SPEED LIMITING TRIALS IN AUSTRALIA

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ABSTRACT

Several trials of speed limiter devices are underway in Australia. The authors review these trials and estimate potential road safety benefits. This review builds on a paper that was prepared for the 20th ESV.

It was found that the technology is ready for widespread implementation. Extensive trials of ISA throughout the world have demonstrated the potential for significant accident savings as well as other community benefits.

There is a compelling case for governments to actively support ISA implementation.

INTRODUCTION

Most motorists do not appreciate the extra risks involved in travelling just a few km/h over the speed limit. Most think that the risk of a casualty crash is doubled if you are travelling at least 25km/h over the speed limit (Hatfield & Job 2006). Research has found that that, in urban areas, the risk of a casualty crash is doubled for each 5km/h over the limit. So travelling at 70km/h in a 60km/h zone quadruples the risk of a crash in which someone is hospitalised. As a result, it is estimated that about 10% of casualties could be prevented if the large group of motorists who routinely travel at up to 10km/h over the limit were encouraged to obey the speed limits. About 20% of casualties could be prevented if all vehicles complied with the speed limits (Kloeden & others 2002, Tate & Carsten 2008). Savings in fatal crashes would be larger.

"Minor" speeding therefore makes up a large proportion of preventable road trauma. It is difficult for enforcement methods alone to have an effect on this minor speeding. An added problem is that even motorists who want to obey the speed limits (to keep their life, licence or livelihood) have difficulty doing so in modern cars on city roads.

This is where Intelligent Speed Assistance (ISA - also known as Intelligent Speed Adaptation) comes into its own. The system has a simple function, backed up by clever technology. It knows the location and speed of the vehicle and, from an on-board database of speed limits, it can alert the driver to speeding. The authors have been using ISA devices in Sydney since mid 2006 (Paine and others 2007).

Some road safety researchers are surprised that Australia is leading the world with this technology. An initial reaction is that there could be negative outcomes, such as driving at the speed limit rather than to the conditions, but numerous ISA trials around the word have shown these concerns are unsubstantiated (Paine and others 2007).

Some car manufacturers have expressed concern that some types of speed limiters "take control away from the driver". This is also unsubstantiated, firstly because ISA systems do have provision for over-ride by the driver in the event that the set speed is inappropriate and secondly, the claim is somewhat hypocritical given that cruise control has been in use on vehicles for many years and forces the vehicle to travel at a *minimum* speed unless there is driver intervention.

Classification of Speed Limitation Devices

Speed limitation devices assist the driver in not exceeding a specified or selected speed, which is generally the posted speed limit for the section of road being driven along. There are several classifications of speed limitation devices:

- Top-speed limiting - prevents the vehicle for exceeding a set speed. Most modern vehicle engine management systems have a top speed setting but it is usually well in excess of maximum national speed limits and could not be regarded as a safety device.
- Speed alarm set by the driver - alerts the driver if a selected speed is exceeded. Some production vehicles have this feature (eg Holden Commodore).
- Speed limiter set by driver - prevents the vehicles from exceeding the selected speed, except for temporary over-ride situations (eg "kickdown" of throttle pedal). A few production vehicle models have this feature (eg Renault Megane). These are also

known as "Adjustable Speed Limitation Function" (ASLF).

- Intelligent speed alarm ("Passive ISA") - system "knows" the speed limit of the current section of road and direction of travel and alerts the driver if that speed is exceeded. Feedback may be an audible alarm, a visual signal, haptic feedabck such as a vibrating throttle pedal or a combination of these.

- Intelligent speed limiter ("Active ISA") - the system "knows" the speed limit of the current section of road and direction of travel and prevents the vehicle from being accelerated beyond this speed. These systems normally have provision for temporary over-ride.

With the two ISA the speed limit information is available on three levels: static (location based), variable (time and location based) or dynamic (able to be changed in real time through communication with the road infrastructure - eg roadworks). There are increased road safety benefits for each level.

In recent years the feasibility and performance of ISA system have been substantially improved by developments in the Global Positioning Satellite systems (GPS) and the digital mapping of speed limits. Some systems augment the GPS positioning with dead-reckoning systems that work in tunnels.

