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ADAS Conspicuity Results & Potential Improvements



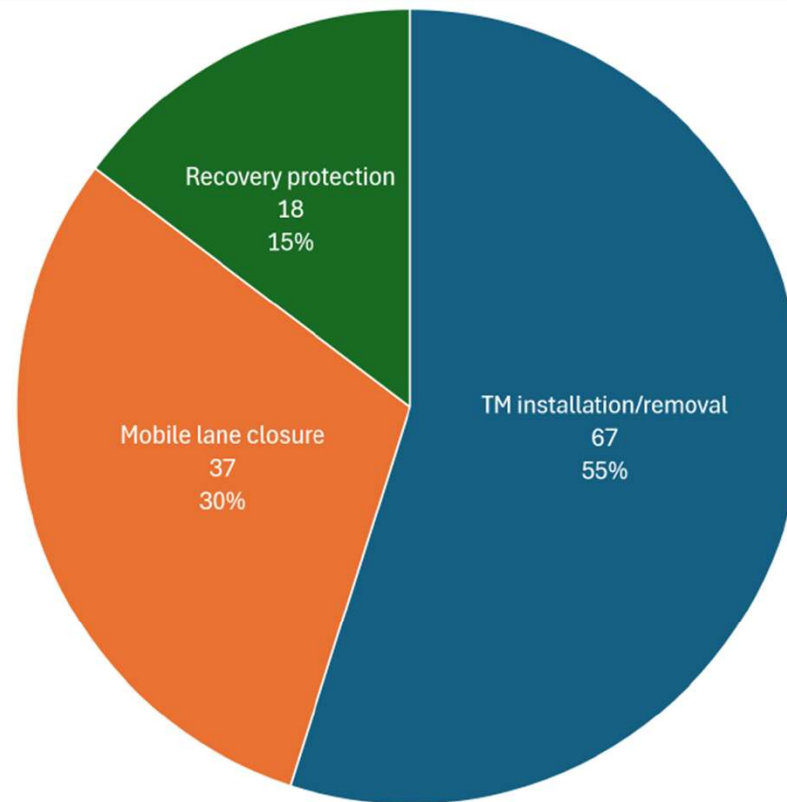
IPV Strike

Incident Data

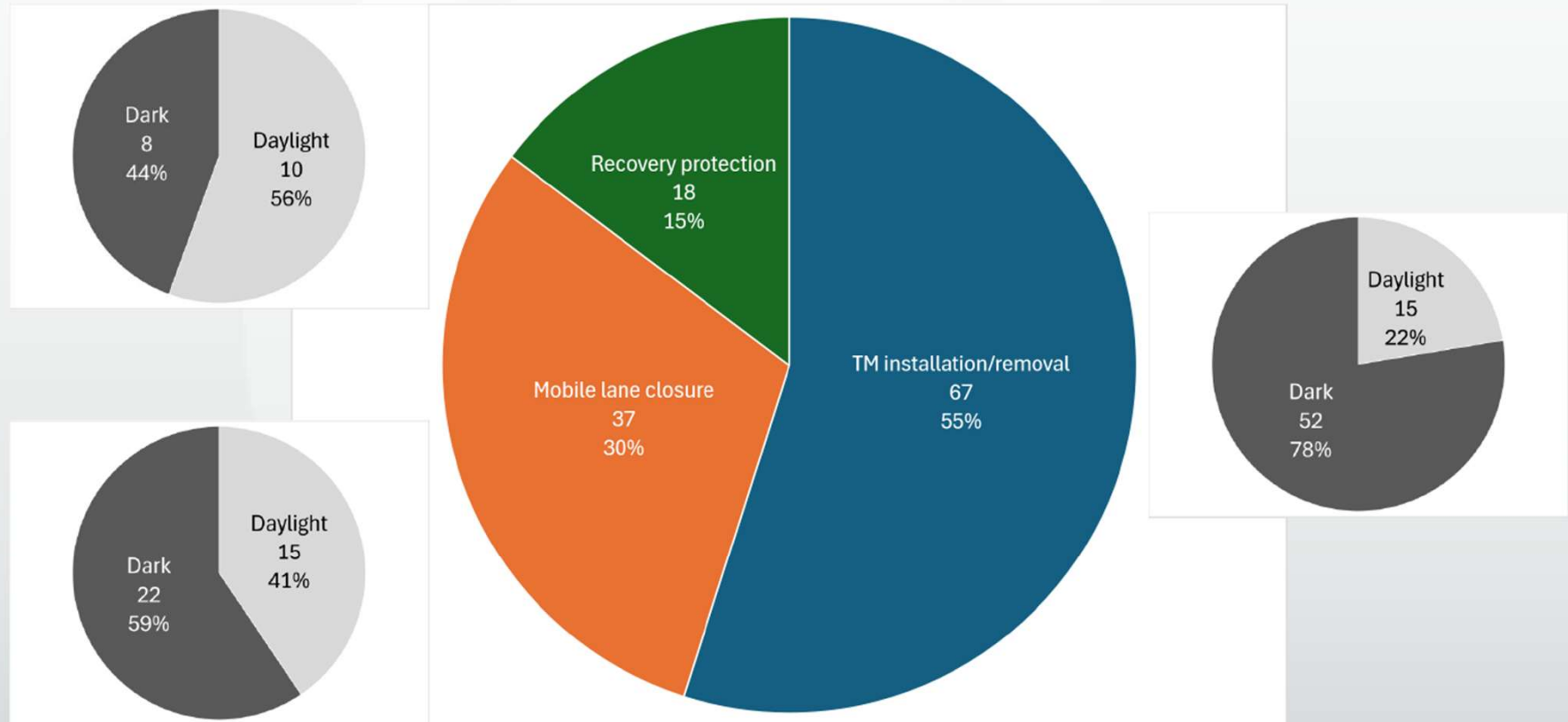
NH IPV Strikes Incident Data

- National Highways provided IPV Strike HART data
- Contains 124 incidents – 122 IPV strikes, 2 other (1 report of HGV in closure but no impact, 1 tipper/grab HGV in closure struck by unsecured load on passing HGV)
- 65 incidents contain enough information to indicate the collision scenario
- Of these 65 incidents, only 6 contain enough information about the striking vehicle to estimate if ADAS was fitted
- Observations:
 - Considered IPV deployments e.g. planned roadworks, mobile lane closures
 - Unplanned deployments e.g. emergency response protecting stranded vehicle
 - IPV operative injury severity often no injury or slight injury from HGV strikes

NH IPV Strikes – Activity



NH IPV Strikes – Activity and Lighting



NH IPV Strikes – Incident Summary

- All pre-impact bullet striking vehicle manoeuvring, including unknowns – 122 cases
- Impact locations in square brackets are inferred from descriptions, not explicitly mentioned

Count of IPV Struck Location		Column Labels							Grand Total
Row Labels		Attenuator rear	[Attenuator rear]	Attenuator rear corner	[Attenuator rear corner]	Offside mirror	Offside	Not known	
Car		21	1	11	3				36
Straight ahead		15							15
Late swerve				4					4
Lost control		1							1
Not known		5	1	7	3				16
LCV		5	1	5	2				13
Straight ahead		4							4
Late swerve				3					3
Not known		1	1	2	2				6
HGV		14	3	10		9	1		37
Straight ahead		10							10
Lane drift		1		2		9	1		13
Late swerve				2					2
Lane change towards IPV then late swerve				3					3
Not known		3	3	3					9
