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The Safety and Effectiveness of Emergency Vehicle Lighting

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Biography

Chief Superintendent Kerry Dunn has been a member of the Queensland Police Service for 29 years, gathering a wide array of operational and management experience in all facets of policing, including being Operations Coordinator for the Southern Police Region from 1999 to 2002. Awarded the Australian Police Medal for services to policing, Chief Superintendent Dunn has performed significant management orientated roles within the area of organised and major crime investigation. Since May 2002 he has managed the State Traffic Support Branch of the Queensland Police Service and has an interest in the development of "Best Practice" approaches involving the collaboration of relevant stakeholders supported by a framework of research and analysis.

Deborah Tunnicliff graduated in sociology and research methods from the Australian National University prior to commencing work as a research assistant with the National Centre for Epidemiology and Population Health. Since then, she has broadened her experience, working both nationally and internationally, focusing primarily on public health and quality assurance. A position within the Commonwealth Department of Health and Aged Care combined these interests as she worked both within the Evaluation and Research Section, and in a project management role within the Public Health Branch. Ms Tunnicliff brings to CARRS-Q a strong interest in evaluative techniques, social research, survey design, statistical analyses, and project management.

Abstract

Vehicle mounted warning lights are used in a wide range of enforcement, road crash, health and fire emergency, road maintenance and development contexts. This paper examines the wide range of factors influencing selection and use of different lighting systems by police, ambulance and fire departments. The nature of the issue means that such research needs to draw on the expertise from a number of disciplinary fields including visual science and optics, road safety, and the policy and practice experience base of relevant emergency staff. The available national and international literature is summarised and key issues that are of particular relevance to the safety of the road user and of the workers in emergency response are identified.

Emergency vehicle lights serve two major functions. Firstly they identify the vehicles as police, fire, ambulance, or other emergency services such as State Emergency Services, Council, or Department of Main Roads to provoke an informed and predictable public response. Secondly, they present a highly conspicuous form, to provide other road users with information about the distance, direction, and speed of the vehicle so that they can behave with due caution or take appropriate action. Most research on this issue is somewhat dated and fails to take emerging lighting technologies and the variety of conditions and

circumstances in which lighting systems have to operate into account. There is a need for well researched and systematically enforced and managed policy and practice both in regard to the use of emergency lighting across all services and in the education of community behaviour in response to emergency signals.
Emergency vehicles present a particular and intermittent hazard to the general road user and a best practice for their use needs to be developed that is evidence-based. Current practice and expectations appear to draw heavily on long established precedents. The development of policy in this area needs to be firmly based on sound up-to-date research. The current paper draws on work being undertaken by the Queensland Police Service in association with QUT School of Optometry and CARRS-Q and showcases a collaborative approach to information sharing in road safety.

1. BODY TEXT

The Queensland Police Service has one of the largest vehicle fleets of any organisation in Queensland, operating approximately 1850 vehicles of which about 450 are fully marked. Emergency vehicle lighting was raised as an issue when the Queensland Police Service became heavily involved with other agencies in Incident Management. A broad crosssection of agencies began discussions on the need to identify appropriate combinations of lighting for varying circumstances with the issue of emergency services personnel and public safety being of paramount concern.

Presently the Queensland Police Service has a broad fleet of vehicles ranging from highly visible booze buses to covert surveillance vehicles. There is a need to ensure that police vehicles and other emergency service and response vehicles can be clearly identified and recognised by the public. In particular, when dealing with incident management principles (for example at a road crash) lighting combinations need to ensure the safety of emergency service workers, while at the same time identifying to the public that there is an incident on the road ahead.

At present a national standard exists for the markings of police vehicles. These markings were determined based on research conducted by the National Police Research Unit (NPRU) in Adelaide, now known as the Australasian Centre for Policing Research. The blue light has always been associated with police, however the move to include a red light on police vehicles nation-wide recognizes that the red light is more visible in certain conditions.

The overarching purpose of police, fire, ambulance and emergency services revolves around public safety. Emergency vehicle lighting promotes this in two ways:

1. Identification: To clearly identify the vehicle as belonging to police, ambulance, fire, or other emergency services so that the relevant response can be made by the public and safety protected.