Systems that require the driver to manually set the speed have several limitations:

- • they assume that the driver knows the speed limit or can decide on a "safe" speed - in both situations the driver can be in serious error.
- • the task of setting the speed is tedious and may be distracting.
- in jurisdictions with many speed limit changes (e.g., in New South Wales where urban speed limits can be 40, 50, 60, 70 and 80 km/h, depending on the road and location) the task of constantly setting and resetting the speed is cumbersome and repetitive.
- • in practice these voluntary systems are unlikely to be used on a regular basis

The following table sets out estimates of the potential savings in serious road crashes *in Australia* through the widespread implementation of various speed limitation devices. The estimates of effectiveness for passive and active ISA are considered to be conservative and result in lower estimated savings than those predicted in the UK and Europe (Tate & Carsten 2008). This is on the assumption that ISA will be voluntary.

Table 1. Estimates of crash savings in Australia

Device	% of all serious crashes potentially influenced (relevant crashes)	% of relevant crashes that are saved by device (effective-ness)	% of all serious crashes saved by device
Top-speed limiting	1% (exceeding 120kmh)	100%	1%
Speed alarm/limiter set by the driver	20%	5% (low due to the task of setting the device)	1%
Passive ISA	20%	25%	5%
Active ISA	20%	50%	10%

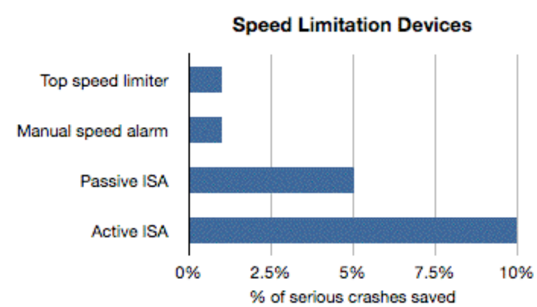

Figure 1. Estimated serious crash savings from speed limitation devices

Passive and active ISA rank highly in a recent analysis of a wide range of vehicle safety technologies to identify priorities for government support (Figure 2, Paine and others 2008). For several reasons ISA ranked higher than Electronic Stability Control (ESC) that has received much attention in recent years.

One reason for this is a 2007 study of ESC in real-world Australian crashes by Monash University. This found that ESC reduced single vehicle car crashes by 27% and single vehicle four-wheel-drive crashes by a remarkable 68%. However, multi-vehicle crashes were unaffected and the overall reduction was found to be about 5% of all crashes (Scully & Newstead, 2007). Savings in serious and fatal crashes could be expected to be greater but are still somewhat less than some estimates for ESC savings derived in parts of Europe and the USA. The Australian results are

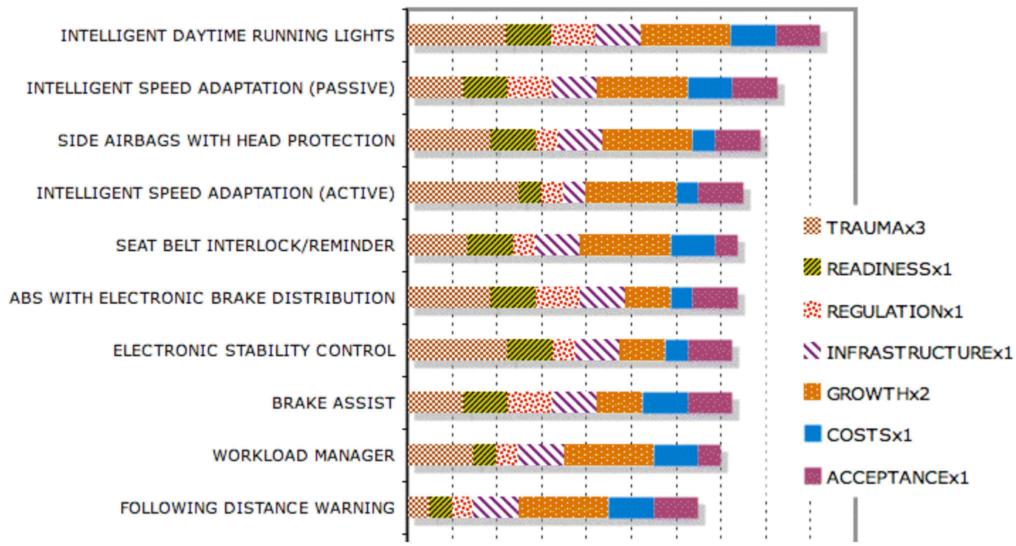

Figure 2. Provisional ranking for a range of in-vehicle technologies deserving government support (nominal maximum score 20). The "growth" category refers to potential for increased uptake through government initiatives.

similar to studies in the UK which found that ESC effectiveness was likely to be highly dependent on local conditions (Thomas 2007). For example, ESC was found to be much more effective in icy and wet conditions - conditions that are comparatively rare in Australia.

