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Australian Competition and Consumer Commission
GPO Box 3648
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Dear Sir/Madam,

I am writing to you regarding the current product safety issues with quad bikes (also known as all-terrain vehicles or ATV's) in Australia and present the following as a submission toward the standard development draft process currently being undertaken.

As part of my studies at Central Queensland University, I undertook an investigative report into quad bike fatalities and feel so strongly about the issues uncovered that I am compelled make a submission. Fatalities from quad bike use have been steadily increasing, with Safe Work Australia recording 126 deaths from quad bikes accidents in the period 2011-2018. This equates to 15 deaths per year, equally spread across recreational and work-related usage. In addition to this the Centre for Accident Research & Road Safety – Queensland reported that from 2003-2011 almost 8000 patients were admitted to hospital for quad bike related injuries, at an estimated cost of $85 million per annum.

There is no standard in Australia for quad bike design - The Federal Chamber of Automotive Industries (FCAI) members have voluntarily adopted the American design standard *ANSI/SVIA-1-2017 for Four-Wheel All-Terrain Vehicles Equipment Configuration, and*

Performance Requirements, however his will have no real effect on the fatality rate as the majority of quad bikes involved in fatal accidents are already in compliance with this standard. In addition, it does not apply to the ever-increasing numbers of Chinese and grey market import quad bikes sold by non-FCAI members and online resellers, making it important that Australia has its own design standard in place to reflect our operating conditions and market. This will help to ensure quad bikes sold in Australia are safe for consumers and suitable for Australian conditions.

In addition there is no mandated standard in Australia for quad bike helmets. New Zealand has implemented their own standard, NZS 8600:2002 All-terrain vehicle helmets and given the close relationship between Australia and New Zealand in regard to standards, mirror adoption of this standard would be feasible in the short term and is likely to have a positive impact on quad bike safety. This is evident from the fact that 45% of the reported fatalities to Safe Work Australia were due to preventable head injuries. New Zealand has shown a 20% decrease in fatalities following introduction of their standard and helmet laws and one could expect to see a similar result here in Australia.

Australia also has no standard in place for the design and fitment of operator protections devices such as roll bars or rollover protection (ROP's).and crush protection devices. These are required equipment on most other items of plant in the workplace and should be considered essential fitment on quad bikes due to their propensity towards lateral and longitudinal instability under dynamic operating conditions. In the event of a rollover the rider has no structure whatsoever to prevent the quad bike pinning them to the ground and data from Safe Work Australia shows that around 60% of quad bike deaths involve a rollover event, with 40% dying from positional asphyxia due to being crushed.

Industry groups led mainly by the FCAI have been vehement in their opposition to mandating fitment of operator protection devices to quad bikes, relying heavily on one 1980's study into motorbike safety and a singular researcher in the United States to support their stance. Given that a) Israel has had regulations requiring the fitment of operator protection devices to quad bikes in place since the 1990's with no deleterious effects and b) recent research by the University of New South Wales Transport and Accident Research arm have shown that commercial operators of recreational quad bikes who have fitted operator protection devices to their bikes demonstrate a marked decrease in injury rates, this stance is almost impossible to defend.

It appears that the FCAI and its constituent members are more concerned with prospective litigation and costs to their business than they are about saving lives and marketing a safe, responsible product.

Recently the Australian Competition and Consumer Commission has carried out the largest compulsory recall in Australian history for faulty Takata airbags which have killed one person and resulted in one serious injury in Australia - yet in comparison quad bike accidents kill 15 people per annum with over 8000 hospital presentations for injuries – there needs to be immediate action to rectify the product safety design issues that are present in quad bikes.

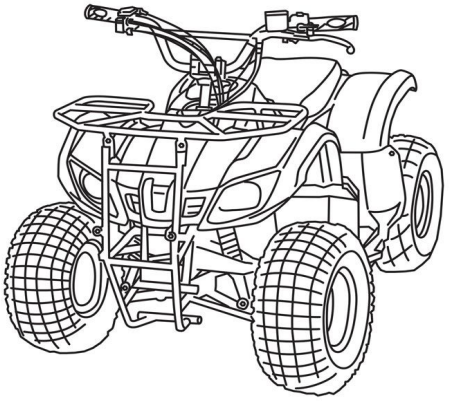
I would urge the Australian Competition and Consumer Commission to act immediately in supporting the implementation of design standards by Standards Australia, as well as mandating the fitment of operator protection devices to all new quad bikes sold in Australia. In addition, I would also urge the Commission to conduct a compulsory recall for all quad bikes to be retrofitted with operator protection devices at the cost of the manufacturer in a similar fashion to the Takata airbag recall.

Yours faithfully,

Emma Abbott

Quad Bike Fatalities:

A Report into the Causative factors of
Quad Bike Accidents and Fatalities from 2011-2018



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Contents:

1. Executive Summary

Quad bikes, also known as all-terrain vehicles, are a common tool in Australian agriculture and forestry. Recent trends indicate that they are becoming far more common as a recreational vehicle as well, with over 50% of sales in 2015 being for sport and recreational purposes (Global Market Insights 2017).

This rise in popularity has been accompanied by a steady increase in fatalities and injuries involving quad bikes, with Safe Work Australia (2019) noting 126 deaths in the period between 2011 and 2018. These fatalities are evenly spread across working and non-working use of quad bikes (Safe Work 2019) and represent a unique challenge to implementation of risk controls to address the death rate.

Examination of the circumstances of these deaths tends to indicate purely human error proximal causes such as operating and turning at speed, operating on an incline, using the incorrect machine for the task, riding under the influence and not wearing a helmet, however a closer examination of the data reveals systemic root causes behind apparent human centric failure. In other words:

> People will make mistakes and...crashes will occur, but the punishment for making a mistake should not be death or serious injury. The focus should be on safer people (through training and education), but also on safer vehicles (that are forgiving of minor lapses in attention, minor errors of judgment, and that mitigate against injury risk if a crash occurs) (State Coroners Court of NSW 2015).

