LIGHT RAIL
Safety and Standards Board

Driver Inattention Systems Guidance

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DESCRIPTION:

THIS DOCUMENT PROVIDES GUIDANCE ON DRIVER INATTENTION SYSTEMS

EXPLANATORY NOTE:

LRSSB is not a regulatory body and compliance with this guidance document is not mandatory. This document reflects good practice and is advisory only. Users are recommended to evaluate this guidance against their own arrangements in a structured and systematic way, noting that parts of this guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not adopt) elements of this guidance should be documented. Compliance with any or all of the contents herein, is entirely at an organisation's own discretion.

SOURCE / RELATED DOCUMENTS:

LRG 1.0 Tramway Principles and Guidance (TPG) (LRSSB)
LRG 6.0 Fatigue Management Guidance (LRSSB)
LRG 11.0 Medical Fitness Guidance (LRSSB)
LRG 18.0 Speed Management Systems Guidance (LRSSB)
Driver Inattention System Trials 5th May 2021 – Issue 3 (Ian Rowe Associates, LRSSB)

RELATED TRAINING COURSES:	**RELATED LEGISLATION:**
N/A	Health & Safety at Work Act 1974 Road Traffic Act 1988 The Management of Health and Safety at Work Regulations 1999 Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) (as amended) The Working Time Regulations 1998

CHANGE NOTES:

Date of Issue	Issue No.	Revision No.	Reviewer	Details of Revision
28/06/2023	01	01	LRSSB	Amendments to text / format

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DRIVER INATTENTION SYSTEMS GUIDANCE

CONTENTS

Revisions from Previous Issue:

New LRG document template and other 'new' formatting.

Figure and Tables listed in the Contents Page.

Changes to Page 1: removal of the named preparer, reviewer and authorising person and insertion of an explanatory note in relation to the status of this guidance document.

Changes / additional items added to Table A Terms and Table B Abbreviations (from existing text).

New Introduction Section added to be consistent with other LRG documentation.

Existing text from Forward and Introduction placed in a new Scope Section to be consistent with other LRG documentation and subsequent renumbering of all text, figure and tables in the following chapters.

Definitions Section removed as definitions explained in Table A Terms.

Amalgamation of Inattention Alerts, Response and Intervention Sections to form one section (Section 9).

Numerous minor presentational, minor factual and typographical changes.

Text added to aid clarification where required / appropriate.

TERMS AND ABBREVIATIONS

Table A – Terms

Term	Definition
Duty Holder	Person in charge of infrastructure or operational activities at a particular time.
Habituation	The driver is habitually resetting the device when alerted, and this has become a subconscious activity that can be performed automatically even when the driver is inattentive.
Line of Sight	Operating mode where a Light Rail vehicle should be able to stop before a reasonably visible stationary obstruction ahead at the intended speed of operation using the service brake.
Medical Fitness	The ability to periodically and satisfactorily demonstrate fitness to work and execute functions.
Microsleep	Unintentional periods of sleep lasting anywhere from a fraction of a second to a few minutes. They are often, but not always, characterised by the closing of eyes or head nodding actions. (RAIB)
Operating	Describes the action of 'driving' or 'being in control of' a Light Rail vehicle based on 'line-of-sight' operation. It includes anyone that is permitted to drive any rail-mounted vehicle over an area to which the public have, or can gain access to.
Safety Management System	A formal management system or framework to manage health and safety.

Table B – Abbreviations

Abbreviation	Definition
ALARP	As Low As Reasonably Practical
CCTV	Closed Circuit Television
DSD	Driver Safety Device
DVD	Driver Vigilance Device
LoS	Line of Sight
LRSSB	Light Rail Safety and Standards Board
PERCLOS	Percentage of Eye Closure
RAIB	Rail Accident Investigation Branch
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended)
TBC	Traction Brake Controller
TPG	Tramways Principles and Guidance
UK	United Kingdom

1. Introduction

1.1. This guidance supports the high level principles set out in LRG 1.0 Tramway Principles and Guidance (TPG) published by the Light Rail Safety and Standards Board (LRSSB).

1.2. This document provides high level guidance for Light Rail system (tramway) operators, owners and infrastructure managers for the selection and implementation of systems designed to detect inattention or incapacitation of the driver and to provide a response that protects against the results of this based on line of sight (LoS) operations only. As with all guidance, this document is not prescriptive and is intended to give advice not to set a mandatory standard for the Light Rail sector, and it is based upon goal setting principles as good practice.

