

Initial consideration by ORR

1. RAIB addressed all 15 recommendations to ORR when the report was published on 7 December 2017.
2. ORR identified that the far-reaching and inter-related nature of many of the recommendations required cross industry collaboration in considering how to progress the required actions. Recognising the far-reaching nature of many of the recommendations and the need for implementation to be coordinated on an industry-wide basis, it was appropriate for ORR (as owner of two of the recommendations and given our legal responsibilities in relation to all RAIB recommendations) to facilitate this initial cross-industry collaboration.
3. ORR held a conference in Manchester on 22 January 2018 with tram owners, operators and infrastructure managers, along with DfT, UKTram and RSSB, to help all parties establish a common understanding of the scope and deliverables for recommendations 1 - 9.
4. ORR carefully considered the recommendations, taking into account the outcomes of the Manchester conference and initial meetings of the Light Rail Safety and Standards Board (LRSSB) steering group that was established following that conference. In March 2018 ORR passed recommendations 1 – 5 to all tram owners, operators and infrastructure managers; and recommendations 6 - 8 to tram owners and operators.

Table 1: Tram owners, operators and infrastructure managers

Network	Owner (recs 1-8)	Operator (recs 1-8)	Infrastructure Manager (recs 1-5)
Croydon	Transport for London (TfL)	First Tram Operations Ltd (TOL)	London Trams
West Midlands	West Midlands Combined Authority trading as Transport for West Midlands (TfWM)	Midland Metro Limited trading as West Midlands Metro (WMM)*	Shared between Transport for West Midlands and West Midlands Metro
Blackpool	Blackpool Borough Council (BBC)	Blackpool Transport Services (BTS)	Blackpool Borough Council
Edinburgh	City of Edinburgh Council (CoEC)	Edinburgh Trams	Edinburgh Trams

Network	Owner (recs 1-8)	Operator (recs 1-8)	Infrastructure Manager (recs 1-5)
Manchester	Transport for Greater Manchester (TfGM)	KeolisAmey Metrolink (KAM)	Transport for Greater Manchester
Nottingham	Nottingham Council/ Tramlink Nottingham Ltd (TNL)	Nottingham Trams Ltd (NTL)	Nottingham Trams Ltd
Sheffield	South Yorkshire PTE (SYPTe)	South Yorkshire Supertram Ltd (SYSL)	South Yorkshire Supertram Ltd

*until 24 June 2018 West Midlands Metro operated as National Express Midland Metro (NX Metro)

5. ORR also wrote to DfT highlighting that, in its opinion, they had a critical role to play in enabling tram industry owners, operators, and infrastructure managers to discharge the recommendations.

6. Recommendations 10 - 13 were addressed to Tram Operations Ltd; and recommendations 10, 13, 14 and 15 to London Trams. In addition to passing these recommendations to LT and TOL, ORR also brought recommendations 10 - 15 to the attention of all other tram owners and operators due to the important lessons that they could promote. ORR did not ask these organisations for a formal response for these particular recommendations.

7. Recommendations 1 and 9 were addressed to ORR.

8. Each end implementer was asked to take the recommendations into consideration and where appropriate act upon them and advise ORR of their conclusions. The consideration given to each recommendation is included below.

9. Annex B identifies the correspondence with end implementers on which ORR's decisions have been based.

Recommendation statuses

10. In accordance with Regulation 12(2)(b) of the Railways (Accident Investigation and Reporting) Regulations 2005, ORR is required to report formally to RAIB end implementer progress against recommendations.

11. When reporting end implementer responses to RAIB recommendations, ORR categorises them using statuses. The purpose of statuses is to indicate if we think the recommendation has been implemented; if there is a credible plan in place to deliver implementation; or if there are not yet suitable arrangements in place.

