IMPROVING WORKER SAFETY THROUGH BETTER VISIBILITY

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Abstract

A recent Work Safe Australia report shows that in the period of 2008-2009, 444 people lost their lives as a result of work related injuries with 286 dying of injuries sustained in the course of work activities. Of these 286 workplace fatalities 100 people died in road related trauma.
Better visibility of personnel working along roadsides has gained a greater focus over recent years with the use of fluorescent garments and reflective materials now mandatory. However the visibility of roadside objects and vehicles which can also contribute not only to the injury of workers' but also to other road users' has not gained the same focus.
Road work zones typically show higher accident rates than non-work sections due to the change in the road environment which is unfamiliar, lacks delineation and carries distractions that may occur owing to construction activities. Part one of this paper highlights the dangers of vehicles working on the road or parked along roadways, including emergency services and other working vehicle types. Part two focuses on accident studies and best practice handbooks (Arrows, Europe) helping traffic professionals, authorities, designers and contractors to create safer, cost-effective road work designs and operations. Part three looks at specific risks associated with truck driving, representing one fifth of all workplace deaths. It will provide details on benefits of introducing new safety standards in several countries to enhance the visibility of heavy vehicles and trailers.
High-visibility reflective markings can significantly improve personal visibility and worker safety, but are also a relatively low-cost and practical solution to improve the visibility of vehicles and objects in any roadside workplace.

Key words
Road work safety, vehicle safety, worker safety, retroreflectivity, visibility, road user safety

Introduction – What is the problem?

Since the abstract has been prepared, Safe Work Australia published its latest report in March 2012 on Work Related Traumatic Injury Fatalities, Australia. The 2009-2010 period shows the lowest number of death since 2003 when reporting began, as 337 people lost their lives which accounts for a 25% decrease in the number of fatalities. Unfortunately this downward trend will not continue as reported accidents during 2010-2011 are rising, showing a 7% increase on the previous reporting period. When we attempt to analyse the data available from 2003, we can conclude that 30% of the workers were killed in a vehicle incident on a public road, 30% in a vehicle incident on non-public roads and 30% of workplace fatalities did not involve any vehicles. Heavy vehicle crashes were the most frequent cause of worker fatalities. The most endangered group comprises of the truck drivers themselves, in this seven year period 438 lost their lives, being followed by workers in other cars or utilities (57) and 48 workers working around or with trucks and cargo. Table 1 below summarises data from 2003 and indicates that

46% of work related fatalities involved a vehicle. Out of these incidents 73% happened on a public road, whereas 27% at various worksites in the 2009-2010 reporting period.

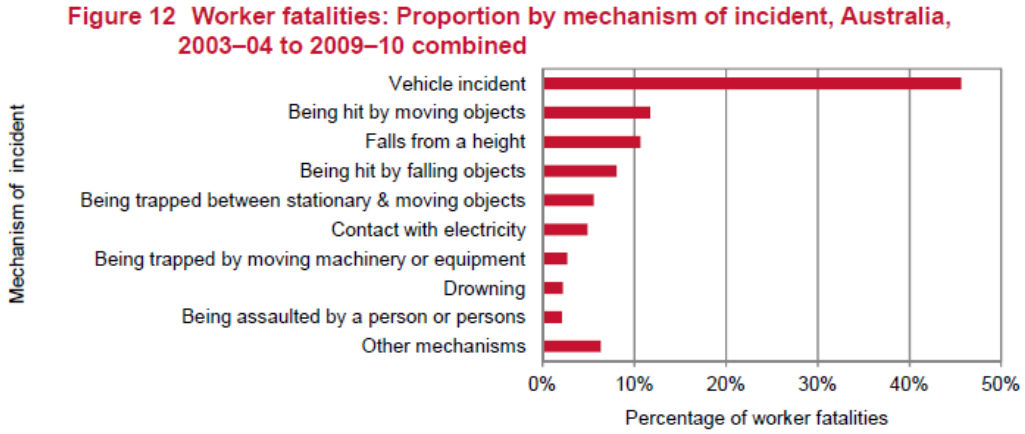

Table 1 – Worker fatalities 2003-2010 by mechanism of incident, Safe Work Australia, March 2012

The casualties from road related workplace trauma represent 13% of the national road toll and the costs estimated in relation with workplace accidents comprise $1.5 billion annually. (CARRS-Q 2008) This amount, however, among other items might not include medical expenses, rehabilitation, lost productivity, costs of investigation and vehicle damage / write off expenses. It is clear that this figure represents a huge burden on society overall and this is why all stakeholders cooperating together are open to investigate innovative technologies that can assist in reducing and preventing workplace death and injuries.