Another advantage of ISA is that it is easily retrofitted to most vehicles. The average age of vehicles in Australia is more than ten years. This means it will take at least ten years for a technology that is only fitted to new years to penetrate half of the fleet.

In contrast there is no technical limit to the rate at which a retrofittable technology like ISA could be introduced. It could also be targeted at high-risk groups such as novice drivers, who generally drive older vehicles and tend to be last to benefit from technologies such as ESC, that can only be reasonably fitted to new vehicles. This may be one of the reasons that the European Transport Safety Council strongly supports the introduction of ISA (ETSC 2006).

The point is that ISA deserves no less attention than ESC when it comes to government road safety strategies. Furthermore, these strategies should consider opportunities for retrofitting older vehicles and not just look at standards for new vehicles.

Daytime running lights (DRLs) are another technology that ranks highly in the list for government support and is easily retrofitted. The "intelligent" component of DRLs refers to light-sensing technology that automatically switches to headlights when ambient light levels drop (ie automatic headlights).

AUSTRALIAN ISA PRODUCTS

There are two ISA products for sale in Australia. Both products are technically fully-functional. Their only limitation is the extent of mapping of speed limits and this coverage is expanding swiftly to become nationwide.

SpeedAlert passive ISA

In mid-2006 a Sydney company, Smart Car Technologies, began commercial sales of a GPS-based speed limit advisory system. SpeedAlert is a software package that is designed to work with compatible Personal Digital Assistants (PDAs), programmable mobile phones and Sat-Nav Systems. SpeedAlert works with GPS to pinpoint the position of the car. Using a pre-recorded database of speed limits, the software is able to recognise the current speed zone the car is travelling in (including direction of travel). Using GPS, SpeedAlert is also able to accurately calculate the speed of the vehicle and so is able to warn the driver, using audible and/or visual alerts, if the car exceeds the speed limit at any time. No connection to the vehicle's speedometer system or other components is required.

The system is designed to be highly portable and can be easily transferred between vehicles. Costs range from US$90 for software and a 12 month update subscription to about US$500 for a PDA with built-in GPS receiver and the SpeedAlert software and update service. Updates are downloaded over the Internet and are typically several megabytes.

SpeedAlert displays the current speed limit as large black numerals inside a red circle (Figure 3). The current vehicle speed is displayed in smaller numerals below the speed limit. If the speed limit is exceeded the numerals turn to red. Depending on user settings, an audible beep is activated at higher speeds. The beeps continue until the vehicle speed is decreased. There are two levels of beeping depending on the amount by which the speed limit is exceeded. The driver can choose to mute the beep, but the mute facility is over-ridden in the vicinity of a school zones or fixed speed cameras.

In 2008 the SpeedAlert system was integrated into an Australian portable sat-nav device that sells for about US$100. The SpeedAlert component costs less than US$10 to "activate" after a trial period but even if the full $100 cost is used, this is highly cost-effective safety device that can be used in any vehicle.

The system can be set to operate in SpeedAlert mode (Figure 3) that only displays the current speed limit and vehicle speed. This overcomes concerns about the distraction caused by the display of navigation maps. When operated in map mode the speed limit is displayed in the bottom left of the screen (Figure 4). The visual and audible speed alerts still function when the map is displayed.

Figure 3. SpeedAlert mode for the sat-nav device.

Figure 4. Speed limit displayed on navigation map.

Early in 2009 Smart Car Technologies began beta-testing a live-update version of SpeedAlert that uses the mobile phone network:

"SpeedAlert™ LIVE determines the position of your vehicle on the road by accessing the GPS signal from your mobile phone. It sends those co-ordinates to our server through your mobile phone's GPRS service. Our server then interrogates a proprietary database of speed limits and returns to the mobile phone the speed limit for that section of the road you are on." (from www.speedalert.com.au)

With cooperation from road authorities this new system will be able to provide drivers with current information about variable speed limits on motorways and temporary speed limits such as roadworks or accidents (the latter does not apply anywhere in Australia at present but a live-update ISA system would make this feasible).

SpeedAlert and the associated speed limit database has been developed as a commercial product, independently of government projects. Mapping was carried out using on-road data collection. Most major cities in Australia, and their connecting highways, are now covered and more areas are being added each month. The SpeedAlert system can be readily implemented in other countries.

