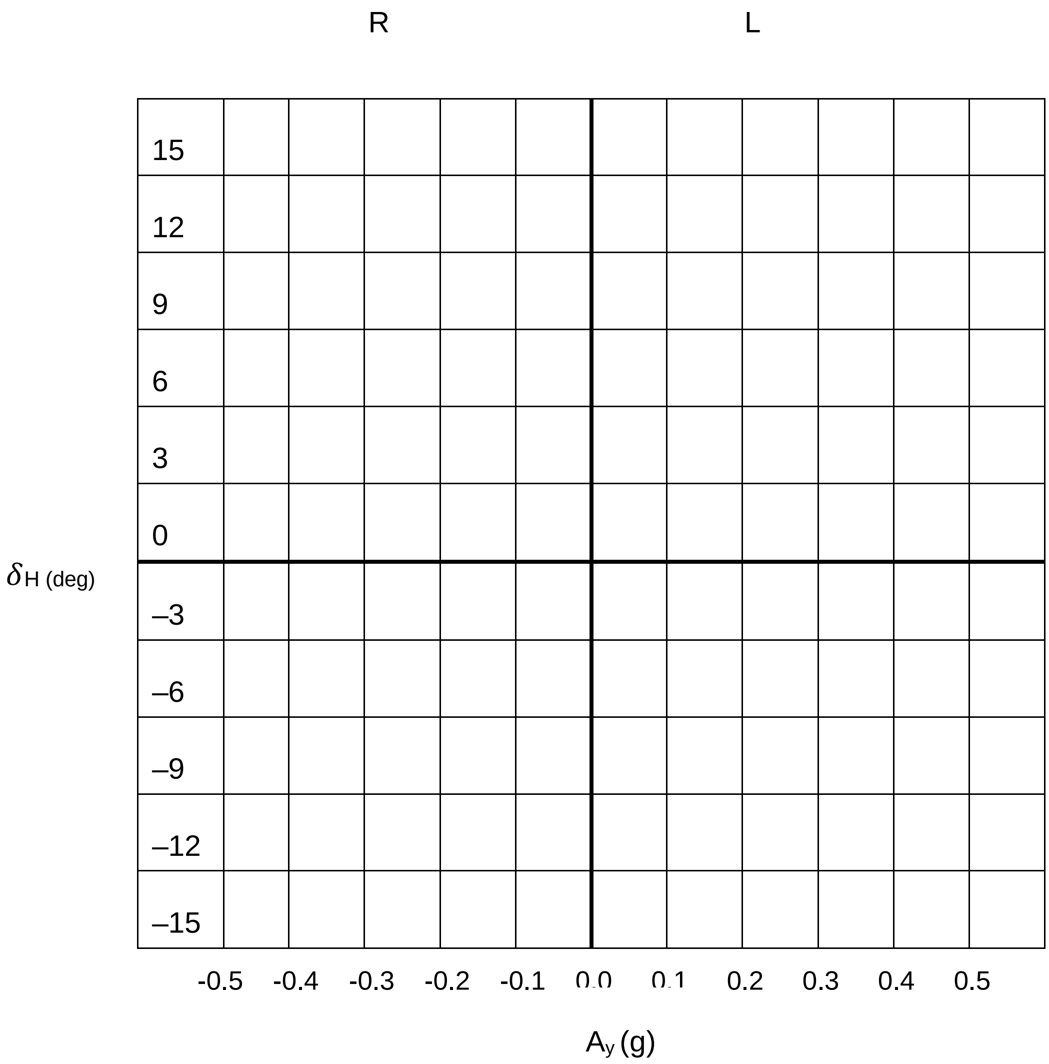
Appendix 1 (Test Report)

General Data

Vehicle Identification			
Make:	Model:	Year:	Type:
VIN or Manufacturer Serial Number:			
Steering Type:			
Suspension Type:	Front:	Rear:	
Engine Size:			
Tyres:	Make:	Model:	Size:
Tyre Pressures:	Front: kPa	Rear: kPa	
Tyre Tread: (depth/condition):			
Rims:	Front:	Rear:	
Wheelbase:			
Track	Front: mm	Rear: mm	
Steering Ratio			
Other:			
Vehicle Loading			
Tare Mass	Left Front: kgs	Right Front: kgs	Sum: kgs
	Rear: kgs	Rear: kgs	Sum: kgs
	Sum: kgs	Sum: kgs	Total: kgs
Rider Only Mass (103 kgs)	Rider: kgs	Test Eqpt: (less) kgs	Ballast: kgs
Test Personnel			
Rider Name			
Observer			
Comments			

Appendix 1 – 2

Presentation of Results



Vehicle: ....

Turning radius (constant). ....