Not known		7	8	9	4	2	2	4	36
Straight ahead		4							4
Lane drift						2			2
Late swerve				2			2		4
Not known		3	8	7	4			4	26
Grand Total		47	13	35	9	11	3	4	122

NH IPV Strikes – Incident Summary

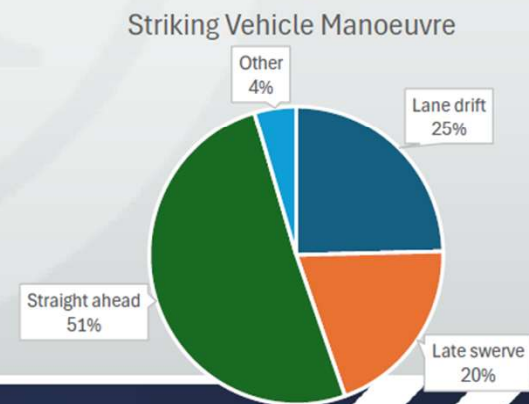
- Known pre-impact striking vehicle manoeuvring only – 65 cases
- Three predominant collision types with IPVs
 1. Car/van/HGV driving straight ahead, large overlap with attenuator, no driver attempt to avoid (blue)
 2. Car/van/HGV driver last moment swerve to avoid IPV collision, but clip rear corner of attenuator (orange)
 3. Close passing HGV hits IPV offside mirror (purple)

Count of IPV Struck Location		Column Labels			
Row Labels		Attenuator rear	Attenuator rear corner	Offside mirror	Offside
Car		16	4		
Straight ahead		15			
Late swerve			4		
Lost control		1			
LCV		4	3		
Straight ahead		4			
Late swerve			3		
HGV		11	7	9	1
Straight ahead		10			
Lane drift		1	2	9	1
Late swerve			2		
Lane change towards IPV then late swerve			3		
Not known		4	2	2	2
Straight ahead		4			
Lane drift				2	
Late swerve			2		2
Grand Total		35	16	11	3

NH IPV Strikes Incident Data

- The 65 collisions can be broken down into three main groups:
 - HGV lane position/lane departure – striking vehicle close passes/drifts towards IPV
 - IPV offside mirror strike – often not stopping
 - Side swipe with IPV bodywork or glancing collision with attenuator
 - Inattentive car/van/HGV driver last moment swerve around IPV
 - Low overlap impact or glancing collision with IPV attenuator – some drivers flee scene on foot
 - Inattentive car/van/HGV driver makes no attempt to avoid or brakes late
 - Large overlap, full speed collision with attenuator
 - Note: some straight-ahead cases possibly involved swerve, but not clear in report.