Speedshield passive/active ISA

Melbourne company, Automotion Control Systems (ACS), has developed an active speed control system which has been in operation in industrial locations such as warehouses since 2003. The system is in widespread use on forklifts and similar vehicles by several major Australian companies.

The company further developed this system for use in cars and commercial vehicles. In 2006 ACS was awarded a contract to conduct ISA demonstration projects with the Transport Accident Commission of Victoria and with the Office of Road Safety and Main Roads WA of Western Australia. In 2008 New South Wales Roads and Traffic Authority also installed Speedshield Active ISA in two vehicles for evaluation purposes. Approximately 100 units were in operation across Australia at the time of writing.

Speedshield uses a combination of GPS and gyroscope dead-reckoning to establish vehicle location and local speed limits. Radio beacons and wireless communication are used to provide speed zone database updates to the in-vehicle speed zone map. The system accommodates temporary speed control (e.g. roadworks, accidents etc.) by use of bollards fitted with roadside transceivers (developed fore the industrial application) and time-based limits such as school zones. Figure 5 shows the display used in the demonstration projects.

Figure 5. Speedshield display

A control module is installed between the accelerator pedal and the engine and mirrors the driver's throttle movement until the speed limit is reached, at which stage the module will hold the throttle signal. An optional over-ride can be engaged if the driver briefly pushes the accelerator pedal to the floor.

Speedshield stores the last known position so that ,on start up, the system is provided with the last known speed value instantly. This has the benefit of giving an instantaneous start up and allowing start up in non-GPS areas, such as underground car parks. Use of the dead reckoning system also assists in obtaining a GPS fix more quickly.

Because the Speedshield system interacts electronically with the throttle regulation system there is no decrease in power to the vehicle when travelling at or below the speed limit. The kickdown override can be set at variable levels, for driver preference, however the authors prefer a setting whereby the pedal has to be depressed almost fully to the floor to activate, much like the kickdown function of an automatic transmission. This allows the driver to easily engage the override when necessary but prevented inadvertent activation (such as when driving up steep hills).

A noticeable benefit of the system is reduced fatigue, particularly for longer trips. This benefit was also reported by truck and bus drivers when top-speed limiters were introduced for these vehicles in the early 1990s (Paine 1996).

AUSTRALIAN ISA PROJECTS

Three Australia States are currently conducting ISA projects. The following descriptions are based on advice provided by the State authorities early in 2009.

In addition to the government ISA projects , individual companies have also bought into ISA technologies, and the systems are in use for day-to-day operations (e.g., heavy vehicles used for transport haulage). As yet, there have been no public reports relating to these activities.

Transport Accident Commission of Victoria

In 2002 the TAC commenced the Safecar project that developed and trialled several ITS technologies, including ISA with haptic feedback. Positive results were reported by Regan and others (2006).

TAC has commenced a new ISA demonstration project, as described below.

In Phase 1, participants were provided with instruction sheets on how the ISA system works after the system was successfully installed in their vehicles but were not provided with verbal briefings. A total of 34 participants participated in Phase 1 of the demonstration project

Phase 2 entails stronger expectation setting. The instruction sheets were modified slightly to emphasise the limitations of the map database and participants are also given a verbal briefing by staff at the TAC post installation to reiterate the device is still in prototype form and the mapping is not complete and that anomalies are to be expected.

Phase 3 will entail varying the operational settings of the ISA system to determine the best fit between road safety benefits and consumer acceptance.

Participants' experience from phase one of the project have mainly been positive. The overall ranking for the usability, acceptability and functionality of the ISA device in its current form was considered good by over half the participants, with an even greater proportion believing ISA has great road safety benefits. A few minor, but important issues such as the inaccuracies of the current incomplete map will be addressed in subsequent phases. In phase 2 of the demonstration project, participants will receive instruction sheets with stronger emphasis on the limitations of the database upfront and a verbal briefing to reiterate the limited coverage of the database will be provided. Participants' response will be monitored to gauge the success of this approach and any feedback will be fed into phase 3 of the demonstration project.

Roads and Traffic Authority of New South Wales

In November 2007, the RTA commenced the development of the New South Wales ISA Trial. By the end of the project it is expected that around 100 vehicles from private fleets in the Illawarra Region will be fitted with an ISA device, as well as a speed data recorder.

The project will cover three Local Government Areas:

Wollongong City

Shellharbour City

Kiama Municipality

The total length of the road network in this area is approximately 2,500 km and boasts a population of more than 263,000.