1.3. Much of this guidance is based on the experience gained from good practice from existing UK Light Rail systems and other related industries and published documents. It does not prescribe or endorse particular arrangements adopted by any existing UK Light Rail system and is intended to give guidance and advice.

1.4. This guidance is not intended to be applied retrospectively to existing Light Rail systems. However, owners and operators should consider and assess any implementation of this guidance and / or any subsequent revision to ensure continual improvement in reducing risks, so far as is reasonably practicable.

2. Scope

2.1. In order to reduce the likelihood of a serious accident being incurred as a result of a Light Rail vehicle overturning or a derailment, LRSSB have published two guidance documents drawn from commissioned research: LRG 17.0 Driver Inattention Systems Guidance and LRG 18.0 Speed Management Systems Guidance.

2.2. This document relates to driver inattention, a possible precedent of overspeed, which in turn describes a technological approach to detect driver inattention and the automatic response from this type of system in the case of continued inattention.

2.3. It is important to note that no single approach provides a comprehensive solution to driver inattention and / or vehicle overspeed in isolation. However, the joint implementation of both systems acting in synergy delivers a significant reduction in risk.

2.5 The purpose of this document is to provide improved safety for LoS Light Rail vehicle operation where the driver has a pivotal role in the safe operation of the vehicle and would otherwise represent a single point of failure.

2.6 Following this guidance will also support compliance with Recommendation 4 of the RAIB report into the Sandilands accident in 2016[1]. This explicitly states the following:

> *"UK tram operators, owners and infrastructure managers should work together to research and evaluate systems capable of reliably detecting driver attention state and initiating appropriate automatic responses if a low level of alertness is identified. Such responses might include an alarm to alert the tram driver and / or the application of the tram brakes.*
>
> *The research and evaluation should include considering use of in-cab CCTV to facilitate the investigation of incidents."*

2.7 This guidance does not cover the root causes of driver inattention, but rather the various system approaches for detection of inattention and their responses.

2.8 Research into a number of systems designed to detect inattention has been conducted, and the results are available in the report: Driver Inattention System Trials. 5th May 2021 – Issue 3 (Ian Rowe Associates, LRSSB)[2]. This document uses this report to cite incidences and includes examples from this research and trials that have been conducted into the different system options and engagement with various stakeholders.

2.9 In LoS operation, the driver is the key mitigator of risk in the system. The performance of the driver is critical for system safety, and the competence and attention of that driver is critical to safety performance.

2.10 Any driver inattention is likely to result in negative safety outcomes.

1 Overturning of a tram at Sandilands junction, Croydon (9 November 2016): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931905/R182017_201022_Sandilands_v2.2.pdf

2 https://resources.lrssb.org/download/driver-inattention-system-trials

3. Examples of Inattention

3.1 There are many examples of accidents and incidents caused by inattention in LoS transport systems. These range from daily incidents of driving without due care and attention to high-profile accidents resulting in multiple fatalities.

3.2. Examples of inattention on Light Rail systems have resulted in recent near-miss incidents such as the following:

- An incident where it appeared that the driver lost situational awareness at the point that the tracks made a sharp turn off the highway. The driver had lost concentration and thought they were driving in an entirely different location. There was no suggestion that the driver's eyes were closed before or during the incident.
- An incident where the driver approached a platform at normal approach speed but lost awareness and failed to stop at the platform or comply with the stop signal at the end of the platform. There was no indication that the driver had fallen asleep prior to, or during, the incident.