Based on this tenet and having regards to current research and trends in data, recommendations can be made for risk controls to be put in place that will directly influence the fatality rate of quad bike accidents from a systems safety perspective.

2. Introduction

Quad bikes (also referred to as ATV's or all-terrain vehicles) are an ubiquitous tool on many Australian farms and are also used for transport, sport and recreation purposes. To gain a perspective on the scope of the quad bike fatality issue, it is necessary to define the context and the current market, current industry regulation and standards as well as examine quad bike accident data.

Following on from this, it is then possible to analyse current research and data to tease out causative factors and risk factors in order to make evidence based recommendations for change.

3. Scope

3.1 Quad bike definition

Quad bikes are defined by the American National Standards Institute 2015 as a three or four wheel vehicle that travels on low-pressure tires, with a seat that is straddled by the operator, along with handlebars for steering control (American National Standards Institute 2015), see Figure 1 below:

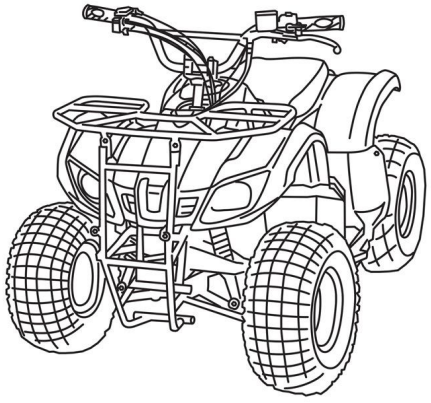

Figure 1: Representative quad bike illustration (Department of Infrastructure and Government 2018).

Most quad bikes are single person vehicles but some have provisions for passengers. A large range of genuine and aftermarket accessories and fitting options are available such as spray tanks, carry racks, trailers and tow along equipment which may change the ride and handling of the vehicle.

Quad bikes are designed for off-road use on unpaved ground and can reach speeds rivalling small cars. They also have a high vertical centre of gravity, creating a risk of rollover (Australian Competition and Consumer Commission 2017).

The ACCC (Australian Competition and Consumer Commission) categorises ATV's into three categories:

- Youth: Smaller, lightweight versions of adult sized quad's designed for under 16's
- Sport: Lighter weight models with a lower centre of gravity and quicker acceleration

- Utility: Heavier, larger engine capacity models designed to tow and move loads.

There is estimated to be a fleet of 380,000 quad bikes in Australia and they are traditionally heavily used in the workplace, especially in agriculture, farming and forestry. Recent sales trends have indicated a shift towards being purchased more predominantly for private usage such as hobby farming, sports and recreation; in 2015 recreation and sport accounted for a total of 53.3% of all quad bike sales in Australia (Global Market Insights 2017).

3.2 Current design standards and regulation

There is no design standard for quad bike design currently in force in Australia. As quad bikes are not considered to be on-road vehicles, they are not encompassed in the Australian Design Rules for motor vehicles (Department of Infrastructure and Regional Development 2017).

America has a mandatory national standard - ANSI/SVIA-1-2017 for Four-Wheel All-Terrain Vehicles Equipment Configuration, and Performance Requirements (US Standard).

In the absence of an applicable Australian standard, Federal Chamber of Automotive Industries (FCAI) members have adopted the American National Standards Institute (ANSI/SVIA) standard for quad bikes on a voluntary basis for all quad bikes imported by their members (FCAI 2016). There are no domestically manufactured models of quad bike in Australia; all are imported with the majority coming from the US market and therefore adhering to the ANSI standard. This, however, does not apply to the ever increasing numbers of Chinese and grey market import quad bikes being sold by in stores by non-FCAI members and in online sales marketplaces such as EBay.

The European Union also has a design standard in place that mirrors the American standard (European Parliament 2013).

Israel has a design standard in place for rear safety frames which are mandatory fitment to quad bikes in the country (Israel Ministry of Transport 2014). Rollover Protection Devices (ROP’s) are not mandatory in Australia and do not have a design standard in place.

Regulation for quad bike usage in Australia is limited; quad bikes utilised on public roads are regulated under transport regulation in all states and territories differently with no real regulation applying for off-road use. Quad bikes are permitted to be used on public roads with varying requirements between states in regards to licencing, speed limits, helmets and registration (ACCC 2017, p. 37).

When used in a workplace setting quad bikes are classified as plant under the model Work Health and Safety Act (2011) and Work Health and Safety Regulations (2011) in most states. Under these, manufacturers, importers and suppliers of plant all have obligations under the Act to ensure the safety of the product they supply in regards to vehicle stability and operator protection devices. PCBU's (Persons Conducting a Business or Undertaking) also have obligations to manage the risks associated with use of plant in the workplace such as providing safe systems of work. Under individual state legislation in Victoria and Western Australia, risks from plant must be managed in a way that mirrors the model Act and Regulation with minor differences.

3.3 Quad bike accidents, injuries and fatalities

According to Safe Work Australia (2019), there were 126 fatalities attributed to quad bike accidents between January 2001 and December 2018 Australia-wide.

Of these fatalities:

39% were on incline
55% were on uneven ground
60% included rollovers
36% had indicated a weight imbalance due to carrying a load or towing
58% were not wearing a helmet and 32% was unknown if wearing a helmet
49% occurred in a private or domestic setting
49% occurred whilst the deceased was working
84% were male
10% were children under the age of 16
0% of the quad bikes were fitted with a roll protection device

(Safe Work Australia 2019).