The region includes a large workforce that commutes up to 80 km per day into Wollongong City from the neighbouring Shellharbour and Kiama areas. The roads have a wide variety of speed zones including 40 km/h high pedestrian, 40 km/h school zones, 50 km/h and 60 km/h urban areas, 80 km/h winding rural roads and 100km/h freeways. This Region also boasts a culturally and socio-economically diverse population including people employed in the heavy manufacturing, mining, and rural industries as well as government administration and tertiary education.

Mapping of all 960 speed zones in the trial area has been completed and a process for updating changes to speed zones has been developed through spatial web server software. Data recorders are in the process of being installed in all participants' vehicles. The data recorders send a snapshot of each vehicle's location and speed every ten seconds. Vehicle speed data is then joined spatially with speed zone information to build speed limit compliance reports for each vehicle in the trial. It is planned to log vehicle speeds for up to three months before ISA devices are installed as a baseline measure of speed limit compliance.

Supportive ISA systems will be installed in approximately 40% of trial vehicles with the remainder receiving an Advisory System. Vehicles will retain their ISA device for around four months during which speed limit compliance data will continue to be captured. Preliminary results of the trial will be presented at the 2009 Intelligent Speed Adaptation Conference to be held in Sydney, Australia on 10 November 2009.

Western Australia

The Office of Road Safety (ORS) and Main Roads West Australia (MRWA) are conducting a trial of advisory ISA systems using GPS and other potential technology in the State of Western Australia (WA). The objective of the trial is to test user acceptance of the system with the aim of creating demand within the general community for ISA as a tool that will support them in choosing speeds that are at or below the prevailing speed limit.

Promotion of the ISA trial will highlight the community benefits of this driver support technology. The ISA pilot project involves the development and demonstration of a low cost compact advisory ISA unit that can be fitted to most modern vehicles and is marketable to the public. Fifty advisory Speedshield units have been purchased and installed in various fleets for an evaluation of driver's attitudes to and experiences with the technology. A PDA display unit, alerts the driver, via a system of audible and visual signals, if they are exceeding the speed limit applicable to the road.

The WA ISA trial has required the creation of a Statewide electronic speed limit map database by MRWA, as well as development of associated technologies for remotely updating speed information on installed ISA units. The partnership that Victoria and WA have entered into with ACS (Speedshield) for the demonstration trial has given Main Roads WA valuable knowledge and experience in providing speed limit data to external providers of ISA technology and, when the trial is fully underway, will allow them to address critical issues such as data security, reliability and accuracy.

In December 2007 45 key stakeholders across Perth and regional WA were invited to trial the ISA devices. Installations of advisory ISA units in the volunteer vehicles commenced in the first week of March 2008, with around 35 vehicles fitted to date. All bar one of the vehicles fitted to date are metropolitan-based, although a number do regular country trips. Volunteers are expected to trial the ISA units for around 6 months, during which their experiences and feedback on the usefulness and convenience of the devices will be surveyed.

Exit surveys have been sent to the first 25 participants, with around half returned to date. Initial feedback has shown that the biggest problem has been with the PDA display unit itself (sequence of starting). Some errors in the map database have also been reported.

A communications plan promoting the benefits of ISA to both government fleet managers and the general community will be finalised by mid 2009.

The next phase of the MRWA trial sees the deployment of transmitter systems to make automatic in-vehicle updates to the speed limit map (without the driver needing to take any action) and warning transmitters for accident scenes, roadworks zones and level crossing. ISA-equipped vehicles travelling within a theoretical 5 km radius of these beacons will automatically receive map updates. It is expected that the beacons will be in operation by June 2009.

Wireless Speed Limit updates

One issue with ISA systems is keeping data in the vehicle up to date as speed limits change. The MRWA project trials transmitters that are used to send data updates to ISA equipped vehicles. These transmitters send selected data to replace any part of the in-vehicle speed limit dataset that has been updated. Only the part of the dataset that has changed is updated, thereby reducing the amount of data that needs to be transferred. This reduces communications costs and the time a vehicle has to be within range to receive updates.

These transmitters may also be configured to provide temporary updates such as would be required in the case of accident scenes or road works zones.

Level crossing transmitters

Another innovative development in the MRWA ISA trial is the deployment of level crossing transmitters. These transmitters, are used to warn drivers when there is a train in proximity to the level crossing. The signal from the transmitters can be used to trigger passive (audio/visual) alerts and/or active speed limiting in vehicles.