4. Types and Causes of Inattention

4.1 There are many types and causes of inattention. The following are the most common associated with LoS driving:

- Incapacitation:
  - Illness rendering the driver incapable of being attentive. This can include sudden onset illness such as a stroke or heart attack or a progressive illness that impairs cognition such that the necessary vigilance, situational awareness or the required response is compromised.
- Sleep and micro-sleeps:
  - Sleepiness decreases the ability of the driver to detect and react to evolving situations in a timely manner. Excessive sleepiness leads to incidents of microsleep, the loss of all situational awareness and the ability to respond appropriately.
- Distraction:
  - Visual distraction occurs when the driver's concentration is removed from the necessary driving task by something unexpected that commands attention. This kind of distraction is commonplace in all kinds of driving situations and includes incidents where attention is drawn to an accident on another carriageway causing the driver to stop monitoring the road conditions ahead (sometimes known as rubbernecking); and
  - Cognitive distraction is when the driver diverts their attention to a cognitively demanding task other than that of driving the vehicle. Examples of this include work or home situations that are of concern to the driver. This can dominate cognitive capacity at the expense of the attention necessary for the driving task. The driver could also be simply daydreaming. This can be described as the stream of consciousness that detaches from current external tasks when attention drifts to a more personal and internal direction and is more likely to occur when the cognitive demands of the driving task are low. It is likely that the incidents summarised above in Section 3.2 may have been the result of cognitive distraction.

4.2 Visual and cognitive distraction can also come from other aspects of the driver's role such as having to read in-cab displays or use controls not in the forward visual field. This underlines the need for human factor assessments of cab layouts and the driver interface.

4.3 Of the various types of inattention, incapacitation due to illness is less likely to occur than the others listed as procedures to continually assess drivers' health and fitness to drive are implemented by Light Rail operators. Refer to LRG 11.0 Medical Fitness Guidance for further information.

4.4 Inattention due to fatigue, resulting in sleepiness, is commonplace for all drivers of vehicles on roads and is thought to be the cause of many accidents on motorways where vehicles travel at high speed and drivers can become less cognitively stimulated. Refer to LRG 6.0 Fatigue Management Guidance for further information.

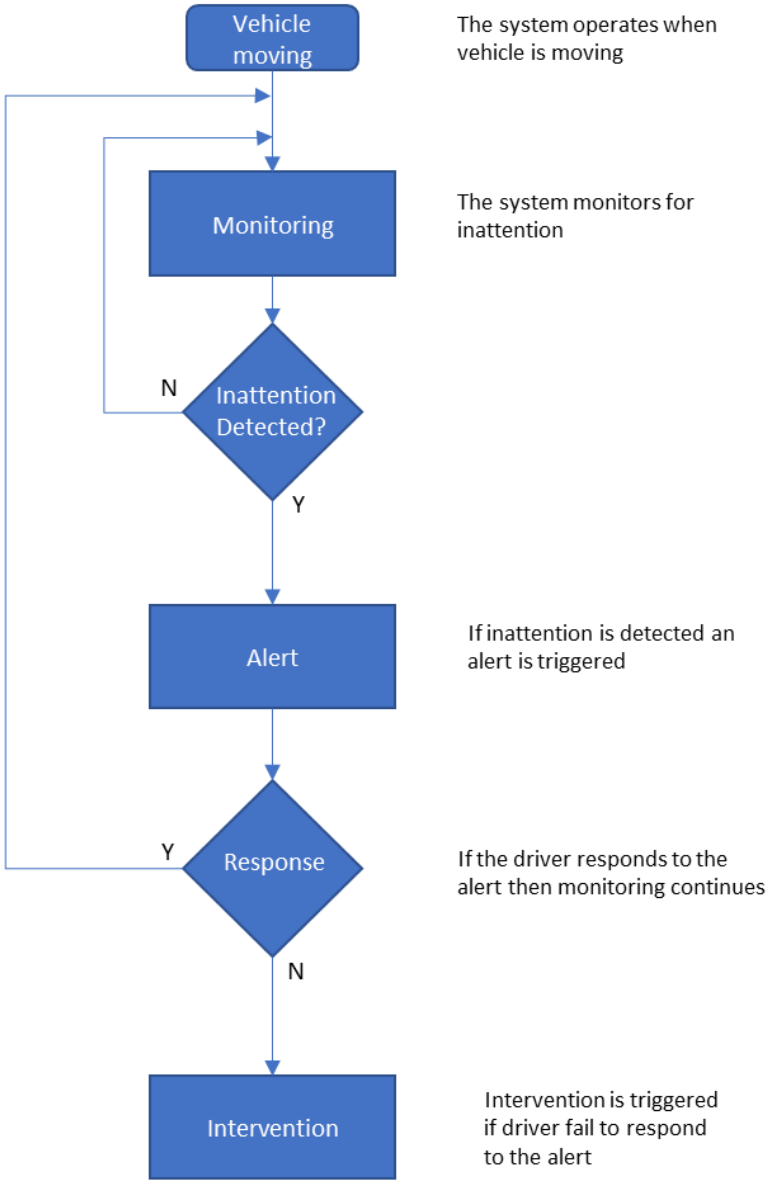
4.5 Distraction is also a cause of many accidents. For example, accidents on motorways are often caused by drivers being distracted by an incident and colliding with traffic ahead.