An examination and collation of coronial inquest data from the three joint coronial inquests held in Tasmania, Qld and New South Wales was undertaken and is attached at Appendix 1. Of the 27 fatalities examined:

100% of the deaths of children under 16 were on adult sized quad bikes
40% died from traumatic or positional asphyxia due to being trapped underneath the bike
11% died from chest injuries
50% died due to head injuries
0% of the quad bikes involved were fitted with rollover protection devices
11% were wearing a helmet (one chest injuries, one larynx injury, one helmet came off)
80% occurred on quad bikes of greater than 400cc engine displacement
50% occurred on quad bikes of greater than 500cc engine displacement
30% were in a workplace
1 out of the 27 reported having had any formal training on quad bike operation
Of the 10 deaths where speeds were known or estimated by crash scene investigators, 6 were doing greater than 40km/h
22% were carrying a load or towing
66% involved a rollover (either lateral or end over end)

In data collected by the ACCC (2017), the Centre for Accident Research & Road Safety – Queensland reported that from 2003-2011 almost 8000 patients were admitted to hospital for quad bike related injuries, with average hospitalisation times of 2.5 days for children and 3.4 days for adults. Common causes of injury were head injuries, thoracic injuries and shoulder/arm injuries (ACCC 2017).

The ACCC (2017) estimated the total cost of quad bike deaths and injuries to be $85.19 million per annum in Australia; they acknowledge that this is likely to be a underestimate due to not taking into account broader social and economic factors. This figure is significant given that the estimated retail value of quad bikes to be sold in 2017 of $258.7 million.

4. Risk and Causal Factors

4.1 Quad bike design and inherent instability

Quad bikes, given their high centre of gravity and narrow wheel track have a propensity towards instability under operational conditions (MacMillan 2017). This may be aggravated by the carrying of a load and the ability or inability of the rider to participate in maintaining stability by utilising ‘active riding techniques’ (Safe Work Australia 2018).

According to TARS (2017), the quad bikes that they tested for dynamic instability satisfied the static stability requirements of the ANSI/SVIA 1–2010 Standard; an indication that both the standards were set too low to be useful in preventing rollover and that testing static stability is not adequate in predicting the stability margins of a quad bike. This is backed up by data collated from coronial inquest findings (Appendix 1), where 50% of the bikes with a known origin that were involved in a rollover were designed in accordance with this standard.

The ACCC (2017) estimates that 95% of the quad bikes in the Australian market were of US origin and would therefore satisfy the ANSI/SVIA 1–2010 Standard. This estimation has been used to support the adoption by Australia of a Standard that mirrors the US Standard due to it having little impact on current importers and resellers (State Coroners Court of NSW 2015), however interrogation of fatality data shows that this would have minimal impact on fatality rates in Australia.

Data from Safe Work Australia (2019) and analysis of the three state coronial inquests (Appendix 1), showed that around 60% of quad bike deaths involve a rollover event, with 40% dying from asphyxia due to being crushed. This is backed up by the findings of McIntosh et. al. (2014), who stated that 60% of work related quad bike fatalities involved crush injuries without accompanying impact injuries and that 50% were pinned under the bike as a result of the accident.

The standard quad bike design offers no occupant protection in the event of a rollover. Not one of the 126 fatalities reported by Safe Work Australia (2019) had any form of occupant protection device fitted.

Industry promotes rider separation as the solution to riders being pinned underneath quad bikes in a rollover event. The FCAI strongly opposes the mandatory fitment of rollover protection devices to quad bikes (FCAI 2016) and this advice appears to rely on a series of studies conducted by Dr. Peter Bothwell in the early 1970's on motorbike safety. While there are some similarities between the two, quad bikes are much heavier and a quad bike accident more likely to result in the rider being crushed or pinned by the machine resulting in asphyxia (TARS 2015). Furthermore, TARS research showed a statistically significant increase in injury where the rider separated from the bike (TARS 2015), proving that utilising rider separation as a risk mitigation practice is causing further harm to riders. In addition, according to Safe Work Australia (2019) and TARS (2015) almost 50% of fatalities occurring in a workplace/farming context were caused by mechanical asphyxia due to pinning, with over 70% deemed to have been survivable if the rider was not pinned.

Another hazard is the fact that design issues in quad bikes currently in the market are not self-evident to consumers due to the lack of a safety rating system for quad bikes such as the Australasian New Car Assessment Program (ANCAP) for cars (TARS 2015). Consumers are reliant on information provided to them by salesman and their own research and experience to make a choice of machine. In a statement to police after the death of his wife Angela Stackman after rolling their quad bike, Mark Partridge told police that they had bought the bigger sized quad as they felt it was safer because of the extra weight (State Coroners Court of NSW 2015, p.12). Given Ms Stackmans additional physical limitations and their intention to mount a spray tank on the bike, the opposite is true - had information on the weight/engine capacity ratio in regards to stability been available to them they may well have made a different purchase of a much lighter quad with a lower centre of gravity.

4.2 Operational instability

Operational stability of quad bikes can be affected in various ways which are outside the control of the manufacturer including:

- Bike kerb weight/Operator weight ratio

Quad bikes are designed to be ridden utilising 'active rider' techniques, the success of which is primarily governed by the bike kerb weight/operator weight ratio (Macmillan 2017) and the

capability of the rider (TARS 2015 p.88). Collated coronial data (Appendix 1) showed that in the majority of cases, riders were utilising larger capacity bikes with a greater kerb weight. This also occurs when children are permitted to ride inappropriate or adult sized quad bikes; according to Safe Work Australia (2019) children represent around 10% of all quad bike fatalities and in all cases were riding adult sized quad bikes beyond their physical and weight capability.

- Rider ability (active riding and operator skill set, operation under the influence of alcohol, medical conditions, age)

Quad bikes currently in the market are sold as being active riding machines - where the rider is required to actively influence the stability of the vehicle using their weight distribution (TARS 2015). Many factors can influence a riders ability to participate actively in control, including operator skill, operating under the influence of drugs or alcohol, pre-existing medical conditions and age.