Collision manoeuvre	No. of identifiable incidents	% of identifiable incidents
Lane position/lane departure	16	25%
Last moment swerve	13	20%
Straight-ahead	33	51%
Other	3	4%



Advanced Driver Assistance Systems

Results of testing

Euro NCAP work vs Ringway work

Euro NCAP

VUT's	Vehicle Reference
	Car 1
	Car 2
	Car 3
	Car 4
	Car 5
	Car 6
	Car 7
	HGV 1

Target Vehicles
Soft Car Target (GVT)
Curtainside Trailer
Impact Protection Vehicle (IPV)
Soft Truck Target
Skeletal Trailer (without container)
Volvo EX90

Ringway

Bullet Vehicles	Vehicle Reference
	Car 1
	Car 2
	Car 3
	Car 4
	Car 5
	HGV 1

Target Vehicles
Soft Car Target (GVT)
Curtainside Trailer
Impact Protection Vehicle (IPV)
Grit spreading Vehicle (Gritter)
Vacuum Extractor Vehicle (Vactor)
Barrier Rig Vehicle

Euro NCAP Results summary

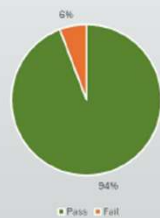
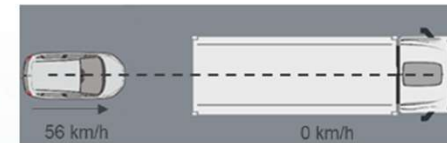
- Euro NCAP focus will be on greatest number of collisions
 - Daylight, standard vehicles
 - What can be done to new cars, trucks, to improve the ADAS
- Situation greatly improved with modern radar camera AEB
 - Focus likely to be robustness to different scenarios
 - Topography, offsets, angled vehicles, darkness

	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7	HGV 1
GVT	100%		100%	60%			100%	
Volvo EX90								
Curtainside	100%	100%	100%	25%			33%	67%
Skeletal	0%		0%	50%			67%	100%
Soft Truck Target	100%		100%	0%			33%	67%
IPV	100%	80%	76%	43%			100%	33%

	Car 1	Car 2	Car 3	Car 4	Car 5	Car 6	Car 7	HGV 1
GVT	100%	100%		100%	75%			0%
Volvo EX90	100%	100%		83%	83%			50%
Curtainside	100%	100%	100%	60%	83%			50%
Skeletal	62%	100%		70%	83%			
Soft Truck Target	83%	100%		50%	67%			0%
IPV	100%	100%	100%	48%				100%



Notes:
GVT and Soft Truck Trailer had no lights
All other vehicles had taillights illuminated
IPV was tested with and without flashing amber lights



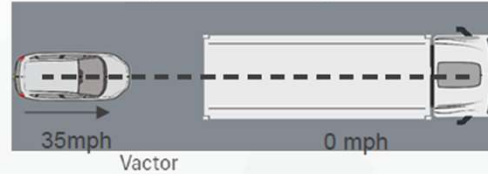
Ringway: General finding baseline vehicles



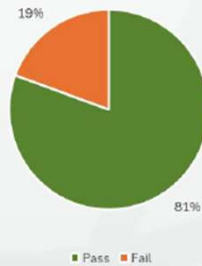
- Note: two less passenger cars on Ringway day – from ‘good’ end of performance
- Baseline detection with vehicles used on Ringway day, slightly worse as a result



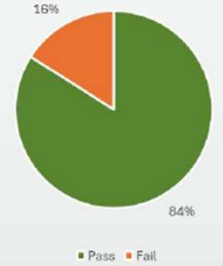
Ringway: Stationary Target, Full Overlap



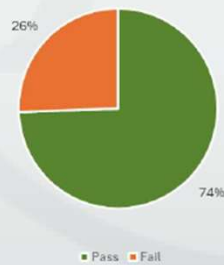
*Car 3 not tested against gritter in this scenario, inclusion of estimated Car 3 results would give the same overall result +/- 1%



Impact Protection Vehicle

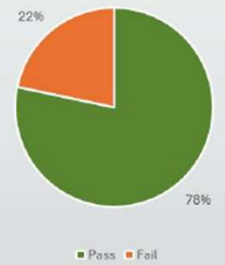


Barrier Rig



*Car 1 not tested against gritter in this scenario, inclusion of estimated Car 1 results would increase pass rate to 83%

Gritter



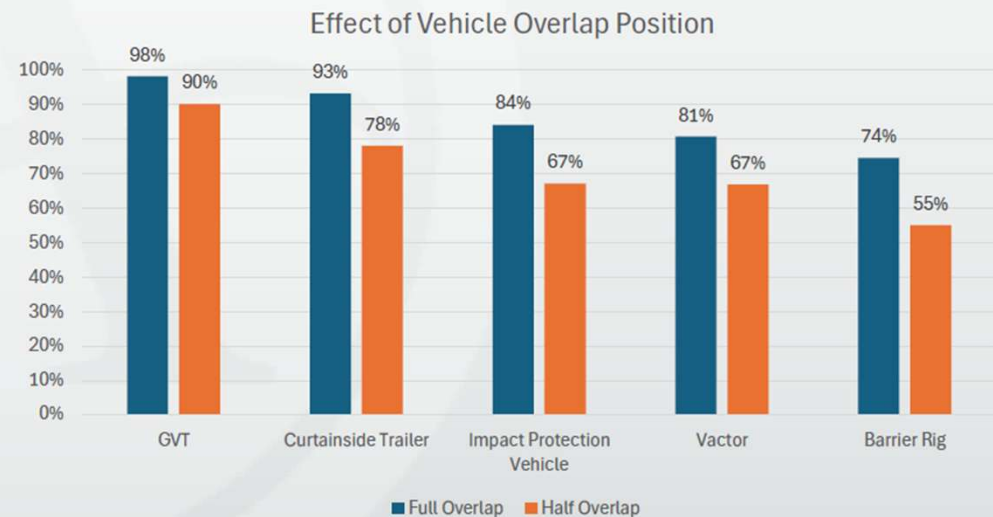
Stationary Target, Full Overlap

- Ringway roadworks vehicles are detected often by ADAS, but significantly less than standard test targets, standard HGVs and passenger cars.
- The single HGV tested, saw a larger reduction compared to standard targets, than the typical passenger car, but the worst individual vehicle was a passenger car. HGV impacts carry a larger risk of injury to occupants of Ringway vehicles.
- Only one HGV was tested so this may not be representative of the full HGV fleet.