Cognitive distraction is more likely to occur for those who are very familiar with the driving task where many aspects of this task can be performed sub-consciously releasing cognitive capacity for other activities. This can significantly increase reaction time which can lead to accidents.

5. System Phases

5.1 Although there are different approaches, all inattention systems include the following elements as shown in Figure 5.1 below and are referenced throughout this document.

Figure 5.1 - Inattention System Elements and Flow



6. System Approaches

6.1 Several systems were identified during the research into detection of inattention. These include the following approaches that are then further described below:

- Driver Safety Device (DSD);
- Task monitoring (Driver Vigilance Device (DVD));
- Eye closure detection; and
- Look away detection (head position / eye focus).

Driver Safety Device (DSD)

6.2 The DSD, sometimes known as a dead man's device is mandated in LRG 1.0 TPG and requires that this cannot be kept in the operating position other than by a vigilant driver. This system usually uses an additional control such as a switch on the Traction Brake Controller (TBC) or a foot pedal that needs to be constantly engaged whist the vehicle is moving. Release of this control while the vehicle is moving normally results in an immediate alert to the driver (audio / visual). If the driver fails to respond appropriately then brakes are automatically applied.

6.3 This device provides a basic level of safety to ensure that the driver is present and continually operating the device. However, depending on the failure mode of the driver, this device may not provide protection against driver incapacitation or inattention.

6.4 There have been instances where the driver has become inattentive through incapacitation, but their hand or foot has remained resting on the switch. This is borne out by a recent accident where the DSD was found to be fully functional, but when the driver became inattentive, the device did not protect against the inattention as the driver's hand resting on the TBC continued to engage the DSD.

Task Monitoring (Driver Vigilance Device (DVD))

6.5 This is sometimes referred to as a DVD and is widely used in both the Heavy Rail and Light Rail industries. This approach detects physical activity of the driver by monitoring cab controls for operation. If the system detects inactivity for a pre-defined time or distance of travel, an audio / visual alert is triggered. If the driver does not respond to this alert by operating appropriate cab controls, then the system can apply the brakes.

Eye Closure Detection

6.6 Eye closure detection systems, sometimes referred to as PERCLOS (percentage of eye closure), are not well established in the rail sector. These systems are in use in industries such as mining and are increasingly used in the automotive sector.

6.7 These systems generally rely on an infra-red emitter placed in the cab with an infra-red camera trained on the driver's face. This is connected to a processing unit that contains sophisticated facial recognition algorithms to determine the driver's eye position and status. If the system detects eye closure for longer than a pre-determined time then this is considered as a sleep incident which triggers an output from the system. This can be an audio, visual or haptic alert (for example, seat vibration) intended to wake the driver from the sleep state.

6.8 During the research undertaken by Ian Rowe Associates, no systems were identified that produced a brake intervention after an alert if the driver's eyes remained closed or eyes were not detected by the system, though this may be technically feasible.

6.9 Many available eye closure systems also include look away detection.

Look Away Detection (Head Position / Eye Focus)

6.10 This approach uses the same technology as eye closure detection to ascertain head position and direction of gaze. The algorithm uses recognisable face / head features to determine if the driver's head / gaze is turning away from the expected 'looking ahead' (normally required for LoS driving) and triggers an output if the amount of time 'looking away' exceeds a pre-determined threshold.

7. Application of Approaches for Inattention

7.1 Table 7.1 below details the applicability of each approach to detect the common types of inattention.

Table 7.1: Application of Approaches

Type	DSD	Eye Closure	Look Away	Task Monitoring (DVD)
Incapacitation Due To Illness	Intended to protect against this but may not be effective in certain failure modes.	Will protect against this if the driver's eyes close as a result of the incapacitation.	Will protect against this but is dependent on the human failure mode (for example, if the driver's head slumps downwards or to one side).	Yes
Incapacitation Due To Sleep	Will protect against this if the driver releases the switch.	Yes	Will protect against this but is dependent on the driver's head position during sleep (for example, if the driver's head falls downwards or to one side).	Yes
Visual Distraction	No	No	Yes	No
Cognitive Distraction	No	No	No	Yes - will protect if the alert has the effect of regaining the driver's attention.