For the trial, if a train is in proximity, the PDA displays an icon and sounds and audible alert notifying the driver that there is a train close by. The screen switches between the train icon and the current speed limit. For the MRWA trial the speed limit is maintained at the current road speed limit, however it is possible to drop the speed limit to any value when a train is in proximity (i.e. the speed limit drops from 80 normally to 60 but only when there is a train in proximity, once the train is gone the speed limit returns to 80).

For the MRWA trial passive functionality only is to be deployed, with warning icons – no vehicle speed control is proposed, however further investigation of functionality with an active ISA vehicle are proposed.

Once a vehicle enters the transmitters range it is provided with information on the current conditions (i.e. whether there is a train approaching or not).

Changes in transmitter message can be triggered a variety of ways – using fixed transmitters near level crossings that communicate wirelessly with trains, using contact switches, or having transmitters mounted to trains.

CONCLUSIONS

This review of the status of ISA in Australia has found that the technology is ready for widespread implementation. The conclusions from our 2007 paper are still applicable:

Extensive trials of ISA throughout the world have demonstrated the potential for significant accident savings as well as other community benefits.

There is a compelling case for governments to actively support ISA implementation through:

a) assistance with the mapping of speed limits and the maintenance of databases

b) being the first major customers for commercial ISA systems

c) inclusion of ISA in fleet vehicle purchasing policies and occupational health and safety guidelines

d) promoting the benefits and functionality of ISA

e) introducing financial incentives such as tax concessions

f) educating motorists that most fatalities occur at surprisingly low impact speeds and that just a few km/h over the speed limit greatly increases the risk of a serious injury crash.

g) *introducing subsidised ISA rental/purchase schemes for novice drivers*

Additional points from the latest review are:

1. Mapping of Australian speed limits for commercial purposes is progressing reasonably well. However, there is still no national system that keeps track of changes to speed limits. This is necessary for keeping the maps up-to-date.

2. Government support is needed for mapping speed limits. ISA will not take-off until a useful proportion of a region has been mapped. There is a chicken-and-egg dilemma here - the technology will not penetrate the fleet until mapping is complete but commercial mapping is unlikely to proceed unless there are ISA products to use it. Indeed, recent changes to the Euro NCAP rating system encourage manual speed limitation devices but the protocol states "The systems currently available have limitations in the map coverage and map quality. When these technical limitations have been resolved, or when systems are available which use other technical approaches, Euro NCAP will incorporate ISA systems into the protocol".

3. The appendix contains proposed functional and performance requirements for ISA systems, based on the authors' experience using ISA systems in Australia. These requirements should be considered for incorporation in ECE Regulation 89.

4. Strategies for promoting various ITS technologies often overlook the existing vehicle fleet. ISA can be retrofitted to vehicles, thus

enabling a much swifter fleet penetration than technologies that can only be fitted to new vehicles.

5. ISA is absent (or given token treatment) in some international ITS programs, such as the USA. ISA also holds great potential for nations that are becoming motorised such as China because it does not require any roadside infrastructure and can be retrofitted to the current fleet.

A conference on ISA was held in Sydney, Australia, on 1 August 2007 (Faulks and others, 2008)., coinciding with a meeting of a small group of governmental road safety representatives involved in vehicle safety and speeding control activities. Subsequently, the Australian Intelligent Speed Assist Initiative (AISAI) was formed, and this group held a forum in Sydney on 24 June 2008 to discuss minimum standards and functionality issues for ISA, preparatory to developing an integrated national approach.

The 2009 Intelligent Speed Adaptation Conference will be held in Sydney, Australia on 10 November 2009 and is being organised by the Roads and Traffic Authority of NSW.

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> "There is no single vehicle technology remaining to be implemented - neither on the market nor in development - that offers the same safety potential as ISA"
>
> European Transport Safety Council, 2006

APPENDIX

Proposed functional and performance requirements for ISA systems.

These suggestions are intended for the Euro NCAP protocol for assessing "speed limitation devices" and ECE Regulation 89, neither of which currently sets requirements for ISA.

The recommended tolerance of 2km/h above the speed limit is based on the demonstrated accuracy of ISA systems and extensive experience using passive ISA. A 2km/h tolerance allows drivers to travel at the speed limit without excessive speed alerts due to normal variations in vehicle speed. A higher tolerance would lose the road safety benefits arising from a reduction in minor speeding.