Ay = Lateral Acceleration

δ_H = Handlebar angle (degrees)

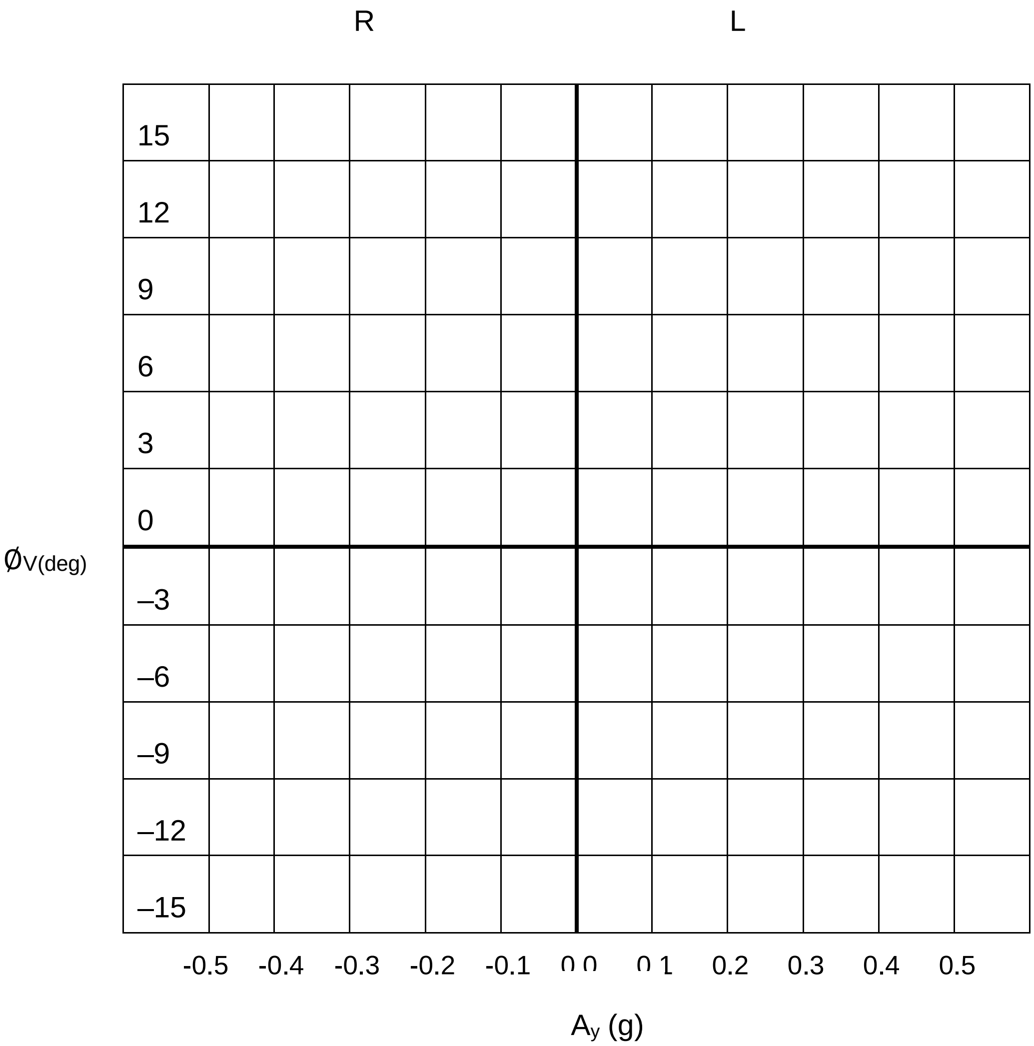
R = Right Turn

L = Left Turn

Handlebar Angle – Characteristic Values

Appendix 1 – 3

Presentation of Results



Vehicle: ....

Turning radius (constant). ....

A_y = Lateral Acceleration

$Ø_V$ = vehicle roll angle (degrees)

R = Right Turn

L = Left Turn

Vehicle Roll Angle – Characteristic Values

Appendix 2 (normative)

Determination of overall (static) steering ratio

2.1 Steering systems

Understeer gradients are stated in terms of the difference in cornering compliances between the front and rear road-wheel "axles". However, cornering compliances include deflections of the steering system due to elastic deformations. In order to include steering-system compliances, understeer is determined from measurements taken at the steering wheel. Steering-wheel angles are referred to the road wheels by the overall steering ratio.
Overall steering ratio (see ISO 8855) is a variable which describes the geometric relationship between steering- wheel angle and average road-wheel angle, measured under conditions of zero aligning moment and lateral force. If the steering system is significantly non-linear, each measured steering-wheel angle must be used together with a plot of average road-wheel angle versus steering-wheel angle to obtain the corresponding road-wheel steer angle. Steer angle gradients are obtained from a plot of road-wheel steer angle versus lateral acceleration.