Of the 27 deaths investigated by the three state coronial inquests, only one fatality had reportedly had any training, which was provided through a TAFE competency module as part of an agricultural qualification (State Coroners Court of NSW 2015). The TARS (2017) survey showed that of the six discrete forms of training, the type providing the greatest protective factor was on the job training provided by a fellow worker or employer with the solely theoretical training least likely to provide a benefit, as shown in Figure 2 below:

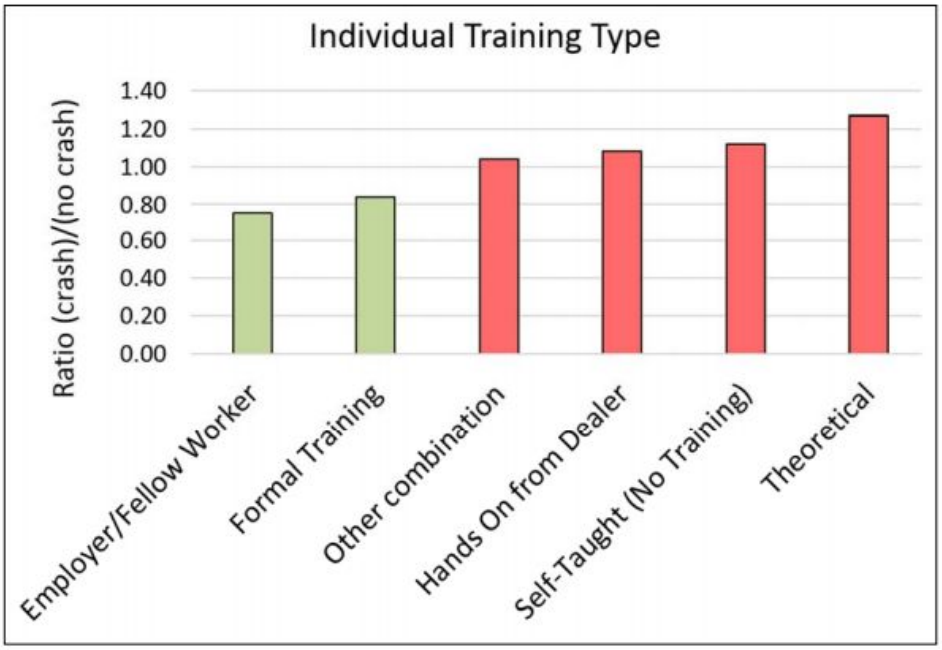

Figure 2: Individual Training Type (TARS 2017).

In addition, the following table, illustrates the reduction in crash rate as years of operational experience increases:

Experience Band	Midpoint	Frequency (riders)	Riding Years	Number Crashes	Crash Rate	Cumulative % of 1541* crashes
Less than one year	0.5	18	9	4	4.44	0.3
1 to less than 3 years	1.5	44	66	11	1.67	1
3 to less than 5 years	4	70	280	20	0.71	2
5 to less than 10 years	7.5	172	1290	73	0.57	7
10 to less than 15 years	12.5	203	2538	104	0.41	14
15 to less than 20 years	17.5	278	4865	145	0.30	23
More than 20 years	25	756	18900	425	0.22	51
Missing Responses = 5						

Figure 3: Crash rate versus years of rider experience: Crash rate results show number of crashes per 10 years of riding (TARS 2017)

Inebriation whilst operating a quad bike is a risk factor which has influenced a number of fatalities. In the coronial inquest data provided in Appendix 1, over 40% of deaths involved the rider being under the influence of alcohol - in many cases well in excess of the drink-driving limits for public roads. The causal link between drink driving and crash rates has been well proven over the years (Homel, R 1991; Dubois et. al 2015) and a similar

situation applies here. Inebriated riders make poor decisions and are unable to participate fully in using their weight to maintain the stability of the bike.

Similarly pre-existing medical conditions can dramatically reduce the operators ability to ride actively and therefore maintain control of the bike. Seven of the twenty seven fatalities explored by the joint coronial inquests (Appendix 1) had some form of physical medical condition which, in limiting their ability to maintain dynamic stability of the quad bike may well have contributed to the incident and their subsequent death.

The reliance on active riding to maintain the stability margin of quad bikes is also reflected by the higher representation of aged riders (who are less likely to be 'active riders') that are involved in workplace fatalities; in data examined by TARS (2015, p. 9) 78% were 50 years or older; 50% were 60 years or older; 42% were 65 years or older; and 33% were 70 years or older.

- Centre of gravity issues (Fitment of tools and accessories, carrying of passengers)

Carrying a load on a quad bike raises the bikes centre of gravity, reducing its stability envelope. Carrying accessories such as spray tanks and load frames can add the equivalent weight of another adult or more depending on the size of the tank. There is currently no requirement for sellers of accessory gear to ensure that the fitting of such equipment does not compromise the safety of the quad bike (TARS 2015 p.7). Most quad bikes in the current Australian fleet are designed to carry one rider only; the addition of passengers has a similar effect as adding accessories and can readily unbalance a quad bike as well as compounding matters by limiting the riders ability to actively ride the bike. Safe Work Australia (2019) data shows that over 33% of quad bike fatalities involve a weight imbalance such as carrying passengers or cargo.

- Operation on an incline, uneven or loose ground

Operation on an incline or uneven ground was implicated in 39% and 55% respectively of quad bike fatalities between 2011 and 2018 (Safe Work Australia 2019). Despite the common moniker of 'all terrain vehicle', quad bikes are not well suited to operation on anything other than flat ground due to their higher centre of gravity and operation of a quad bike under such conditions makes it more likely that a quad bike will experience rollover

during a loss of control event. Quads experience both lateral and longitudinal rollover on inclines and this was well illustrated by stability testing undertaken by TARS in 2015 and published as part of the final report on their Quad Bike Performance Project, where the Tilt Table Ratios (a measure of rollover resistance) for a range of common quad bikes in the market was examined with the results highlighting the pronounced reduction in stability margins for quad bikes on inclines and uneven ground due to their higher centre of gravity.