Table 2: Explanation of status category

	Status	Explanation
	Implemented	All actions to deliver a recommendation have been completed.
	Implementation on-going	ORR is content with the proposed action plan to implement the recommendation and the timescale for delivery that has been presented by the end implementer.
	Progressing	ORR is satisfied that the end implementer is taking suitable action to consider and address a recommendation, but a formal completion date has not yet been provided.
	Not applicable	The recommendation was not addressed to the duty holder

Other statuses not relevant to this report

	Status	Explanation
	Implemented by alternative means	The risk associated with a recommendation has been addressed by alternative means.
	Insufficient response	Either the end implementer has failed to provide a response; or has provided a response that does not adequately satisfy ORR that sufficient action is being taken to properly consider and address a recommendation

Immediate actions

12. Since the accident, all tram operators have taken practical steps to improve risk control. In response to the Urgent Safety Advice issued by RAIB on 14 November 2016, all tram operators carried out route risk assessments, identified high risk locations and made changes to signage as necessary. This included provision of new signs, sign relocation, and actions to increase visibility. Additionally, Croydon has reduced the maximum allowable speed on its system from 80 to 70kph, and made physical changes to the infrastructure at Sandilands.

13. Although recommendation 11 was only addressed to TOL, all other operators also reviewed their approach to fatigue risk management. Measures taken as a result include sleep hygiene briefings for drivers, reviewing rosters, and a greater emphasis on reporting fatigue. All operators also reviewed and enhanced their arrangements for monitoring adherence with speed limits across their systems, through increased active checking and driver performance management.

14. Three operators already have driver vigilance devices fitted and operating on their trams fleets. All are reviewing their arrangements to satisfy themselves their systems are operating at an optimal level.

15. UKTram established Subcommittee 1 (SC1) to coordinate the industry response to the RAIB report and consider technical and operational measures to address recommendations 3 – 8. The subcommittee reviewed the actions taken by TfL/TOL and ensured this was communicated to the rest of the industry so they could take appropriate action for their own systems.

16. In parallel to subcommittee 1, individual tram operators are taking action to explore how they can address the recommendations, in preparation for receiving the output of subcommittee 1. Actions taken include initiating research work, engaging with tram suppliers and manufacturers, and initiating vehicle trials with novel technology on behalf of the sector.

Recommendation 1

The intent of this recommendation is to improve the management of safety risk in the UK tram industry by enabling more effective UK-wide cooperation.

ORR should work with the UK tram industry to develop a body to enable more effective UK-wide cooperation on matters related to safety, and the development of common standards and good practice guidance. As a minimum, the purpose and aims of this body should be to:

- i. provide a forum for the discussion of common safety issues and the exchange of experience;
- ii. the provision of authoritative and impartial advice and guidance on matters related to safety;
- iii. managing the development of safety related design and operational standards, and their subsequent maintenance;
- iv. participation in the development of industry standards and guidance by international bodies;
- v. sponsoring and project management of the research and development needed to inform the above;
- vi. gathering data, monitoring and reporting on the industry's safety performance (including comparisons of safety performance on different tramways);
- vii. providing suitable guidance on effective safety management, including guidance applicable to public highways;
- viii. working with tramways to help plan industry safety improvement; and
- ix. disseminating good practice from both the UK and overseas industries.

The body should be suitably constituted and funded to enable the effective delivery of the above functions. It should be structured so that ORR promotes, encourages and supports its operation.

ORR decision

17. At our suggestion, RAIB agreed that ORR should own and lead this recommendation in order to put us in a position to support and facilitate industry action.

18. At a meeting in November 2017, ORR and UKTram agreed to establish an independent review group to research options on how to satisfy the requirements of recommendation 1. It was decided that the most appropriate way to fulfil this function would be to develop a safety and standards board. The safety and standards board would have close links with UKTram, but not be functionally part of it.

19. Recommendation 1 requires the UK tram industry to establish a safety and standards body; this will potentially have far reaching consequences on the whole of the sector. Additionally, many of the other recommendations require cross industry co-ordination and as such we felt it was appropriate for ORR to facilitate the initial cross-industry collaboration. To that end, ORR convened an industry conference in Manchester on 22 January 2018.