7.2 As seen in the table above, no single approach can detect ALL types of inattention.

8. Approaches Strengths and Weaknesses

8.1 Each approach to detection of inattention has their own strengths and weaknesses as detailed below in Table 8.1:

Table 8.1: Approach Strengths and Weaknesses

Approach	Strengths	Weaknesses
DSD	Proven system to detect that the driver is present.	Dependent on the mode of any driver failure, this device may not protect against incapacitation. For example, if a driver were to 'slump' and hold down the switch.
Task Monitoring (DVD)	In the cab system - does not require physical connection to driver. High efficacy in the detection of driver movement.	Depending on implementation, there is a likelihood that the driver resets the device whilst still being inattentive. This can be caused by a subconscious reflex response to the alert (habituation).
Eye Closure	In-cab system - does not require physical connection to the driver. Technology for detection of eye closure shows high efficacy in detection. System may record video footage that can be reviewed to investigate incidents. Ability to gather data of eye closure incidents to inform the Fatigue Risk Management System.	Facial detection may be impaired if system is unable to recognise nose and mouth (for example, if the driver is wearing a mask). System may be prone to false positive detections (for example, driver squinting).
Look Away	In-cab system - does not require physical connection to driver.	Ability only to detect visual distraction outside the forward facing field of view.

9. Inattention Alerts, Response and Intervention

Inattention Alerts

9.1 On detection of inattention, systems may provide any or all of the following:

- Audio alert: an in-cab audio alarm designed to regain driver attention to the driving task. This can be a buzzer / bell or could be a voice alarm;
- Visual alert: an in-cab indicator designed to support the audio alert;
- Haptic alert: a device such as a seat vibrator intended to physically nudge the driver into wakefulness; and / or
- Remote reporting: information about the detection sent to an external location (such as control room) to inform system management of the detection.

Response

9.2 When inattention is detected, the alert is intended stimulate the driver back to an attentive state. If the driver does not respond to the alert, an intervention may be triggered.

Intervention

9.3 The normal intervention is the automatic application of the vehicle brakes. The type of braking force applied may be the following:

- Full-service brake: brings the vehicle to a halt without the use of a magnetic track brake. This results in deceleration forces that are typical during normal vehicle operation; and
- Hazard Brake: brings the vehicle to a sudden halt in the quickest possible time. May result in excessive deceleration forces that could result in falls of passengers in the saloon.

10. Conclusions

10.1 It is important to understand that no inattention system is flawless and weaknesses in each system need to be understood and mitigated wherever possible.

10.2 Whilst acknowledging the weaknesses, the recommendations in this guidance have been drawn up to help to deliver an approach to reduce risk to as low as reasonably practical (ALARP) based on the maturity of technology and technological development at the time of publication of this document.

Why DSD?

10.3 A DSD system is already fitted to all second generation[3] Light Rail rolling stock in the UK. This system is designed to protect against the driver becoming incapacitated, and in all cases these systems automatically apply the brakes if the detection is not engaged (for example, the driver releases the switch for more than a pre-defined time).

10.4 Whilst being designed to protect against incapacitation, the protection offered is dependent on the failure mode of the driver. For example, if the driver were to 'slump' and hold down the switch in doing so, the DSD would not protect against this failure mode.

10.5 Although the flaws in this approach are well understood, DSD offers some protection against incapacitation, and as vehicles are already fitted with this system, it is recommended that these systems continue to be fitted in new vehicles and are retained in existing vehicles.

Why DVD?

10.6 DVD is a well-established existing technology that is already used in Heavy Rail vehicles and some Light Rail vehicles in the UK.

10.7 The system is designed to monitor driver action and requires a regular reset in order to continue driving the vehicle. Failure to do so results in an automatic application of the brakes.

10.8 There are a number of documented Heavy Rail incidents where this system has failed to detect inattention, and investigation into these incidents has cited habituation[4] as the reason for system failure. The habituation issue is therefore considered as a weakness in this approach.