Definitions

- Intelligent Speed Assistance (ISA) system means a vehicle technology that is able to determine the statutory speed limit of the current section of road and direction of travel and takes action if the vehicle exceeds that speed limit by a specified amount.
- An Active ISA system prevents the vehicle from exceeding the speed limit (beyond a specified amount) through normal operation of the accelerator control. An unusual, positive action by the driver is needed to intentionally exceed the speed limit.
- A Passive ISA system provides a warning to the driver if the speed limit is exceeded by a specified amount.
- V_{limit} is the statutory speed limit as determined by an ISA system.

Requirements for ISA systems

X.1 Requirements for all ISA systems

X.1.1 The ISA system must be capable of locating the vehicle to within a radius of 10m of the true vehicle position (based on a recognised GIS system) for at least 99% of the time that the vehicle is operating on roads with reasonable GPS reception (or other applicable location technology)

X.1.2 In tunnels and other poor reception areas a backup location system is preferred.

X.1.3 At speeds above 20km/h the vehicle speed shall be calculated to within 1km/h of the actual travelling speed (eg 1% accuracy at 100km/h).

X.1.4 The ISA function shall operate whenever the vehicle is travelling at more than 20km/h (it may also operate at lower speeds)

X.1.5 In the event that the system is not functioning correctly the driver is to be notified and the system is to completely disengage.

X.1.6 When the vehicle is travelling along roads at the speed limit the ISA system shall act on a change of speed limit as close as possible to the change location but in no case more than 3 seconds after the change point has been passed.

X.1.7 When there is reasonable GPS reception (or other location technology is available) the time to activate ISA functions shall be no more than 60 seconds after the vehicle is started.

X.1.8 The operation of the ISA functions must be simple, intuitive and cause minimal driver distraction. The system shall be capable of automatic operation whenever the vehicle is started. For important functions audio/voice feedback is preferred to confirm driver selections so that the driver does not need to look at the display after making a selection.

X.2 Requirements for Speed Limit Database

In order to operate correctly, most ISA systems in use or under development need access to a database of speed limits for roads that will normally be used by the vehicle. The following are provisional requirements for such databases, pending the development of appropriate standards for speed limit databases. Other technologies such as roadside transmitters and optical recognition system are not precluded but should provide equivalent system performance.

X.2.1 The ISA system shall have access to an acceptable speed limit database or equivalent data system. This may be stored on the vehicle, accessed by electronic communication or a combination of methods.

X.2.2 The speed limit database shall cover at least 80% of the roads in the region in which the ISA system is marketed and be at least 99% accurate for the speed limits on these roads (determined on a per kilometre basis). Partial coverage is acceptable for an on-board database, provided that users can obtain replacement/supplementary data for additional areas to make up the minimum 80% coverage requirement.

X.2.3 Temporal speed limits (eg special speed limits during school commuting times) shall be recorded in the speed limit database.

X.2.4 The speed limit database shall be updateable and the service provider must have a system in place to track speed limit changes and provide updates to users at least every three months.

X.2.5 Other road features/hazards such as tunnels and railway level crossings may be recorded in the database. Roadside speed cameras and similar enforcement devices may also be recorded, where permitted in the country concerned.

X.2.6 ISA systems shall be tested by travelling on a test course that is covered by the ISA speed limit database. It is recommended that the test course includes non-public sections of road so that the vehicle can be driven in excess of a nominal speed limit, set in the ISA speed limit database for this purpose.

X.3. Requirements for alarms/warnings (applies to active and passive ISA)

Alarms may be visual, audible or haptic (physical feedback to driver).

X.3.1 ISA alarms shall activate whenever the vehicle is travelling 2km/h or more beyond V_{limit} . No alarm shall activate when the vehicle is travelling at V_{limit} or less.

X.3.2 Visual ISA alarms may activate at 1km/h beyond V_{limit}. An audible or haptic alarm must not activate at a lower speed than a visual alarm.

X.3.3 There should be no designed delay to the activation of any alarm (that is, it should activate as soon as the designated speed exceedance is detected). However, an audible or haptic alarm may gradually increase in intensity provided that it is audible/detectable in a quiet vehicle from the start and reaches full intensity within 5 seconds.

X.3.4 After the 5 second period the audio warning signal shall be clear to the driver and distinguishable from audio signals used for other purposes. Quieter systems are acceptable if the ISA system causes the audio entertainment system of the vehicle to mute whenever the vehicle is travelling 2km/h or more beyond V_{limit} for more than 5 seconds.

X.3.5 Volume adjustment and muting of audio warning signals is acceptable provided that the system resets to at least half volume when restarted and there is visual indication to the driver that muting is in effect.

