Daytime Running Lights

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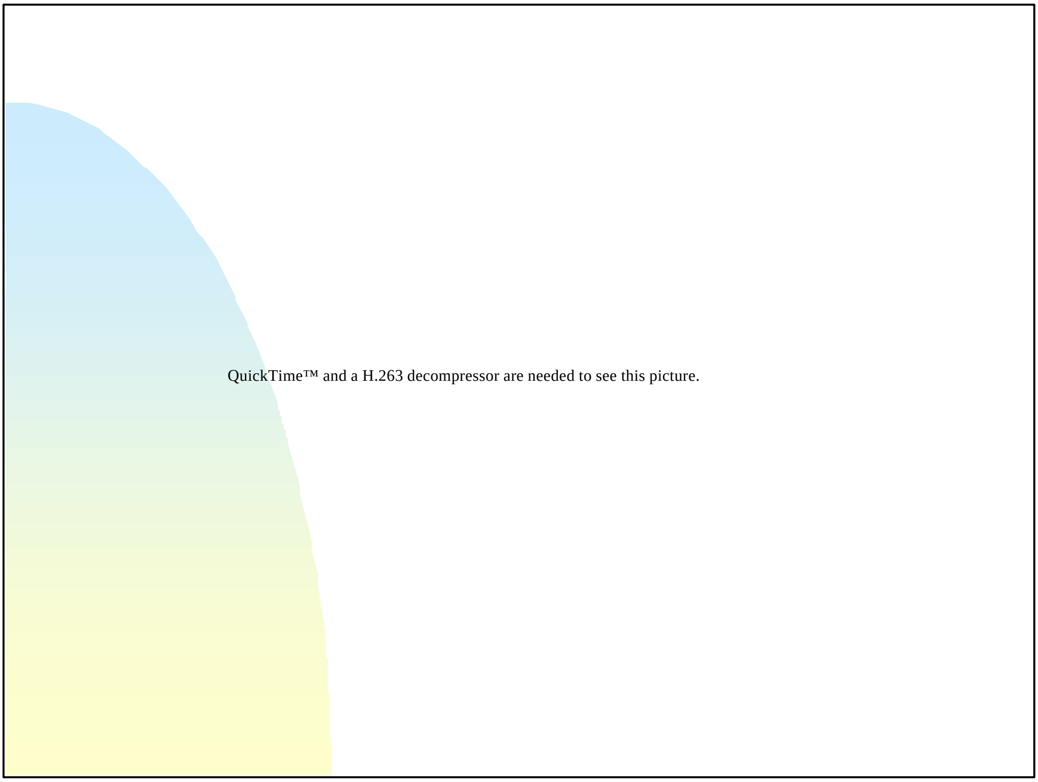
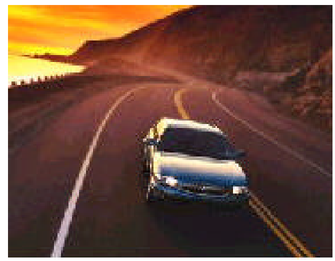
Vehicle Design and Research P/L



Turn on light!

Introduction

- Daytime running lights (DRLs) are bright lights that are intended to make the front of the vehicle more conspicuous during the day
- A variety of lighting systems have been used as DRLs - the most popular has been the daytime used of low beam headlights



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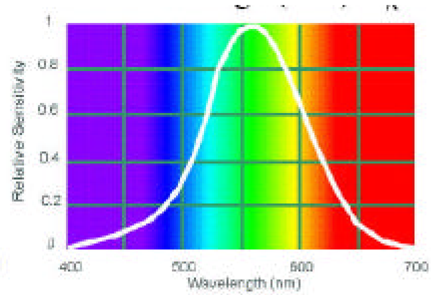