Australia has set a target to reduce the number of annual road fatalities and serious injuries by at least 30% between 2011 and 2020. (ATC 2011) The National Road Safety Strategy 2011-2020 emphasizes that road safety is a shared responsibility, building a national road safety culture is crucial to achieve the desired results. Examples as recognising the need for trials, demonstrating practical applications, analysing cost-benefits, supporting trial projects by allocating separate budget to fulfil the emerging needs, or offering financial incentives for those who outperform current standards and regulations would help to develop the shared responsibility mindset and achieve targets. Many of the road safety initiatives are high cost and long term and will take many years to implement, but many of the low cost, immediate impact measures are often ignored. The advancements in retroreflective technologies can deliver immediate results and targeted applications, for example at road work zones, or in case of roadside workers, are able to prove the benefits in short term.

Work zones as black spots

What is a work zone? By definition, working in traffic interferes with normal flow, causing more dangerous and unexpected navigation conditions. We can differentiate among different types of zones according to the type of work being carried out:

1. Road work zone – can be a construction or maintenance zone, for example a new road section is being built, line remarking is being done on existing road surface, and usually these activities can differ in length lasting from some days to even several years.
2. Utility work zone – for example gas / electricity / water pipes repair work, workers are working on the road or at road side, the actual job can last for a couple of hours and involves a significantly lower number of crew than in a road work zone. In many cases these repairs are carried out during storm and foggy conditions that add to the risk of accidents with lower visibility and challenges associated with driving when it is raining or misty. These conditions include rain hitting the windshield, movement and condition of wipers, steamed windshield,

glare from oncoming cars, headlight misalignment, road spray and the difficulty of light transmission through the rain. Visibility is significantly reduced, it is difficult to find the delineation of the road between lanes and the verge, signs, vehicles and people are hardly recognisable.

Figure 1 – Roadwork vehicles blend into the environment

Professionals including road workers, traffic controllers, utilities employees, service maintenance people (e.g.: grass cutting) working on the road or road side are exposed to significant risks. Other road users, car, truck or bus drivers and vulnerable road users as cyclists or pedestrians also share this risk in a road work zone. As statistics demonstrate there is a higher fatality rate and higher number of serious injuries associated with working on or alongside the road compared to other occupations.

No one can argue that the number of work zone activities and infrastructure repairs is increasing and as a consequence of this the number of incidents might be rising as well. These necessary projects are complicated by night time work lighting and visual clutter, growing traffic, extreme weather, poor driving conditions, pedestrian workers next to travelling vehicles and an ageing driving population. Due to the frequent occurence of night time work and the increasing trend to close down roads at night to minimise congestion, road workers and road users can experience an increased risk when passing or driving by these work areas.

Studies in Finland and Slovenia showed that 'motorists are up to five times as likely to get hurt when travelling through a work zone' while in Germany research has shown that approximately one quarter of collisions happening on national routes occur at work zones. (ETSC 2011). In NSW there were 450 active worksites around the state in 2005 and 603 crashes happened. 10 people died and 356 were injured in 2005. (RTA 2005)

Research has also identified that road works that take longer and cover a lengthier geographical distance have lower crash rates as opposed to short term works in short length zones. (SWOV 2010)

Current standards and specifications

AS/NZS 1742.3:2009 Manual of Uniform Traffic Control Devices, Part 3: Traffic Control for Works on Roads covers signage and delineation requirements for road works ensuring safety for workers and road users. It includes high visibility clothing, signs and other devices, but does not specify how visible road side objects, equipment or vehicles should be.

RMS Traffic Control at Work Sites, Section 3 (2010) standardises signs, barriers, delineators, temporary pavement markings, attenuators and safety barrier systems to protect workers. Similar documents exist in all states; for example: MUTCD Part 2: Traffic Control Devices for General Use – 3rd issue August 2011 by Queensland Government. It is interesting that

truck mounted attenuators are recommended in many state road authority documents, but there is no general regulation about what visibility markings these and other vehicles must carry to promote safety. Delineators and their technical requirements are governed by a separate standard; AS/NZS 1901.2:2007, Retroreflective materials and devices for road traffic control purposes, Part 2: Retroreflective devices (non-pavement application).
In the UK, however, Chapter 8 of the Traffic signs Manual was published by the Department of Transport in 2009 and it provides guidelines of visibility markings for operators on public highways including road maintenance trucks, smaller vans or any vehicle that needs to stop to carry out inspection or work on high speed roads. Section five sets the requirements in detail what conspicuious side and rear markings should be applied, what colours should be used and mandates the usage of fluorescent colours to enhance daytime visibility as well. This is a national document and ensures that all companies operating on the roads follow the specification.