2. Conspicuity: To present a highly visible form (360°) that: allows identification at a distance sufficient for road users or pedestrians to take appropriate action. This may be facilitating an unobstructed, speedy path for the emergency vehicle, or it may be avoiding the parked emergency vehicle and being alert to possible hazards, traffic operations or random breath testing etc., provides information about the speed and distance of the emergency vehicle, facilitates the safe movement of emergency services workers or police around accidents or during the course of performing operational tasks such as Random Breath Testing.

Emergency vehicle lighting also raises important occupational health and safety considerations for emergency service personnel.
1. It is important that the best use is made of available lighting technology to facilitate identification and conspicuity.
2. Correct policy and procedures should be in place to facilitate the safe use of emergency vehicle lights and sirens to minimise accidents involving emergency vehicles.

Research on the best type, and best use of, emergency vehicle lights has become largely out-dated as lighting technology, along with societal changes in transport, has progressed at a rate which has outstripped research into this area.

To address this, the Queensland Police Service, CARRS-Q, and the QUT School of Optometry intend to assess the relative effectiveness of different lighting combinations and flash patterns mounted on emergency vehicles. An analysis of current interstate and overseas policies and practices governing the use of emergency vehicle lighting will also be conducted with the view of developing “Best Practice” policies and procedures around the use of emergency vehicle lighting.

2. AN OVERVIEW OF THE RESEARCH TO DATE

2.1 Identification

Emergency vehicle lighting is determined by State legislation. All States in Australia except Queensland and the Northern Territory, have fitted their emergency vehicles with combination blue/red flashing lights. The Northern Territory has legislation that allows all emergency vehicles to use this combination although currently the police and fire-trucks use both red and blue whilst the ambulance service uses red and white.
In Queensland, Ambulance and Fire services have red and white light combinations, while Police have red and blue. Brisbane City Council Traffic Response Units and State

Emergency Service vehicles have amber lighting on vehicles.
Misidentification problems by the public due to changes in emergency vehicle lighting (i.e. moving all emergency vehicles to red / blue) has not been identified as an issue. However, ambulance and fire personnel becoming subject to attack due to mis-identification as police has been reported, but changes to uniform appear to have reduced this problem. There have not been reports of more attacks on emergency service personnel due to changes in lighting on vehicles.

From the public point of view, driver reactions should be similar regardless of whether the vehicle belongs to police, fire, or ambulance services. If an emergency vehicle approaches from the rear, drivers are required to pull over to allow the vehicle to pass, and if the vehicle does not pass, they should stop. If the emergency vehicle is ahead, the appropriate reaction is to slow down and be prepared to stop (Nash, B., 1999).

2.2 Conspicuity

It is essential that emergency vehicles be highly visible from all angles, to a distance of at least 200 meters (Vehicle Standards, Driver and Vehicle Policy Branch, 1998). In practice, visibility can vary, as depending on the nature of the emergency, vehicles may be parked with headlights lighting the emergency site, parked as a blockade, be moving at high speed, or operating within a variety of weather conditions or backgrounds. Lighting must also facilitate the safe movement of emergency workers around accidents/traffic hazards. Two police officers were killed between 1989 and 1992 whilst performing traffic duties on foot

because drivers failed to see them (Work-related fatalities study team, 1999).

Lighting is becoming increasingly important as sirens are drowned out by car stereos, air conditioning systems, and the fact that modern vehicles are increasingly well soundproofed. When heard, drivers often experience difficulty locating the direction of sirens.

It has been reported that a combination of different coloured lights is more effective than a single coloured light, and that a flashing light gains more attention than a continuous light (provided the background does not also include flashing lights) (Rubin et. al., 1981; Berkhout, 1979). However, the colour of any flashing light is indistinguishable at some angles. Therefore, when viewed peripherally (as often occurs when an emergency vehicles approach) colour may not be recognised at all in the first instance – it is the flashing component of the light that attracts attention. It is only when the person turns their gaze towards the lights that colour becomes apparent (Howett and LESL, 1979). This is why it is essential to undertake systematic research on both colour and flash patterning.