	Car 1	Car 2	Car 3	Car 4	HGV 1
GVT	100%	100%	100%	91%	100%
Curtainside	100%	100%	75%	90%	100%
IPV	100%	100%	100%	63%	57%
Gritter	n/a	100%	100%	29%	85%
Vactor	100%	100%	n/a	30%	92%
Barrier Rig	100%	100%	40%	80%	52%

Half overlap condition

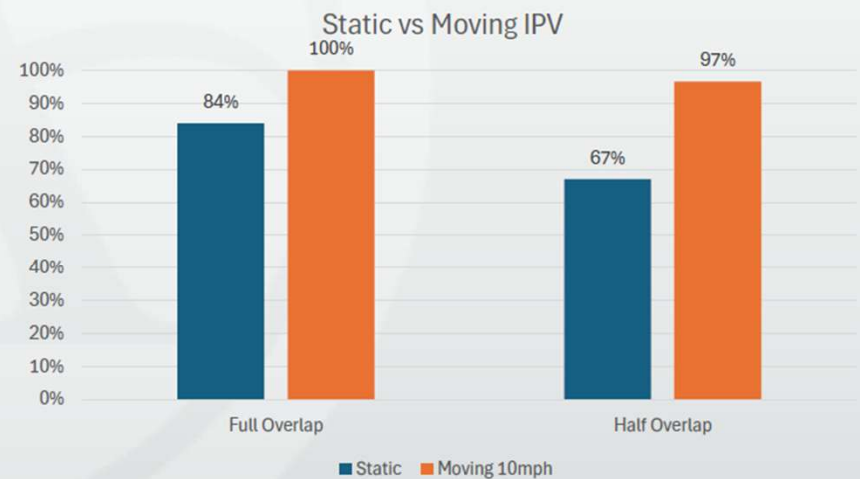
- The second scenario tested is with half of the bullet vehicle overlapping the target vehicle.
- Consistent with quite a few real incidents (other real incidents have less overlap).
- Results demonstrate reduction in detection rates for all target vehicles when in a half overlap condition.



Results are only shown where same target vehicle were used at both full and half overlap against the same target.
Not enough data was captured against Gritter to provide representative results.

Stationary vs Moving IPV

- Tests with IPV moving forwards at 10mph full overlap.
- Detection becomes near perfect.



Lighting Conditions

Full overlap, stationary target test were repeated in darkness conditions.

Lighting conditions on target varied.

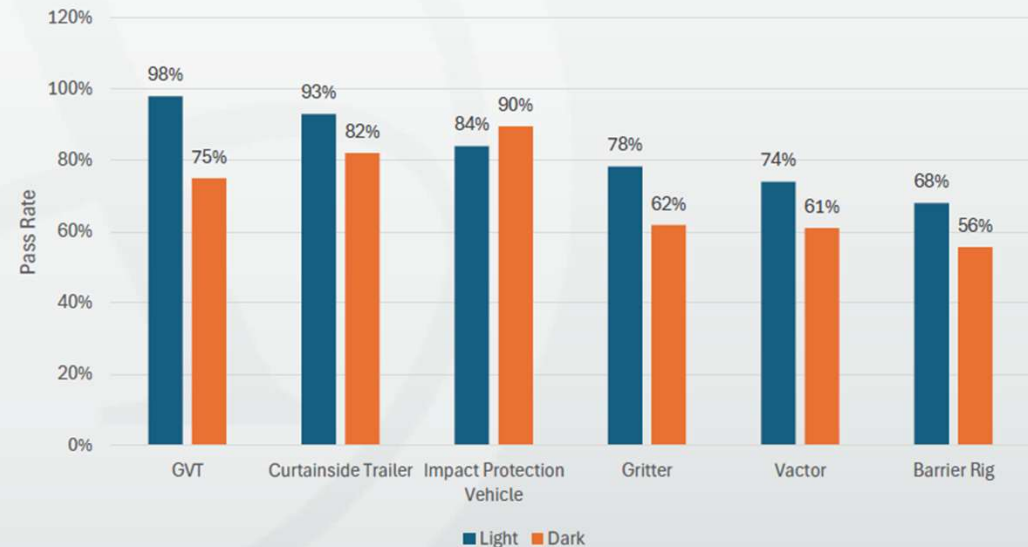
The GVT (no lights) biggest drop in detection

The IPV detection increases in darkness.

When aggregated the ringway vehicles show a similar drop in detection rate to the curtainside trailer.

However, the breakdown of lighting variations on the following slides shows a different picture.