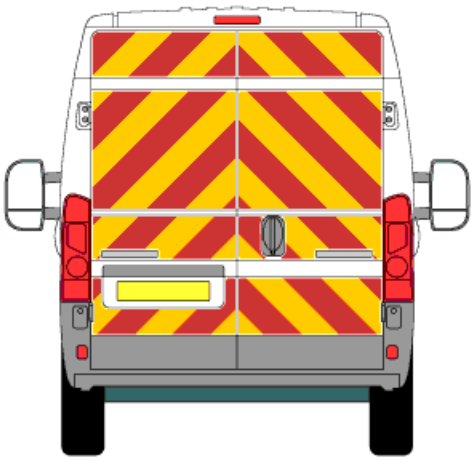

Figure 2 – example of rear marking based on Chapter 8 / UK

Road side vehicles safety
When discussing roadside safety from occupational health point of view, we can state that several research studies have been carried out recommending the extensive use of personal safety garments combined with fluorescent colours and retroreflective materials which resulted in numerous regulations and measures implemented to protect workers and drivers' safety. As an example, a recent study done by the researchers of Queensland University of Technology (Wood et al. 2010) highlights the most effective configuration of retroreflective markers on road workers' protective gear drawing the conclusion such as the adoption of reflective markers in a biomotion configuration has the potential to be an affordable and convenient way to provide a sizeable safety benefit. Adding biomotion markings to standard vests can enhance the night-time conspicuity of roadway workers by capitalizing on perceptual capabilties that have already been well documented.
The benefits of using high visibilty clothing providing both daytime and night time visibility are indisputable. Although better visibility of personnel working along roadsides has always been focused on intensively, not so many studies are available about the visibility of roadside objects and vehicles which can also contribute not only to workers' but also to other road users' safety indirectly.
Safety is of high concern at roadwork zones with workers being exposed to traffic movements and changing road conditions. It has been confirmed that road work zones show higher

accident rates than non-work sections due to the change in the road environment and the distractions that may occur owing to construction activities.
As road work zones are set up relatively frequently due to the many projects improving or maintaining existing networks, not only are work site personnel endangered, but accidents may involve other road users, drivers, cyclists and pedestrians as well.
Results of accident studies show that more than half the accidents on work zone areas on motorways are rear-end collisions (e.g. 60% in the UK, 63% in Germany). Those accidents, as well as sideswipe crashes, are found to occur mainly in the daytime, with higher traffic volumes. Another relatively common work zone accident type is collision with a fixed object, more commonly occurring at night-time and associated with inappropriate vehicle speeds. Finally, of special importance for road work zones are accidents involving collisions with road workers. The European ARROWS study (1996-1998) concluded that accident rates tend to be higher for work zones of shorter duration and for work zones utilizing full (rather than partial) contraflow.
Complementing the use of high visibility protective garments, it is also important to apply fluorescent and retroreflective markings to roadside vehicles to alert drivers and roadworkers to all vehicles on site in order to help preventing collisions with parked or moving objects.

Figure 3 - Roadside vehicles marked up with fluorescent retroreflective materials to increase day and night time visibility

Similarly, emergency response services are considered as a dangerous operation. Response vehicles may drive at higher speeds, cross into oncoming traffic and enter controlled intersections requiring greater visual and audible detection for other motorists.
Visibility and conspicuity are two very important factors to ensure emergency vehicle safety while on the roads or parked along roadways. Reducing the risk exposure of emergency services personnel servicing the public is a key focus area and some facts demonstrate how important it is to address this issue.
Studies conducted in the United States and elsewhere suggest that increasing emergency vehicle visibility and conspicuity holds promise for enhancing first responders' safety when exposed to traffic both inside and outside their response vehicles (e.g., patrol cars, motorcycles, fire apparatus, and ambulances). (FEMA 2009)
The importance of addressing vehicle characteristics and human factors to help positively affect the safety of emergency workers operating along the Nation's roadways is starkly established by first responders' morbidity and mortality experience. Over the past decade, numerous law enforcement officers, firefighters, and EMS workers were injured or killed in roadside crashes throughout the United States. (FEMA 2009)