20. At the conference, the industry representatives agreed to establish a safety and standards body to take forward the key cross-industry requirements of recommendation 1. A steering group was established to consider how the standards body would be constituted, funded and the type of work it would undertake.

21. Significantly, at this conference the DfT representative stated that he was liaising with the Department's finance team regarding funding. A firmer commitment to provide financial support to the establishment and running of the standards body was made at the July LRSSB steering group meeting.

22. The first meeting of the steering group was held on 27 February 2018 and it has met on a monthly basis since then. The steering group is made up of representatives from tram owners, operators and infrastructure managers, along with ORR and DfT. The project to establish the standards body is being managed by UK Tram and they chair the steering group.

23. The steering group considered three options for an organisation that could deliver the requirements of the safety and standards board: an expanded role for UKTram; developing RSSB's remit to deliver the functions of a safety and standards board for the tramway sector, or creating a new body. Industry duty holders decided the most effective way of fulfilling those requirements would be to establish a new body – the Light Rail Safety and Standards Board (LRSSB). They also decided that LRSSB should investigate the advantages of expanding the role of the LRSSB to include all light railways, and not be restricted to tramways.

24. The LRSSB has been formally established, with a registered company name, a shadow board and an interim chief executive officer (CEO) appointed. It has developed a costed and prioritised work plan setting out key activities for years one and two. It has begun the recruitment exercise for a chair and non-executive directors. Once funding has been secured UKTram will elect a substantive Board and appoint a CEO.

25. The LRSSB is a subsidiary company of UKTram, with a separate governing body from the main UKTram Board, an independent chair and a board comprising of industry representatives. Funding would be ring fenced from the UK Tram budget.

26. LRSSB developed a funding model in conjunction with DfT that proposes how the costs should be shared between the sector and DfT and how the sector share should be split between individual operators. All tram owning authorities and operators have formally agreed to support the LRSSB in accordance with the funding model and have committed to provide one third of the funding for it for an initial three year period, on condition that DfT provide the other two thirds. ORR is in regular communication with DfT officials to gain greater clarity regarding their commitment to provide funding, and recently met with the Parliamentary Under Secretary of State for Transport.

27. Nottingham City Council's support of the proposed funding model is limited to the first years cost allocation only and that subsequent contribution requirement is subject to UKTram reporting on the previous 12 months and to a review of the Business Plan and future resource requirements of the LRSSB.

28. The DfT has not yet formally committed the required funding nor indicated timescales as to when this funding will be made available. We believe the formal DfT funding commitment will be confirmed imminently and at that stage the recommendation can be reported as implemented.

29. If the funding is not forthcoming, it is unlikely that the LRSSB could be established as envisaged.

30. The primary functions of the LRSSB:

- Industry risk model informing industry decisions and sharing best practice (see recommendation 2).

The LRSSB will develop and implement an industry-wide risk model for adoption by all relevant Light Rapid Transit systems in the British Isles

- Development of standards and guidance

The LRSSB will be the custodian for Light Rail standards and guidance for the UK. This will include standards for operations, engineering, highways interface, management, environment quality and health & safety

- Interface with International bodies

LRSSB will develop and oversee mutually beneficial relationships with relevant international bodies

- Light Rail innovation and research

LRSSB will initiate and commission research with potential commercial benefit in the wider industry field. LRSSB will also monitor relevant international research programmes to ensure the benefit of any lessons learned. Human factors research and spread of best practice will be a high priority.

- Interface with Government bodies

LRSSB will develop and oversee mutually beneficial relationships with relevant government departments and governmental bodies, to include as a minimum DfT, ORR, BEIR and the DWP

- Safety accident and near miss reporting, collation and analysis

LRSSB will develop a standardised safety reporting system, to be applicable to all tramways and light railways, to provide national oversight and understanding.

- Reviewing dissemination of industry information and lessons learned

This will include encouraging and facilitating peer review between systems with shared and agreed outcomes to the benefit of all members.