Effect of Daylight vs Darkness



Results are only shown where same bullet / target combination was tested both day and night

Darkness – Target vehicle lighting conditions

IPV



Vactor



Gritter



Barrier Rig



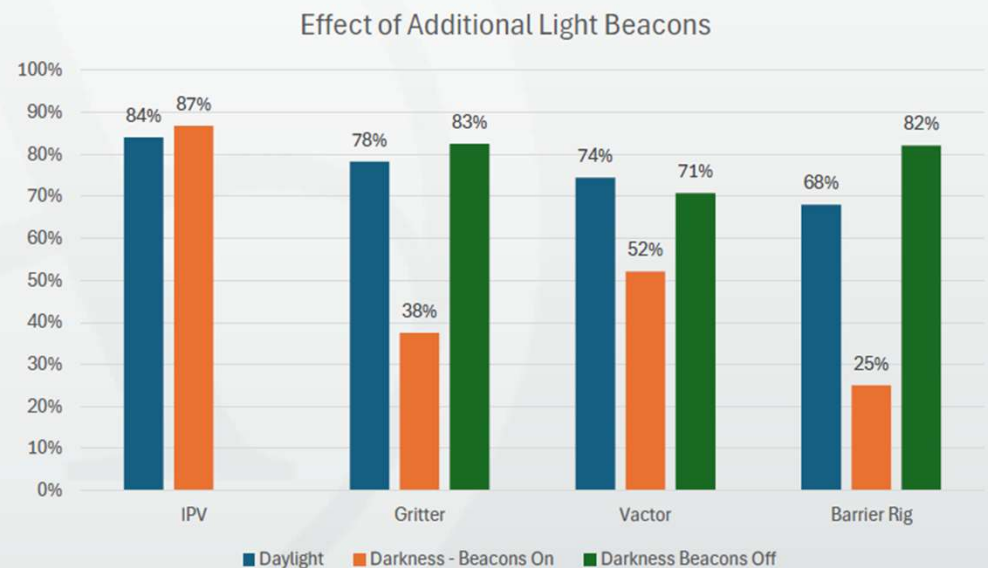
Lighting Conditions - Additional Beacons

Three Ringway vehicles, tests were repeated in daylight, darkness with/without additional beacons on

For the IPV, as results with the beacons switched on were similar to daylight performance, tests were not repeated with the beacons off.

For the other three vehicles there was a significant drop in detection rates when tested in darkness with beacons on, compared to daylight performance.

When the tests were repeated with beacons off and taillights only on, the detection rates return to a similar level to daylight conditions.



Results are only shown where same bullet / target combination was tested in all three lighting variations.

Lighting Conditions - Additional Beacons

As in other tests, the conditions affected bullet vehicle systems differently, but

- Every bullet car show improved results at night when the target vehicle beacons were switched off.

Daylight	Car 2	Car 3	Car 4	HGV 1
IPV	100%	100%	63%	53%
Gritter	100%	100%	29%	85%
Vactor	100%	n/a	30%	92%
Barrier Rig	100%	40%	80%	50%

Dark Beacons On	Car 2	Car 3	Car 4	HGV 1
IPV	100%	100%	47%	100%
Gritter	100%	50%	0%	0%
Vactor	83%	50%	0%	75%
Barrier Rig	100%	0%	0%	0%

Dark Beacons Off	Car 2	Car 3	Car 4	HGV 1
IPV	n/a	n/a	50%	n/a
Gritter	100%	80%	50%	100%
Vactor	100%	83%	13%	88%
Barrier Rig	100%	100%	29%	100%

Rad-viz effect

Our tests showed limited difference in small number of tests with and without radviz



IPV	Car 1	Car 3	HGV 1
Rad-vis fitted	100%	100%	54%
Rad-vis removed	100%	100%	59%

Vactor	Car 4
Rad-vis added	30%
Rad-vis not-fitted	30%

Angled Skeleton Trailer	Car 3
Rad-vis added	0%
Rad-vis not-fitted	0%

Skeleton Trailer	Car 5 (ACC)
Rad-vis added	75%
Rad-vis not-fitted	17%

Analysis, Theories, Options for improvement

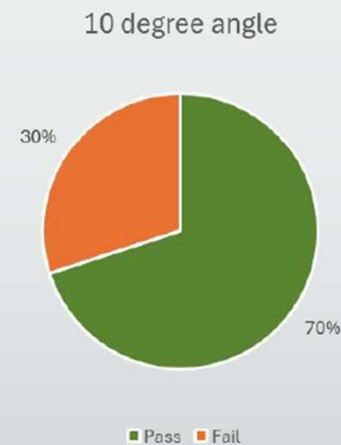
Why did we get these results, what does it mean and where next?

Action 1: Improved incident reporting

- Currently recording incidents but limited details
- Clear (understandable) focus on things in Ringway/NH control e.g. training record, driver drug testing, compliance with roadworks standards etc
- Prevention of future incidents based on safe system approach needs more:
 - Safer vehicles, infrastructure, road users, speeds and better post crash responses
 - E.g. of 124 incidents, only 6 contained make, model, age.
- Hard to know how many incidents each of following options might prevent.
- Variety of incidents is clear – **there is no silver bullet solution.**
- Options for improvement include:
 - Develop IPV strike incident report structure to capture data for populating database
 - Include fields relating to whole safe system, include photos, videos etc
 - Make linkable to Stats 19, other sources of information
 - Use forensic reconstruction techniques to e.g. estimate speeds

Action 2: Operational guidance

- No further research needed
 - Angled vehicles
 - Positions near changes in slope
 - Stationary vehicles
- All reduce probability of detection for at least some vehicles
- Roadworks may happen anywhere, often must be stationary, but if you can....
 - In daylight
 - Use moving vehicles, even 5 mph
 - Place vehicles in flat areas
 - Align with the road