X.3.6 The audio alarm may vary (eg more frequent or more intense) if V_{limit} is exceeded by more than 10km/h (or other increments).

X.3.7 Haptic feedback should not cause driver discomfort or distraction. Preferred methods are mild resistance when depressing the accelerator control or vibration of the accelerator control.

X.3.8 A visual ISA signal must be clearly visible to driver, without the need for the head to be moved from the normal driving position. The system should display V_{limit} (preferably in black numerals) and should flash or change colour (preferably to red) whenever the vehicle is travelling 2km/h or more beyond V_{limit} (a change at 1km/h beyond V_{limit} is also acceptable) [this is a good time to set standards for use of colours in ISA displays]

X.3.9 The visual signal may also display the current vehicle speed, as determined by the ISA system and other information relevant to safe driving and operation of the ISA system, provided that the speeding warning of clause X.3.8 is the most prominent part of the display.

X.4 . Requirements for Passive ISA systems

X.4.1 Passive ISA systems shall use a visual signal (X.3.8) and at least one of the following: audible alarm (X.3.4) or haptic feedback (X.3.7).

X.4.2 Passive ISA systems may allow the driver to change the V_{limit} in the same manner as ASLFs. Where a driver-selected V_{limit} is being used there must be a clear visual indication of this to the driver. For example the display of V_{limit} numerals could be a different colour such as orange. It is preferred that there is a voice announcement of the selected V_{limit}.

X.5 . Requirements for Active ISA systems

Stringent requirements for active ISA are necessary to ensure that motorists are not placed in risky situations, such as not being able to accelerate up to speed to join a motorway. In addition, since it is possible that a vehicle will exceed the speed limit without the driver needing to depress the accelerator pedal (eg speed limit changes or driving down steep hills) then the warning functions of a passive ISA are required so that the driver may intervene to slow the vehicle. Future systems that are able to apply braking might be exempted from this requirement.

X.5.1 Active ISA shall work through modulation of engine power (for example, by intercepting the signal between the accelerator control and the engine management system).

X.5.2 The active ISA system shall prevent an increase in engine power through normal operation of the accelerator control if the vehicle travel speed exceeds V_{limit} by 2km/h or more.

X.5.3 A "kickdown" capability shall be available where the driver may decide to press the accelerator control with extra force or through a large travel in order to over-ride the ISA system and allow the vehicle to exceed V_{limit} .

X.5.4 The "kickdown" function shall deactivate when the vehicle returns to a speed at or below V_{limit} . See also clause X.5.7.

X.5.5 If an active ISA is capable of applying the brakes or engine braking to reduce vehicle speed then this must be able to be deselected by the driver.

X.5.6 Active ISA systems shall include a visual signal (X.3.8) and at least one of the following: audible alarm (X.3.4) or haptic feedback (X.3.7). See section X.3 for alarm requirements. Subject to clause X.5.7, the audible or haptic alarm must operate in "kickdown" mode (X.5.3) but in this case the audible/haptic alarm need not activate until 20 seconds after V_{limit} (+2km/h) is exceeded.

X.5.7 In "kickdown" mode, an audible or haptic alarm need not operate provided that the ISA operation reactivates after two minutes of exceeding Vlimit and the driver is given clear warning (preferably voice announcement) of the pending activation at least 30 seconds beforehand. Other methods of discouraging prolonged periods of exceeding V_{limit} will be considered.

X.5.8 Active ISA systems may allow the driver to change the V_{limit} in the same manner as ASLFs. Where a driver-selected V_{limit} is being used there must be a clear visual indication of this to the driver. For example the display of V_{limit} numerals could be a different colour such as orange. It is preferred that there is a voice announcement of the selected V_{limit}.

X.5.9 Active ISA shall be capable of working in conjunction with any cruise control fitted to the vehicle or shall disable cruise control, where appropriate. It shall not be possible to over-ride the ISA system through operation of a cruise control function.

X.5.10 Active ISA must allow normal use of the transmission and selection of gears. In particular, when the clutch is depressed the ISA system must allow the engine speed to be controlled to match the gear selection.

X.5.11 Where an active ISA becomes inoperative (eg loss of GPS signal or system malfunction) it shall either disengage completely (restoring all normal control to the driver) or set V_{limit} to the maximum speed permitted in the country or region of operation. Driver setting of V_{limit} is permitted in these circumstances, provided that the over-ride functions of clause X.5.3 are still available.

X.5.12 The driver shall be given a warning if the ISA system becomes inoperative. A voice announcement is preferred.