Figure 4- Emergency vehicles marked up with retroreflective and fluorescent retroreflective materials

Working as a police officer is also considered to be a dangerous occupation and car accidents are accounted for the most common cause of officers' death. As they spend a large amount of time in traffic, statistically, they are more likely to be involved in an accident. In the United Kingdom, in a 10 year reporting period from 2000 there were 143 line of duty deaths, and out of these 54 happened in road accidents travelling to or from duty, 46 in road accidents on duty. (policememorial.org.uk 2010) As police partol cars are required to be visible during day and night time conditions including hours in rain and fog from a minimum viewing distance of 500 metres, the UK Home Office Scientific Development Branch has developed a livery scheme which is highly conspicuous and reduces the likelihood of crashes and contributes to officers' and other road users' safety. The Batterburg livery scheme also serves as an easy identification of police vehicles for the public. Harrison (2004) concluded that the greatest benefit of conspicuity would be realised by using colour and luminance contrast and high visibility colours would attract the desired attention for the police partol vehicle from the public. A combination of blue and fluorescent yellow colours proved to be the most efficient and this has also gained great acceptance by police forces.

Figure 5- Battenburg livery using retroreflective films with fluorescent yellow-green and blue colour scheme

It is clear that the properly applied and maintained high visibility markings, including the use of fluorescent materials, can effectively increase the early detection of incident response, police and emergency vehicles.

Best practice handbooks

A research project called ARROWS (Advanced Research on Road Work Safety Standards, Europe) funded by the European Union between 1996-1998 resulted in a practical handbook for road work zone safety helping traffic professionals such as highway authorities, designers and contractors to create a safe road work design and operation. The handbook gives an overview of road work safety standards in European countries and provides uniform guidelines, principles, procedures, tips and checklists to implement a safe road work zone. It features case studies and best practice examples collected from numerous countries alongside with the recommendations of safety measures.

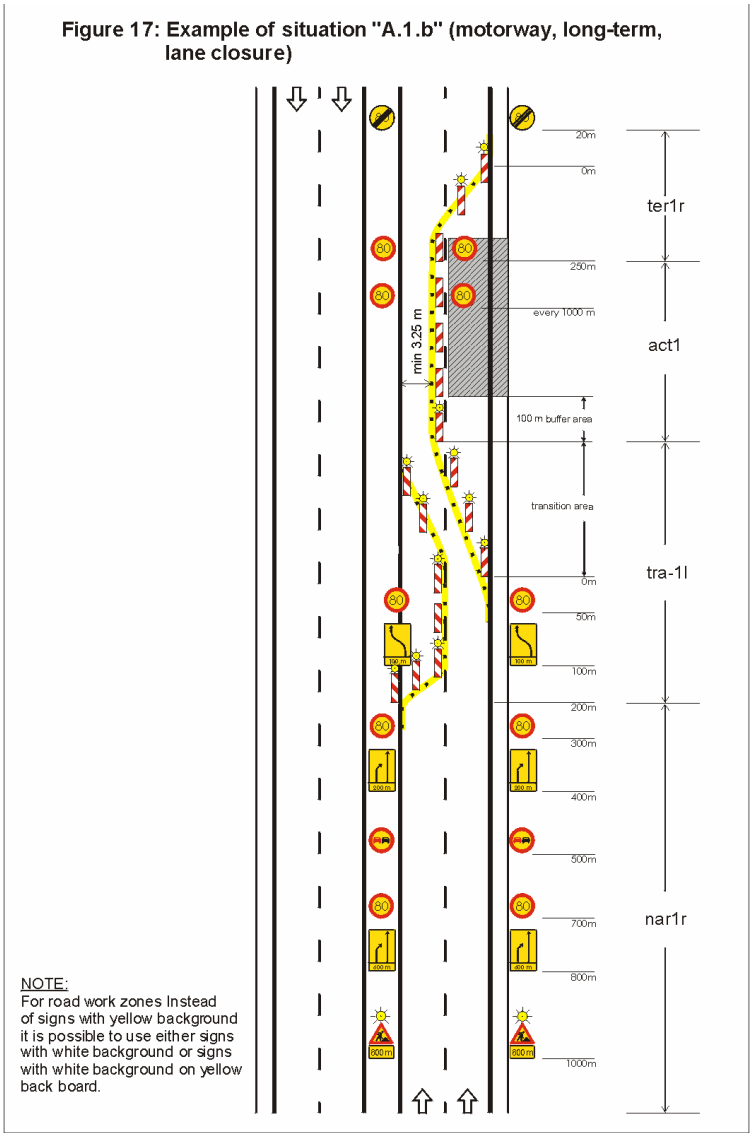

Figure 6 – ARROWS handbook, example of motorway lane closure (Arrows 1998)