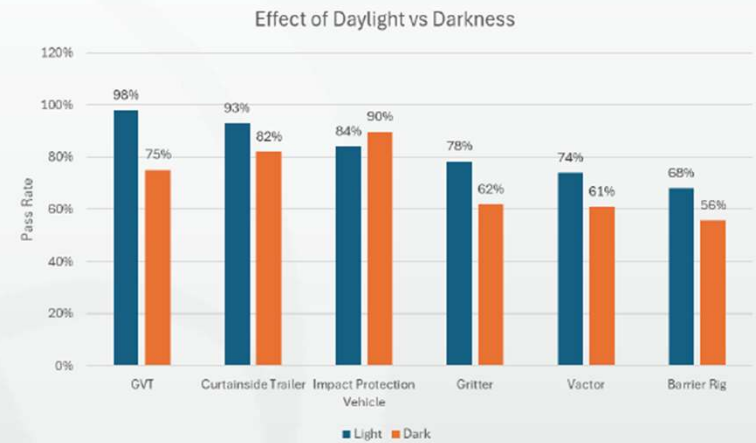
Theory 1 – Conspicuity Markings

- What sort of thing affect how quickly a human can recognise an object:
 - Shape
 - Size
 - Clutter
 - Contrast
 - Colour & Detail
 - Expectation
- What do we do when we want something to be seen?
 - Retroreflective – contrast good
 - Colours clear
 - Shape, detail much less clear
 - Volvo truck feedback: IPV may be seen as gantry sign above road sign, no confidence, no activation



Theory 1 – Conspicuity Markings

- What sort of things affect how quickly a human can recognise an object:
 - Shape
 - Size
 - Clutter
 - Contrast
 - Colour & Detail
 - Expectation
- What works?
 - Black semi-trailer well seen day & night
 - Shape is simple, rectangular, one whole above lights number plate etc
 - Black High contrast during day, poor at night
 - Simple retroreflective rectangle plus standard lights helps at night but not perfect
 - Higher night contrast help?



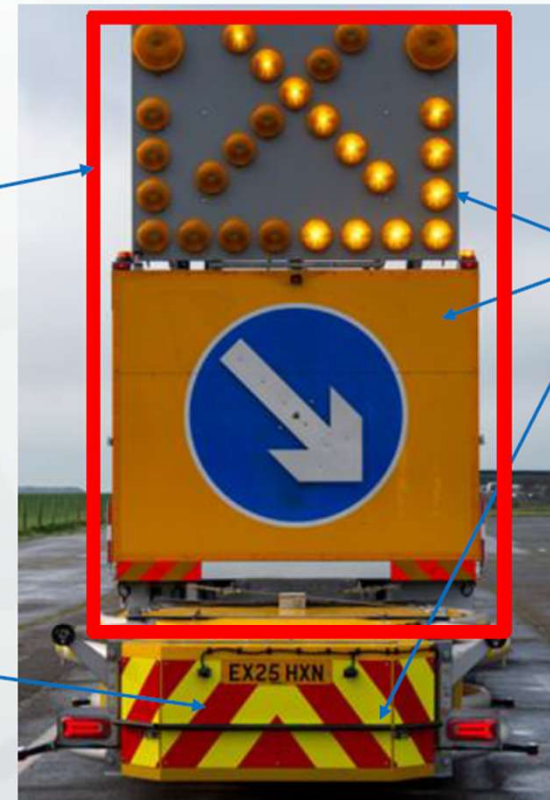
Theory 1: Next Steps

- Create a new set of markings to make the rear of Ringway vehicles look more like a standard semi-trailer
- Re-test at Wroughton in controlled focus style using modern and older legacy fleet ADAS

Rectangular R48 style outline to make like semi-trailer body

Potentially arrange lights number plates and marking to resemble semi-trailer and RUP

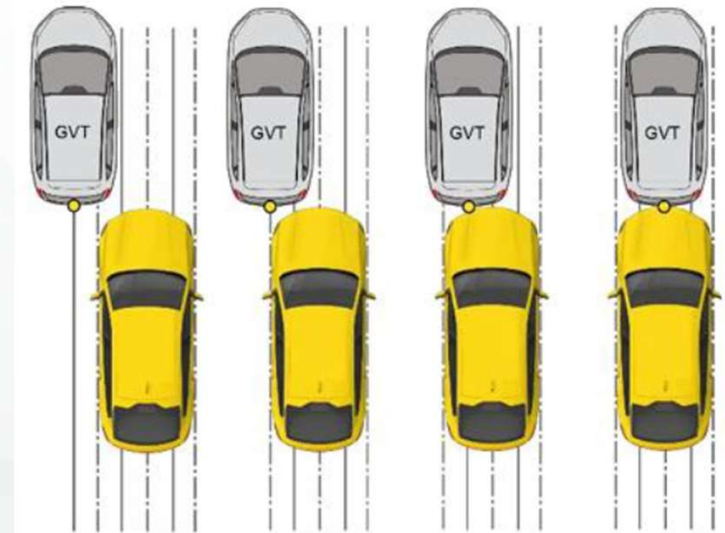
Equalise widths of each element



Integrate with a single uniform background colour – red retroreflective a permitted alternative to chevrons?