- Engine capacity/weight of quad bike

MacMillan (2017) demonstrated a correlation between increasing engine capacity (and resultant greater kerb weight) with a higher centre of gravity of an unladen quad bike. Of the collated coronial inquest data (Appendix 1), none of the fatal crashes occurred on a quad bike of less than 300cc capacity, indeed 50% of fatalities occurred on quads of greater than 500cc capacity. A higher centre of gravity will reduce the vehicles operational stability and this is compounded by operation on anything other than flat ground. A review of US Consumer Product Safety Commission injury data showed a 50% reduction in fatal incidents with a reduction in engine size (TARS 2017, p. 18)

4.3 Personal Protection Equipment (Helmets)

Helmet use is not common amongst quad bike users, either recreationally or when employed in a workplace setting. The TARS (2015, p. 12) survey of individual quad bike operators indicated that 86% of owners had access to a helmet, but only 28% indicated that they always wore one when operating a quad bike. Of the 126 fatalities recorded by Safe Work Australia (2019) for the period between 2011 and 2018, only 10 were wearing helmets and all but one of these were children on age-inappropriate quad bikes or being carried as passengers on single person quad bikes. Data from the coronial inquests (Appendix 1) showed 45% of fatalities were from head injuries, many of which would have been either preventable or commutable if a helmet had been worn. This is backed up by McIntosh et al (2016), who states that 32% of quad bike fatalities are from head injuries and echoed by Bowman et. al (2009), who found that unhelmeted ATV riders were 2.5 times more likely to die from their injuries than those wearing a helmet.

5. Findings

An examination of the available data has demonstrated clear trends in risks and causative factors in quad bike accidents. Many factors were examined across all facets of quad bike supply and use but the root causes and their possible controls appear to be:

- Quad bike and accessory design
    - Inherent instability of bike design coupled with a lack of quad bike design standard for the Australian market

Quad bikes are poorly regulated in the current Australian market. There is no relevant mandatory design standard in place so consumers are at the mercy of a mish mash of voluntary international design standards and principles. There is no independent safety testing of quad bikes or accessories designed to fit them leaving consumers ill-informed

        - Possible Control:
            - Introduce mandatory design standard for Australia for quad bike design including occupant safety devices that meets or exceed the current American standard and is suited to our environmental and workplace conditions
            - Implement a safety system for accessory resellers requiring independent testing of accessories on how they alter the handling and safety of quads

    - Lack of occupant protection devices

The propensity of quad bikes to undergo lateral or longitudinal rollover during operation dictates that operators should be afforded some form of rollover protection. The high percentage of mechanical and positional asphyxia deaths as well as a marked increase in injury risk when the rider is separated from the bike during an incident indicates that relying on rider separation as a control measure is not feasible. Industry support for this as a control measure and vehement opposition to the fitting of occupant protection devices is based on outdated studies and must be discounted in light of recent research such as Macmillan (2009) and TARS (2015; 2017). It also flies in the face of other countries experiences such

as Israel where the fitting of occupant safety devices has been mandated since the 1990's (Lower and Temporley 2016). The lack of rollover protection for the operator would not be tolerated in other items of plant in the workplace and quad bikes should be no exception. Take-up of occupant safety devices/rollover protection devices in the recreational sector has been slow due to cost and lack of information (TARS 2015)

- Possible control:
  - Mandate fitting of an occupant safety device/rollover protection device to all newly sold quad bikes in Australia.
  - Mandate fitting of an occupant safety device/rollover protection device to all quad bikes utilised in a workplace setting and commercial recreation.
  - Encourage fitment of an occupant safety device/rollover protection device to privately owned/recreational quad bikes by subsidising such a program through an industry safety levy on resellers

- Rider issues
  - Operating a quad bike when physically incapable

Many quad bike fatalities involve the rider being under the influence of alcohol or being physically unable to control a machine that relies on 'active riding' techniques for safety either due to physical limitations such as medical conditions, lack of instruction and training on how quad bikes operate in regards to weight shifting and stability or riding a bike too large for their size (such as children on adult sized quad bikes).

- Possible control:
  - Licensing - require workers to obtain a high risk plant licence to operate quad bikes in the workplace (current high risk licences require a certain level of training and capability to obtain)
  - Training - require minimum training to obtain a high risk work licence
  - Legislative controls to prevent drink-riding and provide deterrents for drink riders such as fines/loss of licence

- Implement a educational safety campaign utilising media to make riders aware of the dangers riding a quad bike whilst not physically capable or under the influence can be
- Fit warning labels at point of sale to deter riders from operating when incapable (due to age, physical limitation etc):
- Fit seat weight interlocks to new quad bikes (such as those used on ride on mowers) to prevent children from operating adult sized quads and ensure adult riders are of a minimum weight to start and operate quad
- Encourage retrofitment to existing quad bikes by incorporating this into the rollover protection device subsidisation

- Riding without a helmet

Data from McIntosh et al (2016) indicates that over 30% of quad bike fatalities are from head injuries, many of which would be preventable or survivable if the rider was wearing a suitable helmet. Helmet use is not common amongst quad bike users and needs to be encouraged. Australia does not currently have a design standard for quad bike helmets, however New Zealand does and given the convergence of AS/NZ standards there would be little imbroglio involved in adopting a mirror of this standard for Australia.

- Possible control:
    - Mandate helmet wearing whilst operating a quad bike where possible (i.e. workplace situations, on roads, in public spaces, commercial recreation)
    - Encourage helmet uptake by subsiding purchase of a suitable helmet
    - Adopt the New Zealand helmet standard as a matter of urgency

- Incorrect selection of machine for task

Much of the danger in operating a quad bike comes from utilising quad bikes on terrain unsuited to their use as well as overloading them with passengers and equipment. Inclines

are of a particular danger as they reduce the operational stability envelope of the bike. When combined with a weight imbalance such as carrying passengers or equipment e.g. spray tanks, quad bikes can become unstable very quickly and are less forgiving of operator errors such as turning too quickly or on too sharp a slope.