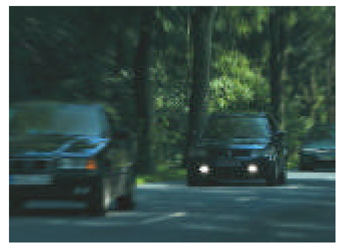

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History

- In 1972 Finland introduced mandatory (manual) use of headlights during the day. Other Scandinavian countries followed.
- In 1989 Canada introduced mandatory automatic DRLs for new cars
- DRLs have been standard on all GM cars in the USA since 1995
- Effectiveness studies have suggested a latitude effect - with the studied DRLs leading to greater accident reductions in high latitude countries

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Potential Accident Reductions

- 50% of daytime road accidents involve one road user failing to see another road user
- DRLs can improve the chances of being seen by other road users.
- On the basis of a large number of effectiveness studies it has been estimated that full implementation of DRLs across Europe would save:
  - 25% of multi-vehicle daytime fatal accidents
  - 20% of multi-vehicle daytime injury accidents

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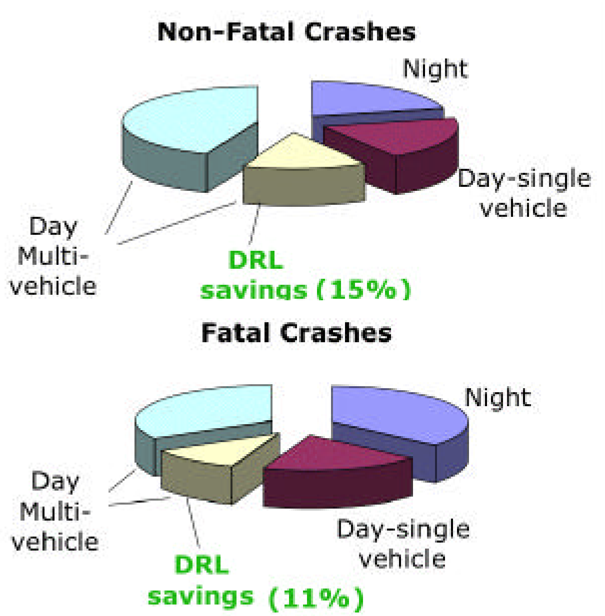
Potential Savings in Australia



64% of fatal crashes and 79% of non-fatal crashes occur during the daytime

About 3/4 of these are multi-vehicle crashes

Therefore 45% of all fatal crashes and 59% of all crashes could be influenced by DRLs

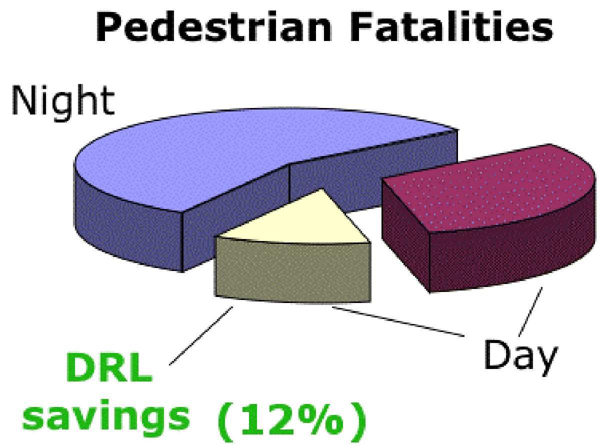
If the savings estimated for Europe could be achieved in Australia this would equate to savings of:

 11% of all fatal accidents

 15% of all other accidents

With new technology there is the potential to exceed these estimates

Potential Savings in Australia



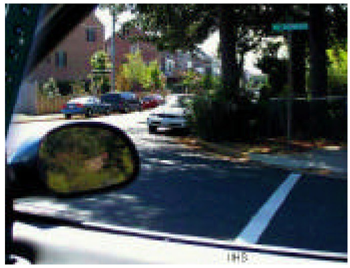
44% of pedestrian fatalities occur during the day

US data indicates that 28% of these could be prevented due to DRLs

This equates to 12% of all pedestrian fatalities

These add up to remarkable savings, assuming that the European predictions can be achieved in Australia. Let us look at how this might be done.