- Training and competence assessment

LRSSB will oversee the development of training packages in relation to safety and standards with an initial emphasis on Independent Competent Person (ICP) accreditation and the spread of best practice in training methods.

LRSSB will formalise the certification of Independent Competent Persons within the Light Rail sector, with a training syllabus and accreditation/certification granted via competency-based assessment and monitoring.

31. LRSSB will also oversee the development of a suite of competency frameworks for all grades of operational staff, with emphasis on drivers, control staff and maintenance staff as a minimum, but with potential for development for other grades.

32. We consider the plan for the LRSSB, set out by UKTram in the list of primary functions, capable of achieving effective implementation of Recommendation 1. LRSSB asked that ORR conduct a review of progress and output of the LRSSB after it has been in operation for two years, and thereafter periodically at an interval to be determined. The purpose of the review is to establish whether the LRSSB is successfully carrying out those functions and meeting the requirements of the recommendation. This will be similar to the review ORR conducts of RSSB every five years.

33. We are encouraged by the progress made by the steering group, with the support of the tram industry, in establishing the LRSSB. We see the collaborative approach fostered through this group as the best means to deliver the improvements required across the industry. As mentioned above, we would expect that the status of the recommendation could be moved to 'implemented', as soon as DfT confirms funding.

34. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, ORR in cooperation with UK tram owners, operators and infrastructure managers; DfT and UKTram has:

- taken the recommendation into consideration; and
- is working on the establishment of the LRSSB, which will be complete once DfT have confirmed the necessary funding

Status: Implementation on-going. ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

35. See Annex B paras 1 to 21 for response from individual duty holders.

Recommendation 2

The intent of the recommendation is to better understand all safety risk associated with tramway operation and then provide updated guidance for the design and operation of tramways (this could be achieved by issuing an updated version of the 'Guidance on tramways' with expanded coverage of operational matters). Particular attention will be required to recognise risks from low frequency / high consequence

events which may not be apparent from precursor incidents on existing UK tramways. Identifying such events is likely to require input from specialists outside the UK tram community, including specialists with knowledge of main line rail and bus environments. Consideration of main line rail and bus issues is intended to inform evaluation of tramway risks; it does not imply that all heavy rail and bus requirements should be applied to tramways.

UK tram operators, owners and infrastructure managers should jointly conduct a systematic review of operational risks and control measures associated with the design, maintenance and operation of tramways. The review should include:

- i. examination of the differing risk profiles of on-street, segregated and off-street running;
- ii. safety issues associated with driving at relatively high speeds in accordance with the line-of-sight principle in segregated and off-street areas, particularly during darkness and when visibility is poor;
- iii. current practice world-wide and the potential of recent technological advances to help manage residual risk;
- iv. safety learning from bus and train sectors that may be applicable to the design and operation of tramways;
- v. consideration of the factors that affect driver attention and alertness across all tram driving scenarios in comparison to driving buses and trains; and
- vi. guidance on timescales for implementing new control measures (eg whether retrospective or only for new equipment).

Using the output of this review UK tram operators, owners and infrastructure managers should then, in consultation with ORR, publish updated guidance on ways of mitigating the risk associated with design, maintenance and operation of UK tramways.

ORR decision

36. In parallel to the establishment of the LRSSB, UK Tram has been leading the industry work to develop and scope a risk analysis model for the tram industry.

37. Atkins Rail have been appointed to develop the model. UKTram selected the model after a review of a number of existing systems, deciding the quantitative risk model used by West Midland Metro fully met the requirements of the RAIB recommendation. The model used by West Midlands Metro was initially developed by Atkins, being a subset of a model used by RSSB for mainline railways. The model has been verified over a period of 12 months and been used for the risk analysis of the West Midland Metro extension to Birmingham New Street.

38. The sector has also agreed on the arrangements to gather the required incident and accident data that the model will use to calculate and track the risk profile. These arrangements are in use by one operator, and roll out preparations are commencing in the remaining six operations.