- Possible control:
  - Fit quad bikes with an inclinometer and warning buzzer when maximum incline reached
  - Implement a educational safety campaign utilising media to make riders aware of the dangers riding a quad bike with passengers or loaded equipment
  - Product legislation requiring accessory manufacturers to provide independent testing before point of sale on how accessories will alter quad bike stability and communicate this to prospective purchasers via Point of sale information or warning labels
  - Select machines more suitable for the task such as side by sides, utilities or tractors

- Selecting a quad with greater than necessary engine capacity/weight

Many users are under a false impression of the larger the quad the safer it is. This is erroneous due to the lack of occupant protection and the heavier kerb weight, which makes it more likely that the rider will suffer mechanical asphyxia from being pinned under the larger machine during an accident. Combined with a larger engine size this raises the centre of gravity of the quad bike narrowing the margin of safety the rider has.

- Possible control:
  - Introduce a Safety rating system for quads at point of sale backed up by independent testing against an Australian standard (similar to the ANCAP program)
  - Fund an independent study to rate common secondhand machines against the same safety system to ensure consumers have adequate knowledge to make informed purchases

6. Recommendations

Harm minimisation involves risk identification and the subsequent implementation of appropriate risk controls, done in accordance with the Hierarchy of Controls, see Figure 4:

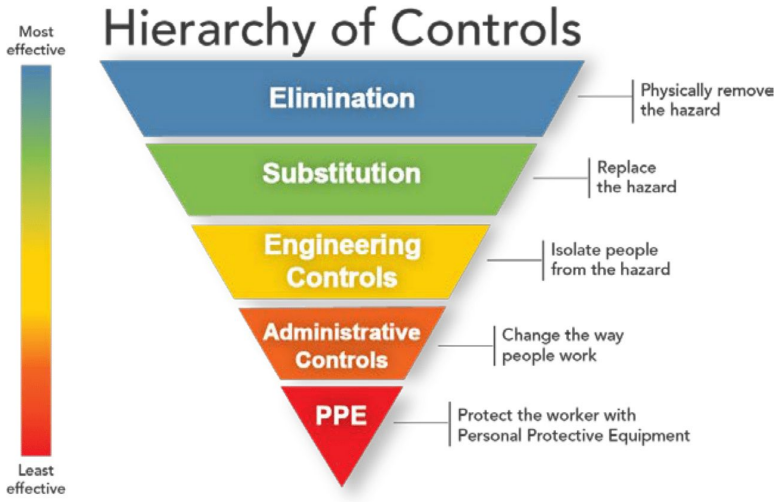

Figure 4: Hierarchy of Controls (Druley 2018).

Of the possible controls suggested in Section 5, many are lower order administrative or PPE based controls which should not be the first choice in the implementation of controls. In the case of quad bikes, eliminating the hazard (being the kinetic energy and gravitational potential energy of the quad bike) is not feasible. Substitution of more suitable machines is to be encouraged however is beyond the reach of government to force. Several engineering controls are feasible and would directly reduce the number of fatalities per year. The one PPE control that is worth implementing is the wearing of helmets. Based on this, the following recommendations are made:

1. Adoption of an Australian Standard for quad bike, accessory and safety equipment design.

For Australia not to have it's own design standard flies in the face of industry best practice and consumer protection. Quad bikes are large machines capable of achieving great speeds which need to be regulated in some shape or form to give consumers a degree of protection from danger. Implementation of the US Standard ANSI/SVIA-1-2017 for Four-Wheel All-Terrain Vehicles Equipment Configuration, and Performance Requirements would have

little effect on FCAI members due to the saturation of US built quads in the primary reseller market, would ensure grey and Chinese imports had to provide buyers with a quality product and would bring a level of certainty to customers wishing to select a safer quad bike.

2. Fitting of occupant safety devices

Occupant safety devices/rollover protection devices are an engineering control eminently suitable for implementation in the field. Despite industry misgivings, current research, such as the TARS (2015) study proving the benefits of these in the commercial recreation sector as well accident/fatality data coupled together the experience of other countries such as Israel strongly supports the fitment of these to all quad bikes. Mandating fitment to new quad bikes and subsidising the purchase and fitment of these via an industry safety levy to increase uptake in the private sector would be feasible and achievable in the short to medium term.

3. Seat weight interlocks

The fitting of seat weight interlocks to quad bikes would eliminate children riding adult sized quad bikes and ensure that quad bikes are only operated by riders having enough body mass to physically influence the stability of the bike. Similar controls are in place for ride on lawn mowers to prevent interactions of the operator with the cutting deck and would work in a similar fashion here. Given that children under the age of 16 are over represented in fatality data fitting a control able to prevent them from riding a quad bike they cannot ride safely is ideal.

4. Helmets

Use of a helmet whilst operating quad bike is a prudent decision. Head injuries are responsible for over a third of all fatalities involving quad bikes and riders are 2.5 times more likely to be injured or killed if not wearing a helmet (Bowman et. al 2009). The lack of an applicable Australian Standard for quad bike helmets actively discourages helmet use as the only standardised motorbike helmets that are somewhat equivalent are full face motorbike helmets which are considered restrictive, impractical and uncomfortable by potential users (TARS 2015). New Zealand has a current Standard - NZS 8600:2002 All-terrain vehicle

helmets and adoption of this by Australia is strongly recommended. Following on from this, mandating the use of helmets in a workplace and commercial recreation setting would further reduce the likelihood of head injuries resulting from a quad bike accident. As far as encouraging use of helmets in the private sector, subsiding helmet purchase for existing quad bike owners could be funded similarly to occupant protection devices by way of an industry safety levy at point of sale.

Quad bike safety needs to be tackled from a systems safety perspective to have the greatest influence over fatality rates; this is stated best by Macmillan (2009) who said:

> In general terms, given the complex and daily changing, rural environment in which many QBs operate, it is unlikely that all the inherent dangerous features can be eliminated by design, all the operational errors can be avoided by education, and all the mis-perceptions by the rider can be correctly perceived.