10.9 However, there are several significant differences in tasks performed by drivers of Heavy Rail vehicles compared with drivers of Light Rail vehicles. For example, Heavy Rail drivers may drive for long periods where there is extremely low task load. In contrast, task load for drivers of Light Rail vehicles has a different profile with significantly less time and distance between higher task load requirements (such as tramstops) and the requirement for constant vigilance necessary in line-of-sight driving.

3 UK Light Rail systems that have been in operation from the 1990's.
4 The driver is habitually resetting the device when alerted, and this has become a subconscious activity that can be performed automatically even when the driver is inattentive.

10.10 The differences in task load between drivers of Heavy Rail vehicles and Light Rail vehicles do not necessarily negate the habituation issue in Light Rail. However, the use of multiple reset inputs to the DVD system does reduce the likelihood of habituation, as the need for constant manual resets by the driver can be significantly reduced using this method.

10.11 If DVD alerts are less frequent and are sufficient to draw attention, it is more likely that an inattentive driver will be brought back to attentiveness by this alert.

10.12 The DVD system can automatically apply the brakes if the driver does not respond appropriately to an alert and this would therefore reduce risk from inattention.

Why DVD is Recommended in Preference to Eye Closure / Look Away Detection

10.13 It is important to note that, whilst sleep, or microsleep, is associated with many incidents of inattention, there have been a number of inattention incidents on UK Light Rail systems where there is no evidence that the driver closed their eyes. In these cases, eye closure detection would be ineffective.

10.14 Research conducted into eye closure detection systems on behalf of LRSSB in 2019 concluded that this is an emerging technology that performs reasonably well in detection of eye closure. However, like any system, there are weaknesses, and these differ from manufacturer to manufacturer. Currently there is no eye closure detection system available that includes brake intervention.

10.15 Look away (physical distraction) that can be detected by an eye closure system may be the cause of drivers being slow to react to emerging hazards ahead. However, this form of distraction is not sighted as a significant factor in the driver inattention incidents that have caused serious accident or near-misses.

10.16 At the time of the publication of this guidance, there was only one eye closure system currently implemented on a Light Rail system in the UK. Whilst this system does provide some protection against inattention due to sleep and has been beneficial in informing the fatigue management system, it does have a number of weaknesses as a real-time safety system. Although the system provides an alert to the driver in the case of detection of eye closure or if the driver looks away from forward facing for a defined period of time, it does not intervene or produce further alerts if the driver fails to respond to the initial alert. The system does not perform any braking intervention. It is also acknowledged that this system is prone to false positive activations.

Summary

10.17 In summary:

- Both DVD and eye closure detection systems have their weaknesses;
- Eye closure detection can only protect against inattention due to sleep or microsleep;
- Eye closure detection systems do not offer the protection of braking intervention for continued inattention;
- Look away distraction is not cited as a significant factor in serious accidents or near misses on UK Light Rail systems; and

- DVD systems can automatically apply the vehicle brakes for continued inattention.

10.18 The risks caused by the weaknesses associated with DVD systems can be reduced by implementing multiple reset inputs to the system.

11. Recommendations

11.1 The recommendations contained in this document have been drawn up taking into consideration the research and trials that have been conducted into the different system options and engagement with various stakeholders. Refer to the Driver Inattention System Trials report for further information.

11.2 As seen from Table 7.1 above, no single approach is capable of detecting all types of inattention. Details on the rationale supporting these recommendations are included in the Driver Inattention System Trials report.

11.3 The following recommendations should apply to all new Light Rail vehicles introduced onto a new or existing network.

11.4 Owners, operators and infrastructure managers should consider applying these to existing fleets with the goal of reducing risk due the driver's inattention to ALARP.

11.5 It is recommended that, as a minimum, Light Rail vehicles are fitted with a DSD and a comprehensively risk assessed and effective task monitoring (DVD) system.

11.6 Further protection offered by eye closure and look away detection systems could also be considered.

11.7 All systems should produce alerts and interventions only when the vehicle is in motion.

11.8 Recommendations for selection and implementation of each type of system are as detailed in the following sections.

DSD

11.9 A DSD should be fitted to all vehicles in accordance with EN 13452[5] (as referred to in LRG 1.0 TPG).

11.10 The device should constantly detect and monitor the physical interaction of the driver with the vehicle via a positive input medium, for example, depression of TBC or foot pedal by the driver both prior to taking traction and whilst the vehicle is in motion with provision of an alert to the driver upon non-detection. The vehicle brakes should automatically be applied if the driver does not respond appropriately to the alert, and brake application should be irrevocable until the vehicle comes to a standstill.