Road Design Sight Distances



Design Speed	Intersection Sight Distance	Overtaking Sight Distance
40km/h	80m	160m
60km/h	120m	220m
80km/h	170m	340m
100km/h	230m	480m

Australian road design practices, as described by Dr Max Lay, give us an indication of the signal range needed for vehicle lights. For example, intersections with cross traffic travelling at 60km/h require sight distances of 120m. Overtaking sections require about double this distance. As I will show, these are quite demanding distances for typical vehicle lights on a bright day.

Visual Ergonomics

- Road design practices also give us an indication of the required intensity of various lights to achieve a given signal range - that is, the light is significantly more noticeable than the background
- Research conducted for traffic signals revealed:
  - Yellow lights needs 3 times the luminous intensity (candela) of red lights for the same signal range.
  - Range is proportional to " intensity
  - Range is inversely proportional to " background illumination, which can vary by 4 orders of magnitude - a light that is clearly seen at dusk might not be noticeable during a bright day
  - Angle from line of sight affects signal range

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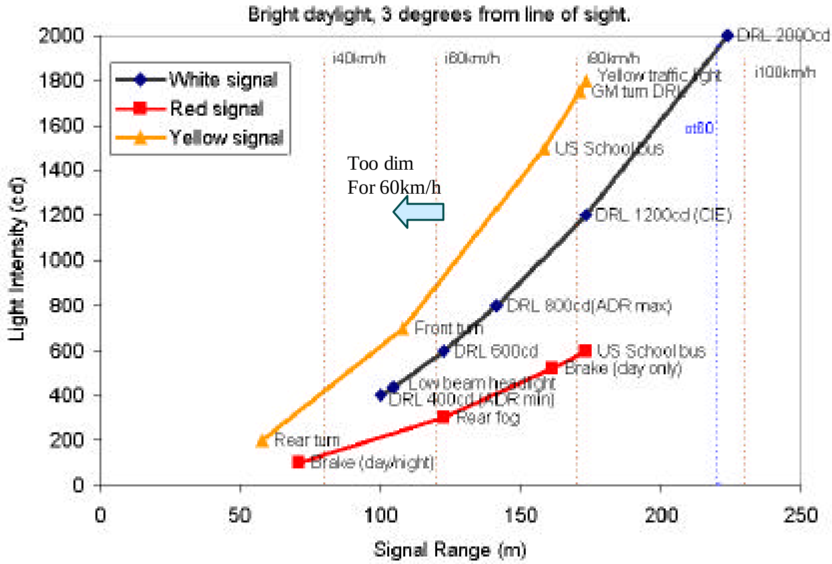
Angle from line of sight affects signal range - the further the light is the the line of sight the brighter it needs to be

Signal Range of Vehicle Lights



Applying some typical road conditions gives these signal ranges for a selection of vehicle lights of various intensities. This graph appears in my research report for the NRMA and RACV.

The horizontal axis is signal range on a bright day

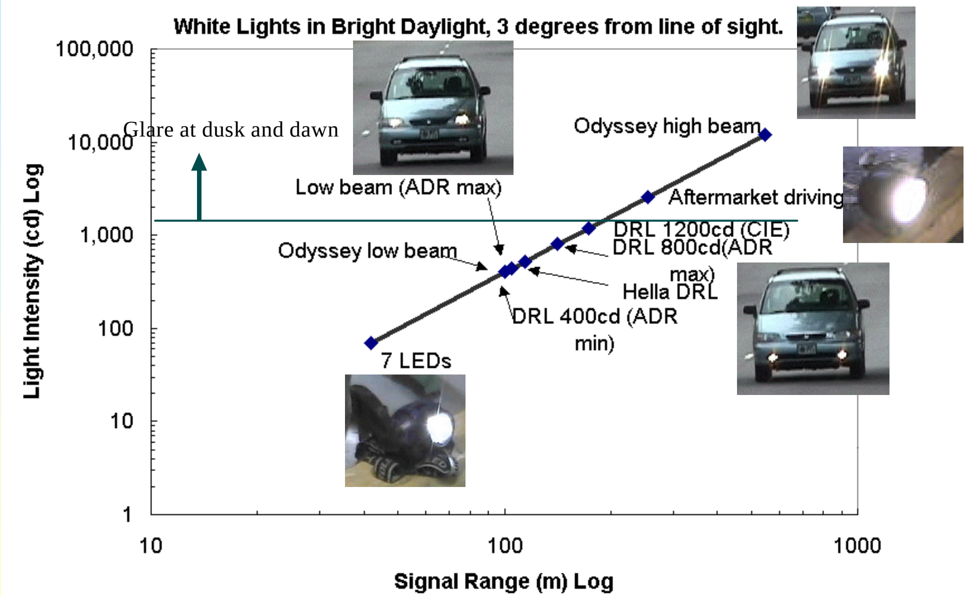
The vertical axis is the signal’s luminous intensity in candela