39. Having identified the most suitable model to assist the industry in understanding its risk profile (phase 1), phase 2 of the project involves developing,

testing and monitoring the model on one system and then rolling out to other systems nationally. Manchester will pilot the model and will include interface with the tram incident reporting database (TAIR). The pilot will begin in March 2019 and if successful, will be implemented across all systems by autumn 2019.

40. The ORR and sector view is that the successful development of an industry risk model is a key enabler for tram owners and operators to make properly informed risk based decisions on how recommendations 3 to 8 should best be discharged. The completion of the risk model will be one of the first tasks of the LRSSB.

41. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, UK tram owners, operators and infrastructure managers have:

- taken the recommendation into consideration; and
- has a plan in place to run a pilot, with full industry adoption expected by Autumn 2019

Status: Implementation on-going. ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

42. See Annex B para 22 to 42 for response from individual duty holders.

Recommendation 3

The intent of this recommendation is to prevent serious accidents due to excessive speed at higher risk locations on tramways. These locations are likely to include all locations where a substantial speed reduction is required for trams approaching at relatively high speed. Implementation of this recommendation may be assisted by work in this area already underway by Croydon tramway organisations.

UK tram operators, owners and infrastructure managers should work together to review, develop, and provide a programme for installing suitable measures to automatically reduce tram speeds if they approach higher risk locations at speeds which could result in derailment or overturning

ORR decision

43. UK Tram have appointed Ian Rowe Associates Ltd (IRAL) to research, identify, and evaluate systems capable of automatically reducing the speed of a tram at high risk locations. IRAL are also carrying out research on behalf of UKTram into driver vigilance devices (recommendation 4). This work analyses the potential impacts, benefits, drawbacks and human factor considerations for each system. The work also considers the practicality, capability and readiness of the various identified solutions. IRAL has provided to UKTram a preliminary report summarising their

conclusions and recommended systems for automatic braking and vigilance devices. They will provide a final report in early December 2018.

44. We are encouraged that the tram industry is working together to address this recommendation and has sought independent expert advice to review what is cutting edge technology that is pushing the boundaries of what is available and already on the market.

45. IRAL initially reviewed 78 possible speed control systems, with 12 systems chosen for further review, testing and manufacturer demonstration.

46. In parallel to the IRAL research, individual tram operators have also undertaken their own reviews of systems that can automatically reduce the speed of a tram if they are approaching a high-risk location too quickly.

47. The action taken by each duty holder and the ORR view on if it addresses the recommendation is summarized in the table below.

End implementer	Summary of response	Status
Tram Operations Ltd	<p>TOL supported LT's work to introduce step-down speeds on the approach to the areas of the tramway where there is a need to reduce the speed by greater than 30kpmh between the higher and lower speed limits.</p> <p>TOL also supported LT's work to increase the visibility of speed signs, add chevron signs at sharp curves and install digital signage at high risk locations to inform drivers if they are speeding.</p> <p>TOL has played an active role supporting the LT research into an automatic speed reduction system.</p>	<p>TOL are supporting the LT project to fit the Croydon tram fleet with a system that can automatically reduce tram speeds. The project is planning to be completed by December 2019.</p> <p>Status: Implementation on-going</p>
London Trams	<p>LT is in the process of researching and procuring an automatic speed reduction system. The outcome of the research has been shared with other tram owners and operators and UK Tram.</p> <p>LT are planning to have selected a system by December 2018, with full fleet roll out and implementation planned by December 2019. TOL has been working closely with LT on this initiative.</p>	<p>LT have started a project to fit the Croydon tram fleet with a system that can automatically reduce tram speeds. The project is planning to be completed by December 2019.</p>