References:

American National Standards Institute 2006, Four-Wheel All-Terrain Vehicles Equipment Configuration, and Performance Requirements (US Standard), accessed 1 January 2018, https://webstore.ansi.org/

Australian Competition and Consumer Commission 2017, Quad bike safety issues paper, accessed 28 December 2018, https://consultation.accc.gov.au/product-safety/quad-bike-safety-investigation/supporting_documents/ACCC%20Quad%20Bike%20Safety%20Issues%20Paper.pdf

Bowman, S., Aitken, M., Helmkamp, J., Maham, S., & Graham, C 2009, Impact of helmets on injuries to riders of all-terrain vehicles, Injury Prevention, vol. 15, no. 1, pp. 3-7, accessed 3 January 2019, https://search-proquest-com.ezproxy.cqu.edu.au/docview/1780957245/fulltextPDF/53A23E5BA48648BDPQ/1?accountid=10016

Department of Infrastructure and Regional Development 2017, Motor Vehicle Standards (Road Vehicles) Determination, online, accessed 12 January 2018, https://infrastructure.gov.au/vehicles/imports/import_options/orneao.aspx

Department of Infrastructure and Government 2018, Representative quad bike illustration, graphic, accessed 11 January 2018, https://infrastructure.gov.au/vehicles/imports/import_options/orneao.aspx

Druley, K 2018, Hierarchy of Controls, image, accessed 12 Jaunary 2019, https://www.safetyandhealthmagazine.com/articles/16790-the-hierarchy-of-controls

Dubois, S., Mullen, N., Weaven, B and Bedard, M 2015, The combined effects of alcohol and cannabis on driving: Impact on crash risk, Forensic Science International, vol. 248, pp. 94-100, accessed 9 January 2019, https://www.sciencedirect.com/science/article/pii/S0379073814005350

European Parliament 2013, 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, accessed 3 January 2019, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:060:0052:0128:EN:PDF

FCAI - see Federal Chamber of Automotive Industries

Federal Chamber of Automotive Industries 2016, ATV Safety, accessed 14 December 2018, https://www.fcai.com.au/Safety/ATV-safety

Global Market Insights 2017, ATV Market Report, accessed 2 January 2018), https://view.joomag.com/pdf-all-terrain-vehicle-atv-market-global-market-insights-inc-all-terrain-vehicle-atv-market-size-was-valued/0832033001474877167?page=3

Homel, R 1991, Drink driving law enforcement and the legal blood alcohol limit in New South Wales, Journal of Accident Analysis and Prevention, vol. 26, no. 2, pp. 147-155, accessed 3 January 2019, https://pdfs.semanticscholar.org/bdec/0d9b079192f6ed2b70120baa8f910a3f9b7b.pdf

Lower, T and Temporley, J 2016, Preventing death and serious injury caused by quad rollovers on Australian farms - Policy Paper, accessed 12 January 2019, https://sydney.edu.au/medicine/aghealth/uploaded/Quad%20Bike/Position_Statement_Quads_Feb%202016.pdf

MacMillan, R 2017, Quad bike operational instability, accessed 2 January 2019,\ https://www.researchgate.net/publication/317273245_Quad-Bike_Operational_Instability

McIntosh A., Patton D., Rechnitzer G & Grzebieta, R 2016, Injury mechanisms in fatal Australian quad bike incidents, Traffic Injury Prevention, Vol. 17, no. 4, pp. 386-390, accessed 14 December 2018, https://www.tandfonline.com/doi/abs/10.1080/15389588.2015.1091073?scroll=top&needAccess=true&journalCode=gcpi20

Ministry of Transport Israel 2014, Transport Regulations Amendments, accessed 11 January 2019,

https://www.gov.il/en/Departments/ministry_of_transport_and_road_safety

Queensland Courts Office of the State Coroner 2015, Inquest into nine (9) deaths caused by Quad Bike accidents , accessed 1 January 2019, https://www.safeworkaustralia.gov.au/system/files/documents/1707/state-coroner-of-qld-quad-bike-deaths-inquest-findings.pdf

Safe Work Australia 2018, Quad bikes, accessed 13 January 2019, https://www.safeworkaustralia.gov.au/quad-bikes

Safe Work Australia 2019, Quad bike fatality data, accessed 31 December 2018, https://www.safeworkaustralia.gov.au/quad-bike-fatality-data#2011

State Coroners Court of NSW 2015, Inquest into the deaths of: Donald Eveleigh, Angela Stackman, FW,, ML Anthony Waldron, Colin Reid, Bradley Jackson, Robert Beamish and LE, File No's 2009/467571 2011/387257 2012/137664 2012/216240 2013/119793 2013/293977 2014/193403 2014/236747 2015/18733, accessed 1 December 2018, https://www.safeworkaustralia.gov.au/system/files/documents/1707/state-coroner-of-nsw-quad-bike-deaths-inquest-findings.pdf

TARS - see Transport and Road Safety University of NSW

Tasmanian Coroners Court 2016, FINDINGS, RECOMMENDATIONS and COMMENTS of Coroner Simon Cooper following the holding of an inquest under the Coroners Act 1995 into the quad bike related deaths of: Heather Dawn Richardson, Jan Severin Jensen, Kendall Russell Bonney, Vicki Mavis Percy, Jay Randall Forsyth, Jacob Graham Green and Roger Maxwell Larner, accessed 22 December 2019, http://www.magistratescourt.tas.gov.au/__data/assets/pdf_file/0007/389455/Quad_bike_related_deaths_of_Heather_Dawn_Richardson,_Jan_Severin_Jensen,_Kendall_Russell_Bonney,_Vicki_Mavis_Percy,_Jay_Randall_Forsyth,_Jabob_Graham_Green_and_Roger_Maxwell_Larner.pdf