Another project called Preventing Road Accidents and Injuries for the Safety of Employees (PRAISE) co-funded by the European Commission focuses on work related safety and educates employers on the know how of safe work environment. The study emphasises that road work vehicles should be made visible and simple measures like visibility markings and keeping the vehicles clean help maintain safety. High performance reflective tapes enable any driver to identify the shape, length and height of a vehicle reducing the risk of collisions especially side and rear end impacts.

Increased truck visibility helps to avoid incidents

Road transport is regarded as a complex system with implications on several factors including road safety, energy consumption and the environment.

The Transport and Storage industry has the highest fatality rate of any industry in Australia. When analysing the fatality numbers between 2003 and 2010 by occupation, truck drives recorded the highest fatality rate among all professions, and one-fifth of all work place deaths (403) are made up of this single occupation. These numbers do not include accidents where death or serious injury occurred to a non-working individual eg: passenger in a truck or collision with a heavy vehicle. (Safe Work Australia 2012)

Schmidt-Clausen (2000) said that the mobility of people and goods affects our growth and well-being, making it one of the major socio-economic challenges of the year's 2000 plus.

Numerous reports are available about the effectiveness of visibility markings aiming at reducing rear and lateral collisions. Visual perception is limited at night which results in relevant information not being received and more attention being required of the motorist. In this situation, trucks, which normally move relatively slowly, represent a potentially dangerous obstacle, especially since the fatality rates for drivers of passenger cars involved in accidents with them are very high on account of the high mass of the trucks. About 40% of road accidents take place at night, dawn or dusk in spite of the fact that not more than a third of the traffic is on the roads (compared to day-time driving). It can be concluded that driving at night is at least twice as dangerous as during the day. (Schmidt-Clausen 2000)

The German technical University of Darmstadt had conducted an examination of night time and day time accidents between a test group comprising 1000 vehicles equipped with high visibility reflective contour markings and a control group of 1000 vehicles without such measures. After the first 2 years of the installations the conclusion was drawn that 95% of night time collisions could have been avoided if trucks of the control group would have had retro-reflective visibility markings. The 10 year study results of increased truck visibility demonstrated that 41% reduction of rear end crashes and 37% decrease of side impacts could be achieved by applying reflective, outline markings on heavy vehicles. The data analysis had also confirmed that the risk of an accident between truck and car was 30 times greater without conspicuity markings. (Schmidt-Clausen 2000)