Theory 2 – Attenuator face width

- Lateral overlap affects AEB response
 - Larger overlap = higher system confidence of collision, reduced opportunity to avoid, stronger intervention
- Below half vehicle overlap, AEB response diminishes
- ~3/4 of white truck overlaps IPV truck
- Only ~1/2 of white truck overlaps attenuator face, defined by lights and vertical edges
- Crash tubes etc. are unusual structure, unlikely to be recognised as part of vehicle width



Theory 2 – Attenuator face width

- If attenuator face was full HGV width, white truck overlap would be ~3/4, may promote AEB response



- But, inhibits ability for drivers to swerve around in last moment reactions and glance off structure—make it soft sacrificial, not structural



Theory 3: Beacon brightness

- In darkness: dimly illuminated vehicle and surroundings, bright beacons as point light sources
- Camera dynamic range: range of light and dark tones captured in a single image
- High dynamic range required to capture details both bright and dark areas at the same time
- Reducing range between brightest light and dark areas supports image interpretation
- Volvo truck FCW response for Barrier Rig in darkness with beacons off, no response with beacons on (most other cars OK)



otobrite

- Next step: How does beacon brightness affect ADAS and driver response?



THE SUNDAY TIMES

Warning over smart braking systems that fail to detect lorries

Nick Rufford and
Hugo Daniel

Automatic car braking systems on some vehicles are failing to prevent drivers crashing into the back of lorries because they cannot detect them, Europe's leading vehicle safety body has said.

Euro NCAP, in collaboration with National Highways, the government agency responsible for operating motorways and trunk roads in the UK, carried out tests of underrun impact collisions – where a car collides with the back of a heavy goods vehicle (HGV) and slides beneath it.

The research, due to be published on Tuesday, found that fitting lorries with better rear protection guards could save up to 400 lives a year across Europe, including at least one a fortnight on average in the UK.

Crash tests carried out at MIRA, the Motor Industry Research in Nuneaton, in Warwickshire, showed that upgrading steel guardrails at the rear of lorry trailers to match systems already in place in the US would significantly reduce the catastrophic effects of rear-end collisions.

Euro NCAP, which rates vehicle safety, and other European safety agencies are now calling for urgent improvements to protect drivers.

The research also found that some Advanced Driver Assistance Systems (ADAS) struggle to detect rear end trailers which prevents automatic braking kicking in.

Many of the accidents happen on motorways when car drivers hit the back of stationary heavy goods vehicles queuing in front of them, or when the lorries are stopped because of a breakdown or flat tyre.

The double failure of some

– usually older – ADAS systems and the physical safety guards fitted on lorries will be announced on Tuesday by Euro NCAP, with safety agencies in Germany and Sweden.

US trailer manufacturers already fit safer underrun guards to their trucks that can prevent deadly impacts. Euro NCAP is urging UK authorities and manufacturers to adopt an American-style system.

"We are hoping that governments across Europe will upgrade legislation and manufacturers will make changes to new and existing vehicles," said Matthew Avery, Euro NCAP's director of strategic development. "In terms of UK casualties, it was 35 killed and 131 seriously injured on UK roads in 2024 due to crashes into the backs of [lorry] trailers, a not insignificant number."

National Highways asked Euro NCAP to investigate driver fatalities last year due to concern that deaths from rear-end collisions involving lorries remained stubbornly high, despite new rules to make the rear bumpers more robust, brought in in 2022.

On a number of occasions, drivers crashed into National Highways' own stationary safety lorries positioned near roadworks to protect road crews, according to a source.

The flashing lights on National Highways' impact protection vehicles, or IPVs, designed to warn drivers of lane closures and speed restrictions, may have "dazzled" some cars' ADAS systems, researchers said.

ADAS has been in use for more than a decade and mandatory on new production cars since 2022. The systems use a network of sensors, including camera and radar, to detect hazards and obstructions, which warn the driver and then apply the brakes if the driver does not react in time.



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Regulations & Legality: Road Vehicle Lighting Regulations

- No vehicle shall be fitted with a lamp showing light to the rear that is not red, except:
 - Multiple items not relevant to roadworks vehicles e.g. direction indicators, blue lights for emergency vehicles etc
 - Amber light from a warning beacon fitted to a range of categories, including:
 - A road clearance vehicle
 - **a vehicle used for the purposes of testing, maintaining, improving, cleansing or watering roads**
 - **A traffic sign**
- Lamps must not automatically flash, except, among others
 - A warning beacon, special warning lamp, lamp forming part of a traffic sign
- Definition of a warning beacon
 - A lamp that is capable of emitting a flashing or rotating beam of light throughout 360° in the horizontal plane
- Definition of a special warning lamp
 - A lamp, fitted to the front or rear of a vehicle, capable of emitting a blue flashing light and not any other kind of light
- Requirements of warning beacons
 - The light shown by any one warning beacon shall be displayed not less than 60 nor more than 240 equal times per minute and the intervals between each display of light shall be constant

Regulations & legality: Engineers Interpretation

▪ Traffic Sign not Warning Beacon ✓

- No 360 deg requirement
- Flash rate appropriate
- Must be Amber

▪ Warning Beacons ✓

- Roof bar 360 degree
- Front repeater, not 360, not a warning beacon, must not flash

▪ Rear Flashers

- Not 360, not a warning beacon, must not flash, must show only red light to rear