Transport and Road Safety University of NSW 2015, Final Project Summary Report: Quad Bike Performance Project Test Results, Conclusions and Recommendations, accessed 16 December 2018,

http://www.tars.unsw.edu.au/research/Current/Quad-Bike_Safety/Reports/Final_Summary_Report4-QBPP_Test_Results_Concl_Recom_Jan-2015.pdf

Transport and Road Safety University of NSW 2017, Quad bike and OPD Workplace Safety Survey Report: Results and Conclusions, accessed 3 January 2019, http://www.quadbike.unsw.edu.au/sites/default/files/uploads/Quad_Workplace_Safety_Survey_Report.pdf

Appendix 1 -

Collated Data from three coronial inquests (NSW, Tasmania and Qld)

State Coroners Court of NSW 2015, Inquest into the deaths of: Donald Eveleigh, Angela Stackman, FW,, ML Anthony Waldron, Colin Reid, Bradley Jackson, Robert Beamish and LE

Tasmanian Coroners Court 2016, FINDINGS, RECOMMENDATIONS and COMMENTS of Coroner Simon Cooper following the holding of an inquest under the Coroners Act 1995 into the quad bike related deaths of: Heather Dawn Richardson, Jan Severin Jensen, Kendall Russell Bonney, Vicki Mavis Percy, Jay Randall Forsyth, Jacob Graham Green and Roger Maxwell Larner

Queensland Courts Office of the State Coroner 2015, Inquest into nine (9) deaths caused by Quad Bike accidents.

Collated fatality data from NSW, Qld and Tasmanina Coronial Inquests

Passenger	Seats	Incline/Uneven	Sex	Age	Physical issues	Alcohol	Speed	Engine Displacement	Age app.?	Cause of Death	Rollover	Helmet	Load	Training	Working?	On/Off Road
No	1	Yes 22.5deg	Female	64	Yes	No	Unknown	Suzuki 500cc	Yes	Chest injuries	Yes - unkown	Yes	No	No	No	Off
Yes	2	Yes - hill	Male	47	No	Yes	<20km/h	Unknown	Yes	Chest injuries	Yes - rear	Yes	Pass	No	No	Off
No	1	Uneven ground	Male	24	No	Yes	>40km/h	Can Am 800cc	Yes	Head Injuries	Unknown	No	Pass	No	No	Off
No	1	No	Female	64	No	No	<20km/h	Bombardier 650cc	Yes	Head Injuries	No	Yes	Trailer	No	No	On
No	1	No	Male	29	No	Yes	<40km/h	Unknown	Yes	Head Injuries	No	No	No	No	No	On
No	1	No	Male	21	No	Yes	>40km/h	Unknown	Yes	Head Injuries	Unknown	No	No	No	No	On
No	1	Yes	Male	75	Yes	No	>40km/h	650cc Unknown	Yes	Traumatic Asphyxia	Yes	No	No	No	No	Off
No	1	Yes	Male	55	No	No	Unknown	Yamaha 350cc	Yes	Drown due to head inj	Yes	No	Yes	No	Yes	Off
No	1	Yes	Female	34	Yes	No	Unknown	Polaris 500cc	Yes	Positional asphyxia	Yes	No	Yes	No	No	Off
Yes - 3	1	Uneven	Female	13	No	No	Unknown	Yamaha 550cc	No	Head injuries	Yes - end over	No	No	No	No	Off
No	1	Yes	Male	68	No	No	Unknown	Yamaha 350cc	Yes	Traumatic asphyxia	Yes	No	Yes	No	Yes	Off
No	1	Yes	Male	65	Yes	No	Unknown	Polaris 500cc	Yes	Traumatic asphyxia	Yes - rear	No	Yes	No	Yes	Off
No	1	No	Male	23	No	Yes 0.3	<20km/h	Honda 350cc	Yes	Traumatic asphyxia	Yes	No	No	No	No	Off
No	1	No	Male	49	No	Yes	Unknown	Unknown	Yes	Traumatic asphyxia	Yes	No	No	No	No	Off
No	1	No	Male	7	No	Yes - driver	Unknown	CF Moto 500cc	No	Traumatic asphyxia	Yes	No	No	No	Yes	Off
No	1	No	Male	43	No	Yes	>80km/h	Honda 400cc	Yes	Head injuries	No	No	No	No	No	Off
No	1	No	Female	19	No	No	Unknown	Yamaha 500cc	Yes	Head injuries	Yes	No	No	Yes	Yes	Off
No	1	Yes	Male	78	Yes	No	Stationary	Honda 400cc	Yes	Positional asphyxia	No	No	No	No	No	Off
No	1	Yes	Female	11	No	No	Unknown	Yamaha 400cc	No	Head injuries	Yes	No	No	No	No	Off
Yes	1	Yes	Male	40	No	Yes	Unknown	Suzuki 750cc	Yes	Chest trauma	Yes - rear	No	No	No	No	Off
Of above	1	Yes	Male	9	No	No	Unknown	Suzuki 750cc	Passenger	Traumatic asphyxia	Yes - rear	Yes	No	No	No	Off
No	1	No	Male	51	No	No	>40km/h	Yamaha 350cc	Yes	Head injuries	Yes	No	No	No	Yes	Off
No	1	No	Female	28	No	Yes	Unknown	Honda 300cc	Yes	Head injuries	No	No	No	No	No	Off
No	1	Flat	Male	86	Yes	No	Unknown	Suzuki 750cc	Yes	Head injuries	No	No	No	No	Yes	Off
No	1	Flat	Male	11	No	No	Unknown	Golden Bee 460cc	No	Positional asphyxia	Yes	Yes	No	No	No	Off
No	1	Uneven	Male	21	No	Yes	<40km/h	Honda 420cc	Yes	Head injuries	Yes	No	No	No	No	Off
No	1	No	Male	43	Yes	No	Unknown	Honda 420cc	Yes	Larynx injury	No	Yes	No	No	Yes	Off