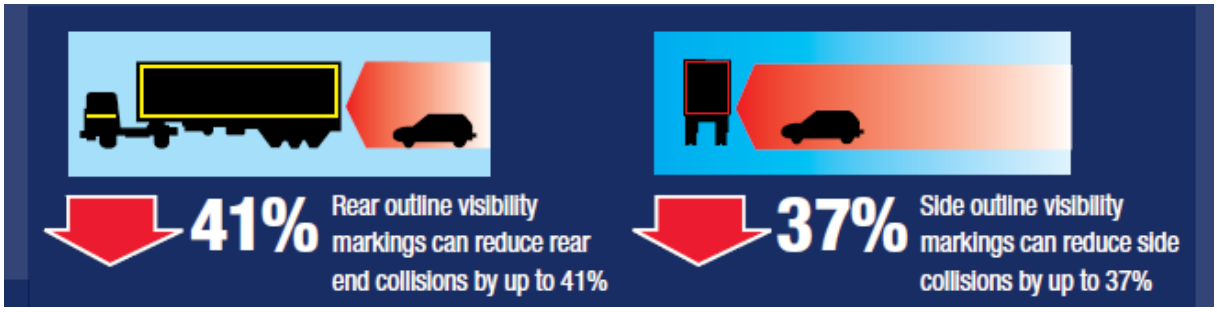

Figure 7 – Potential results with improved truck visibility

Another study commissioned by the European Union and accomplished by the German TUV Rheinland Group in 2004 outlines the situation in the individual member states of the European Union. The study investigated the effects of a mandatory introduction of conspicuity markings for heavy vehicles by creating a detailed cost-benefit analysis for decision makers.
In the past governments tried to minimize the negative impacts of heavy vehicle accidents by introducing a national legislation, but as new technologies and borderless trade evolved there was a crucial need to harmonize the international requirements which led to a new European Directive in 2008. The European-wide study by TUV Rheinland also contributed to the reasons why the European Union decided to implement mandatory conspicuity markings for heavy goods vehicles and trailers in all member states from July 2011. In regards to technical requirements and application guidelines, The European Directive strictly follows the UN regulation 48 and ECE 104.
While in Europe this is a relatively new regulation and no data is accessible yet, the US federal regulation has had a longer history since 1993 and studies are also available on the benefits. The National Highway Traffic Safety Administration USA (NHTSA) has investigated the effectiveness of retroreflective conspicuity tape on heavy trailers. (Morgan 2001) In an effort to quantify the effectiveness of the retroreflective tape requirement on heavy trailers, NHTSA made arrangements with the Florida Highway Patrol and the Pennsylvania State Police to collect data and compile statistics on whether or not retroreflective tape was installed on heavy trailers involved in crashes. Data was collected on 10,959 cases in these two states. The study concluded that the usage of retroreflective tapes on trucks was effective and significant reductions could be achieved in side and rear impacts. In dark conditions defined as dark: not lighted, dark: lighted, dusk and dawn periods, the use of retroreflective tape reduced overall side and rear impacts into heavy trailers by 29 percent. In dark-not-lighted conditions the use of retroreflective tape reduced side and rear impacts by 41 percent. The study also declared that severe crashes were decreased by 44% and that the use of reflective tapes was especially effective in rain and fog conditions.
Both Europe and the US are leading with best practice and demonstrating how the adoption of the high performance retroreflective sheeting for usage in vehicle marking has resulted in another safety improvement for many road users.

Figure 8 – Trucks marked up according to UN48 / ECE104

In Australia the Vehicle Standard (Australian Design Rule 13/00 – Installation of Lighting and Light Signalling Devices on other than L-Group Vehicles) 2005, or in an abbreviated form, ADR 13, refers to conspicuity markings permitting conspicuity markings according to UN Reg. 48 and UN ECE Reg 104. ADR 13 has adopted the full text of UN Reg. 48, but has not yet mandated conspicuity markings as stated in UN Reg. 48. As retroreflective markings substantially add to the visibility of heavy vehicles and their trailers from all angles at a relatively low cost, it should be considered to adopt the mandatory vehicle marking guidelines

by UN Reg 48 and 104 and increase standards in Australia to improve safety of both truck drivers and other road users.

Recommendations and conclusion

Safe Work Australia statistics demonstrate that the presence of road and utility work zones increases the risk of incidents on the roads and that working on the roads is listed among the most dangerous occupations. Although the number of research studies is limited, it is proven that improved safety practices can reverse any negative trends in statistics and can help to prevent accidents. Shorter work zones impose higher risk on workers, still handbooks and guidelines tend to focus on long term work zone management and on the reliance on signage, pavement markings and personal safety garments. High visibility, fluorescent orange or yellow-green safety clothing is now an entrenched part of the safety culture, whereas the usage of fluorescent and retroreflective high-performance materials is not so widespread yet on vehicles to protect those who have duties to carry out on the roads regularly. The role and the benefits of high visibility markings applied on road work, emergency and utility vehicles is curently underestimated and is not recognised in national or state level regulations. Chapter 8 (UK) sets the requirements for rear and side markings on vehicles working on the roads, a similar national specification in Australia would be desirable with the necessary modifications and adaptations.

These readily available retroreflective vehicle technologies should be leveraged to improve road safety for road workers and for all Australian road users. The adoption of the high performance, UN ECE 104 certified retroreflective tapes for usage in heavy vehicle visibility marking is another safety improvement for both heavy vehicle drivers and other road users. A review of the relevant ADR standards needs to be undertaken to take into consideration the latest technology and the global best practice to evaluate the mandatory introduction of visibility markings for heavy vehicles. As long as formal programmes are not put into place, the support of voluntary fleet applications by insurance premiums or other financial incentives, for example, tax deductions, subsidy of the cost of markings, no accident policy and government funding would be necessary. Further research needs to be carried out to understand the differences and similarities between Australia and the rest of the world complemented by consistent accident data collection to support programme evaluation, before and after studies.

Governments at both state and federal levels need to be more proactive and evaluate and exploit these new, highly cost-effective technologies to advance road safety.

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