11.11 The device should also protect against the vehicle moving if the TBC is unintentionally operated.

Task Monitoring (DVD)

11.12 The timer / distance defining the interval of activity monitoring should not be set such that the reset task needs to be conducted at high frequency as this could result in a motor response that can negate the protection offered by the system. For example, setting the system so that the driver needs to activate a switch every 5 seconds will

5 BS EN 13452-1:2003: Railway applications. Braking. Mass transit brake systems. Performance requirements

result in the driver needing to constantly operate the switch. This is likely to become a motor response to positioning the hand on the TBC. If this were the case, there is a likelihood that this resetting behaviour would become sub-conscious and actionable during inattentiveness, therefore negating the detection of inattention.

11.13 The interval used should be derived for each network taking into consideration tolerable time for inattention detection and driver workload (cognitive and physical).

11.14 Typically, the interval set would be as follows:

- Between 20 and 30 seconds if the system uses time as an interval; or
- Between 380 and 420 metres if distance is used as an interval.

11.15 To reduce the likelihood of drivers developing reflex responses to alerts, multiple inputs (such as TBC movement, operation of indicators, sounding of horn / bell etc.) should be used to reset the device in order to reduce the number of manual acknowledgments required by the driver. This will reduce the likelihood of failure of the system caused by habituation.

11.16 In the case of detection, the system should produce an audio alarm suitable in volume and tone to alert the driver. This should be sufficiently distinguishable from other in-cab alarms and be the highest priority in the in-cab alarm hierarchy.

11.17 The alert should be given for a period of between 3 and 4 seconds to enable the driver to respond before automatic intervention. Giving the driver this time to respond will reduce the number of false positive interventions.

11.18 In the case that the driver does not respond to the alert, i.e. acknowledging it by activating the reset control or any other control that resets the device, the system should automatically apply the vehicle brakes. Automatic brake application should be irrevocable until the vehicle comes to a standstill. It is recommended that the full-service brake is applied.

Eye Closure

11.19 The efficacy of the eye closure detection systems should be assured. This should include:

- Reliability under different lighting levels;
- Reliability when driving wearing approved eye wear (for example, spectacles, sunglasses etc.);
- Reliability when driving wearing head wear or face coverings;
- Reliability for anthropometric variation in driver profile and adjustability of seat (for example, sizes, postures etc.);
- Susceptibility to false positive detections (for example, when the driver is squinting); and
- Loss of detection of the eyes when in motion should result in an alert and subsequent intervention if the system continues to fail to detect the eyes or there is no other acknowledgement from the driver.

11.20 In the case of detection, the system should include either, or both, of the following:

- An audio alarm suitable in volume and tone to wake the driver and bring them to an adequately attentive state. This should be sufficiently distinguishable from other in-cab alarms. Consideration should be given to the use of voice alarms as these appear to have a greater effect in drawing attention; and / or
- A seat vibration strong enough to wake the driver and bring them to an adequately attentive state. This should be sufficiently distinguishable from vibration that may be felt in the seat in normal vehicle operation.

11.21 In the case that the driver does not respond to the alert (for example, if the system continues to detect eye closure or the driver does not acknowledge the alert in the case of non-detection of eyes), the system should automatically apply the vehicle brakes. It is recommended that the full-service brake is applied.

Look Away

11.22 The system should be calibrated (angles and time) such that acceptable and necessary 'look away' behaviours, such as checking mirrors, looking left / right at junctions with return to look ahead etc. do not trigger alerts.

11.23 The system should be calibrated such that the field of view defined as 'looking ahead' takes into consideration acceptable monitoring of peripheral vision.

11.24 In the case of detection, the system should include an audio alarm suitable in volume and tone to wake the driver. This should be sufficiently distinguishable from other in-cab alarms. Consideration should be given to the use of voice alarms as these appear to have a greater effect in drawing attention.

11.25 In the case that the driver does not respond to the alert (for example, if the system continues to detect that the driver is looking away), the system should automatically apply the vehicle brakes. It is recommended that the full-service brake is applied.