This illustrates the need for yellow lights to have much higher intensity for the same signal range.

It also shows how inadequate many vehicle lights are on a bright day. The vertical dotted lines show the road design sight distances - for example, intersection with 60km/h cross traffic require a sight distance of 120m. Yellow front turn signals are limited by the ADRs to a maximum intensity of 700cd and have a signal range of 110m on a bright day.

I will come back to these issues at the end of my talk but let us now consider signal ranges of daytime running lights.

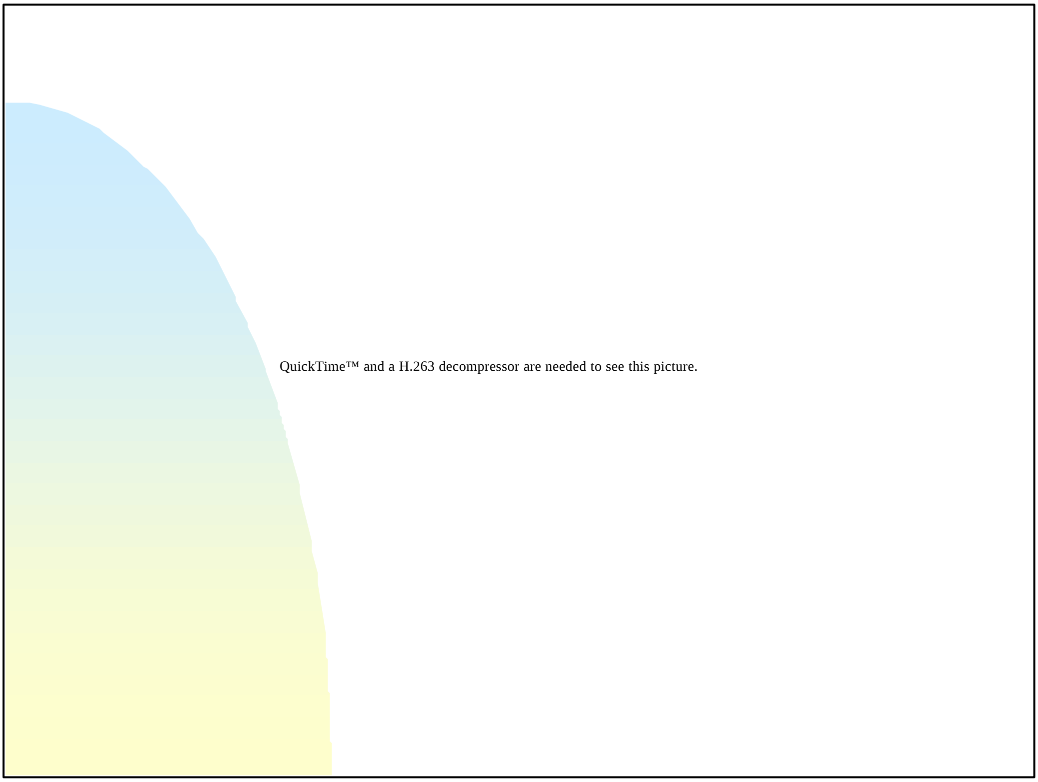
Signal Range of Potential DRLs



This graph show the signal range in bright daylight for a range of potential white DRLs. I have switched to a log-log plot to cover the large range.