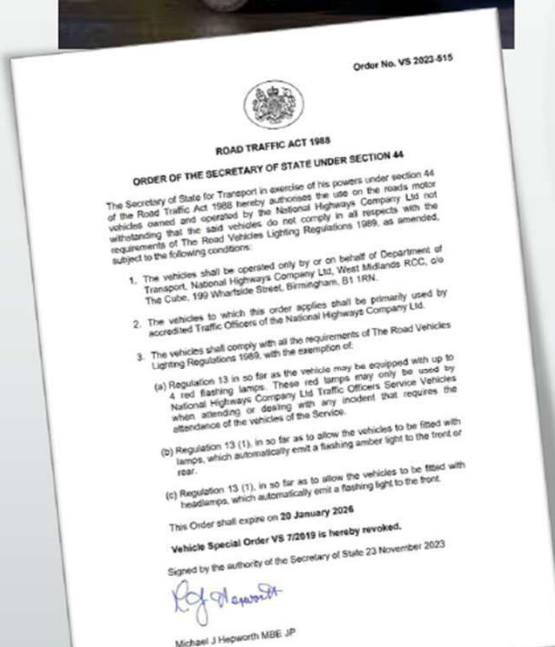


Flash Frequency

- Even if flashers interpreted as warning beacons
- RVLR requires 1 to 4 Hz frequency
- Barrier rig flashers average c 10Hz and may not have "constant intervals"
- IPV is a traffic sign not beacon so doesn't need to comply, but mostly does anyway

Only the Courts Can Interpret the Law

National Highways Traffic Officer vehicles



- Front flashers, also illegal?
- No, National Highways have applied for a 'Vehicle Special Order' under Section 44 of the Road Traffic Act
- Exemption that specifically permits
 - Red flashers to rear
 - Flashing headlamps
 - Amber flashers to front or rear
- No control on frequency
 - Should there be, in light of results?
- Do Ringway have VSO's covering their vehicles?



IPV Strike Incident Reporting



IPV Strike Incident Reporting

- Apollo developed, self-contained python app
- Based on experience of analysing:
 - STATS19 police reported injury incidents, Road Accident In-Depth Studies (RAIDS)
 - DfT Heavy Vehicle Crash Injury Study (HVCIS), National Highways fatals database
 - TfL bus Incident Reporting and Information System (IRIS)
- Structure:
 - Incident details – date, time, location and casualties etc.
 - Vehicle details – IPV and other vehicle(s)
 - Collision details – damage location and severity
- Fields for data entry, drop down menus for consistent reporting and enabling searching, text field for overall incident description

IPV Incident Reporting – Incident

[Incident](#) [Vehicles](#) [Impacts](#) [Incident List](#)

Incident ID: 3

Incident Date	Incident Time
2026/06/29	00:00
Latitude	Longitude
51.500000 - +	-0.100000 - +
Road Class	Speed Limit
Lighting	Visibility

Casualties

Fatal counts drive the Casualty detail tabs (max 10). Serious and Slight counts are recorded for reference only.

Casualty Type	Fatal	Serious	Slight	Total
IPV Driver	0 - +	0 - +	0 - +	0
Other Operatives	0 - +	0 - +	1 - +	1
Other Vehicle Occupants	0 - +	0 - +	0 - +	0

Incident Description

IPV Incident Reporting – Vehicle 1

 Incident  Vehicles  Impacts  Incident List

IPV Details

IPV Details

Make

Year

1900

- +

VIN / ID

Model

Registration

Activity Details

Location

Hard Shoulder

Reason for Deployment

TM Deployment

Attenuator Deployed

Yes

Direction of Travel

Stationary

Travel Speed

0 Mph

IPV Incident Reporting – Vehicle 2

[Incident](#) [Vehicles](#) [Impacts](#) [Incident List](#)

Vehicle Type Group
CAR

Type
Taxi

Body Style
Saloon

Vehicle Details

Make

Year

VIN / ID

Model

Registration

Driver Details

Age (years)

Experience (years)

Hours driven

Gender

Driver Behaviour Factors

☐ None

☐ Fatigue

☐ Reckless/aggressive

☐ Excess Speed

☐ Alcohol

☐ Drugs

☐ Illness/disability

☐ Error of judgement

☐ Lack of attention

☐ Excess Hours

IPV Incident Reporting – Impacts

[Incident](#) [Vehicles](#) [Impacts](#) [Incident List](#)

Impact Details

Striking Vehicle Speed

50 Mph – +

Striking Vehicle Impact Location

Front Nearside Corner ▼

Striking Vehicle Approach

Straight ahead ▼

IPV Impact Location

Rear Offside ▼

IPV Damage Location

☐ Attenuator

☐ Nearside Cab

☐ Farside Cab

☐ Rear Other

☐ Nearside Mirror

☐ Farside Mirror

☐ Nearside body

☐ Farside Body

☐ Front

Striking Vehicle Damage

Damage Severity

Major - Recovery Required ▼

Striking Vehicle Driver Actions

☐ Driver applied brakes

☐ Driver made no attempt to avoid

☐ Driver tried to swerve

☐ Driver stopped (after impact)

☐ Driver lost control (prior to impact)

☐ Driver did not stop (after impact)

Secondary Impact?

Secondary Impact?

No ▼

IPV Strike Incident Reporting

- Currently developed to minimise recording of personal data
- Could be developed to output to Highways Accident Reporting Tool (HART), incorporate IPV colleague details, D&A test results etc.
- App accessible via browser window
- Data accessible via in-built query and viewer, or data can be extracted as .txt or .csv for use elsewhere



Thank you! Questions?