2.2 Measurement

The overall steering ratio shall be determined for each vehicle test configuration over the range of steering wheel angles used during the test. The overall steering ratio will not, in general, represent the dynamic situation because of additional steering-system deflections caused by compliance and geometric effects. It is, however, suitable for removing the effect of different steering-system lever and gear ratios from comparisons of measurements from different vehicles. The compliance and geometric effects referred to above are then quite properly regarded as part of the vehicle handling characteristics.

2.3 Procedure

Using steering alignment radius plates and a handlebar angle sensor, test the range of steering inputs (handlebar angle) required to achieve the desired wheel steering angles (measured by radius plates). Record results on the table below for both left and right steering and determine the steering ratio.

Appendix 2 - 2

Handlebar Angle versus Left and Right Wheel Angles (Averaged)

Handlebar Angle Degrees	Measured Steer Angle - Degrees		
	Left Wheel	Right Wheel	Average
0			
10			
20			
30			
40			
50			
–10			
–20			
–30			
–40			
–50			

Notes:

Ackerman steering requires increased steer to the inside wheel and reduced steer to the outside wheel on a turn. The average of the two represents the wheel angle required to follow the centreline of the test circle.

Steering Ratio = ratio handlebar turn (deg) : averaged wheel turn (deg)

Appendix 3 (Informative)

General information — Theoretical basis for the test methods

The path curvature of a vehicle in steady-state turning at a given speed (i.e. in a given state of steady- state equilibrium) is determined by speed, steering-wheel angle, wheelbase and the elastic and kinematic characteristics of the front and rear steering systems, suspensions and tyres.

In the absence of kinematic and compliance steer effects — for example, at very low speeds — the low, speed path radius is defined geometrically by wheelbase and by front- and rear-wheel steer angles. At increasing speed, steady-state turning results in centrifugal force, which produces kinematic and compliance steer and camber.

When expressed in degrees per metre per second squared (m/s^2) of lateral acceleration and lumped together, these *cornering compliances* produce steer angles and tyre slip angles in front and rear that modify the low-speed path radius. Cornering compliances subtract from the front and rear Ackermann steer angles.

Cornering compliances greater in front than rear increase path radius from the Ackermann condition and produce understeer, while those greater in the rear than in the front reduce path radius and cause oversteer. The difference between the total front and rear cornering compliance is called the *understeer gradient,* expressed in degrees per metre per second squared (or may be expressed in degrees per gravity (deg/g)). Similarly, the change in steering-wheel angle required to maintain a given radius with increasing lateral acceleration is called *steering-wheel angle gradient,* the change in roll angle with lateral acceleration is called *roll angle gradient,* etc.

The test procedures specified herein are designed to measure some of these various vehicle steady-state properties.

The sensitivities of the vehicle's responses to steering inputs are called yaw velocity gain (degrees per second per degree of steering-wheel movement), lateral acceleration gain (m/s^2 per degree of steering-wheel motion), sideslip gain, etc. These can be calculated from the vehicle speed, steering-wheel angle, steering ratio, wheelbase and understeer gradient, or they can be obtained directly from measured data.

Appendix 4 (Informative)

Normalisation of Results

In any general case of a vehicle making a steady-state turn of given radius, the steer angle required will consist of two parts: that due to the Ackermann effect, which for a given radius is proportional to the wheelbase, and that due to the handling characteristics of the vehicle. In addition, the handle-bar angle corresponding to the required steer angle will depend on the overall steering ratio.
Thus, there are three quantities to be taken account of in the general case:

(a) wheelbase, l;

(b) overall steering ratio, i_s;

(c) handle-bar angle gradient, $\partial\delta_H/\partial a_y$.

The units of the handle-bar angle gradient will be degrees per m/s^2 and, by convention, a vehicle with zero steering-wheel angle gradient — that is to say one which needs no movement of its steering wheel when changing speed on a curve of constant radius — is defined as a neutral-steer vehicle.

The handle-bar angle of a neutral-steer quad bike becomes a function only of turning radius, steering ratio and wheelbase.

The handle-bar angle gradient of any vehicle can be normalised by dividing the measured responses of the actual vehicle by the steering ratio.

The practical benefits of doing this are that the steering-wheel angle gradient of vehicles of similar sizes and different steering ratios can be compared analytically by comparing their normalized measured responses.

Comparison of measurements that have not been normalised will not clearly show differences in handle bar angle gradient because they also contain the effects of differences in steering ratio.

References:

ISO 4138:2012, Passenger Cars - Steady State Circular Driving behaviour - Open-loop test methods

American National Standard Institute, American National Standard for Recreational Off-Highway Vehicles, (ANSI/ROHVA 1 - 2011), 11 July 2011

Lower T, Herde E, Fragar L. Quad bike deaths in Australia 2001 to 2010. *Journal of Health, Safety & Environment* 2012