ADR 76 currently limits dedicated DRLs to between 400 and 800cd, in line with the European regulation. As I mentioned earlier, an international committee of vehicle lighting experts recommended a maximum of 1200cd for DRLs. These DRLs would have a signal range of 170m on a bright day, compared with 140m for 800cd lights and 100m for low beam headlights.

The horizontal line at 1200cd shows the preferred upper limit to prevent glare at dawn or dusk. Lights of up to 2000cd should not cause discomfort for oncoming drivers on a bright day but a light sensor control would be needed to ensure the lights dimmed, or switched to low beam headlights at low background light levels.



This movie shows some potential DRLs in action

The tree shadows across the road are about 170m from the camera.

First is my Odyssey wagon approaching without any lights. It takes a little time for the vehicle to travel along this section of road so I will talk about each of the lights in turn. The contrasts are not particularly demanding for conspicuity but it will give you an idea of the effectiveness of the different lights.

Low beam headlights take a while to become noticeable. They are designed to not send light in the direction of oncoming motorists and so perform marginally as a DRL. This could explain the so-called latitude effect because most studies involved low beam headlights that only perform well in dull lighting conditions. Low beam headlights also consume more than 150W, including tail lights, instrument lights and number plate lights. They increase daytime fuel consumption by about 1%.

The second vehicle (behind the Telstra vehicle with headlights) is a dedicated DRLs marketed in Europe by Hella. It has a fan-shaped beam with on-axis intensity of about 500cd (about 100cd more than the low beam headlight). They consume a total of 12W and so overcome any environmental objections to DRLs. It should be possible to design dedicated DRLs that produce 1200cd each (the optimum light intensity for DRLs) but consume no more than 30W. These are halogens globes. It could take some time for banks of LEDs to be developed that offer sufficient light intensity.

Concerns about DRLs

- Many myths and misunderstandings
- Increased fuel consumption not an issue with energy-efficient dedicated DRLs
- Concern about “masking” of vulnerable road users shown to be unfounded - in any case they benefit most from being able to see approaching vehicles.
- Masking of brake lights by tail lights and premature failure of globes not an issue with dedicated DRLs (also high-mounted brake lights help)
- Glare could be a problem at dawn and dusk - overcome by automatic headlights with an ambient light sensor

There are many myths and misunderstandings - I encourage you to read my report for a review of these issues. In brief:

Increased fuel consumption not an issue with energy-efficient dedicated DRLs

Concern about “masking” of vulnerable road users has been shown to be unfounded - in any case vulnerable road users benefit most from being able to see approaching vehicles.

Masking of brake lights by tail lights (that come on with headlights) and premature failure of globes are not issues with dedicated DRLs

Glare could be a problem at dawn and dusk - overcome by automatic headlights with an ambient light sensor

Recommendations

- Change ADR76 to allow white 1200cd DRLs, provided the vehicle has a light sensor that automatically switches to headlights when ambient light levels are low
- Encourage aftermarket dedicated DRLs
- Encourage factory-fitted DRLs (fleets should *insist* on DRLs instead of fog lights that are commonly fitted and are of little use in Australia)
- Reserve yellow DRLs for motorcyles
- Monitor technology such as LEDs

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Encourage factory-fitted DRLs (fleets should insist on DRLs instead of fog lights that are commonly fitted and are of little use in Australia)

Reserve yellow DRLs for motorcyles - they need to be distinctive because of the narrower spacing of motorcycle lights

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Recommendations

Consider a consumer rating (ANCAP) for vehicle lighting systems that

- Encourages dedicated DRLs
- Encourages better performing brake lights and turn signals (such as dual intensity lights linked to a sensor)

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THANK YOU