Anecdotal evidence from emergency vehicle drivers suggests that alternating flashing headlights causes traffic to move out of their way quite effectively, whilst the warning lights aid identification. Flashing headlights do not aid visibility for traffic approaching from the side at intersections and may not be used when the vehicle is stationary. Some research indicates that painting emergency vehicles lime-yellow would be an effective way of improving conspicuity (Solomon, 1990).

Blue lights should ideally be of the same intensity as red lights on emergency vehicles to avoid confusing the public as to the direction and speed of travel of vehicles (Berkhout, 1979). As the human eye has differential sensitivity for lights of different colours and blue light operates within a narrow band of wavelengths, if you used a clear light with blue or red filters, the light bulb under the blue filter would have to be seven times stronger than that of the one under the red filter (Howett et. al., 1978). Research into new technology such as the use of halogen bulbs which use a continuous stream of light to produce alternating red and blue light is required (Stockton, D., 2001)

Berkhout (1979) also studied the impact of different colour and flash combinations on the accuracy of judging the direction (approaching or receding lights) and velocity of moving lights. He found differences between individual lights in terms of the illusion of motion as well as in terms of their relative conspicuity. For example, while all red combinations conveyed more information than red-blue combinations, when red signals were used in a side-to-side alternate flash pattern, they also gave an illusion of receding motion when they were actually stationary. In particular, with advances in lighting technology since the late 70’s, further study on how emergency vehicle visual warning systems affect public perceptions on rate and direction of travel and response times would be useful.

Berkhout, et. al (1999) state that the conspicuity of flash patterns varies with the background environment and traffic conditions surrounding the vehicle. They theorize that modern technology could allow multiple flash patterns to be designed to maximise conspicuity for various conditions. Experiments regarding colour and patterning, particularly in a variety of conditions (day, night, urban, rural, smoke hazards etc.) would be useful and could greatly enhance the effectiveness of emergency vehicle lights as a safety mechanism. Potentially this research could inform some type of future in-vehicle IT lighting sequencing solution.

Further study should be conducted on stationery emergency vehicles, in particular examining ways to ensure the safety of workers around the scene of the parked vehicle.

2.3 Policy and Procedures

Whilst identification and conspicuity are important factors for emergency vehicle accident management, procedural issues governing how and when to use emergency lights and sirens also play a crucial role. Deaths as a result of emergency vehicles having accidents whilst travelling under lights and sirens, have been studied overseas, but little research has been conducted in Australia. However, between 1989 and 1992, four police officers and 11 bystanders were killed in incidents where emergency vehicles were responding in emergency mode. Most of these fatalities occurred at intersections. (Work-related fatalities study team, 1999)

The fact that running emergency vehicles under lights and sirens is riskier than travelling routinely creates an imperative for developing appropriate protocols. Whilst such protocols do exist within Australian emergency services, they are not uniform across States or services.

There is some evidence to show that the use of lights and sirens does not save significant time. Further, many incidents attended by emergency vehicles are not time-sensitive and therefore using lights and sirens is unnecessary (Clawson, 2002).

Many overseas agencies now have dispatch protocols to identify time-critical incidents, meaning only these emergencies are answered with lights and sirens. Incidents which are not time-critical are safely responded to routinely (Clawson, 2002).

As legislative action becomes more common, dispatch records will be increasingly subpoenaed by the courts, meaning that accidents involving emergency vehicles will be critically examined, and any unnecessary risks to public safety could result in costly legislative claims (Clawson, 2002).

A broader education of emergency vehicle drivers on protocols around using lights and sirens and the reasons these are necessary does save lives (Clawson, 2002). In Australia, driver training is not always fully integrated with procedural practice. Overseas, some private ambulance services have installed monitoring devices which record when ambulances are travelling at excessive speed, or making unsafe movements or turns, heavy breaking etc. to encourage safe driver behaviours (Clawson, 2002). Whilst this solution is unlikely to be implemented in the near future in Australia, this issue of driver behaviour does raise important occupational health and safety issues, as well as potential legislative ones, which require consideration in the development of any ‘Best Practice’ guidelines.

3. CONCLUSION

In conclusion, the subject of emergency vehicle lighting is one that has had little systematic, evidence-based research devoted to it. A collaborative approach would ensure that research is driven by practical objectives - in this case, to facilitate real advances in the occupational health and safety of emergency services workers – within an independent and scientific framework.

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