	LT are also supporting UK Tram research into automatic braking systems.	Status: Implementation on-going
Transport for West Midlands	TfWM is working with their existing vehicle supplier (CAF) and other UK operators of the tram type to explore the development of a system to automatically limit /reduce the speed of trams at high risk locations using Balogh tags and a PLC interfacing with the trams Traction Control Unit, HMI, Speedometer and event recorder.	TfWM are considering options to address this recommendation, based on their own research and the output from the UKTram research when completed. Status: Progressing.
West Midlands Metro	NX Metro (who operated the West Midlands Metro until 24 June 2018) introduced step down signage and removed any decrease in speed greater than 30 Kph (see rec 5). A decision on what action to take in response to this recommendation will be informed by the outcome of the industry risk model work (rec 2).	WMM are considering options to address this recommendation, based on their own research and the output from the UKTram research when completed. Status: Progressing.
Blackpool Borough Council	Blackpool Transport Services, together with Blackpool Borough Council's tram promoter is conducting a trial of a Bombardier system which will initially be used for obstacle detection on moving trams, and may in future be able to be used for controlling tram overspeeding	Blackpool Borough Council are considering options to address this recommendation, based on their own research and the output from the UKTram research when completed. Status: Progressing.
Blackpool Transport Services	Blackpool Transport Services is participating in a trial of a Bombardier system which will initially be used for obstacle detection on moving trams, and may in future be able to be used for controlling tram overspeeding.	BTS are considering options to address this recommendation, based on their own research and the output from the

		UKTram research when completed. Status: Progressing.
City of Edinburgh Council	City of Edinburgh Council and Edinburgh Trams are supporting the UKTram research and are awaiting the publication of the report in November 2018. Edinburgh Trams are also discussing possible solutions with their vehicle supplier.	City of Edinburgh Council are supporting Edinburgh Trams work to consider options to address this recommendation, based on their own research and the output from the UKTram research, when completed. Status: Progressing.
Edinburgh Tram	City of Edinburgh Council and Edinburgh Trams are supporting the UKTram research and are awaiting the publication of the report in December 2018. Edinburgh Trams are also discussing possible solutions with their vehicle supplier.	Edinburgh Tram are considering options to address this recommendation, based on their own research and the output from the UKTram research, when completed. Status: Progressing.
Transport for Greater Manchester	A decision on what action to take in response to this recommendation will be informed by the outcome of the industry risk model work (rec 2). TfGM has discussed with a supplier potentially fitting a speed warning or advisory system, which could potentially be linked to the tram braking systems. TfGM are in the process of procuring a new fleet of trams and are discussing with suppliers a system that would augment	TfGM are considering options to address this recommendation, based on their own research and the output from the UKTram research, when completed. Status: Progressing.

	video obstacle detection, which is currently being trialled in Europe.	
Manchester Metrolink	A decision on what action to take in response to this recommendation will be informed by the outcome of the industry risk model work (rec 2) and the TfGM research into a technical solution that could automatically apply the brakes on a tram.	KAM will consider options to address this recommendation informed by the output from the UKTram research when completed. Status: Progressing.
Nottingham Council/ Tramlink Nottingham Ltd	A decision on what action to take in response to this recommendation will be based on the outcome of the UK Tram research into systems that can automatically reduce the speed of a tram and the outcome of the industry risk model work (rec 2).	Nottingham Council/TNL will consider options to address this recommendation informed by the output from the UKTram research when completed. Status: Progressing.
Nottingham Trams	A decision on what action to take in response to this recommendation will be based on the outcome of the UK Tram research into systems that can automatically reduce the speed of a tram and the outcome of the industry risk model work (rec 2).	NTL will consider options to address this recommendation informed by the output from the UKTram research when completed. Status: Progressing.
South Yorkshire PTE	SYPTe is supporting SYSL work in approaching potential suppliers that may form part of a response to recommendations 3 and 4. SYPTe are awaiting the outcome of the work associated with recommendation 2 before taking a decision on further control measures associated with recommendations 3, 4, 6, 7 and 8.	SYPTe/SYSL are considering options to address this recommendation, based on their own research and the output from the UKTram research when completed. Status: Progressing.

South Yorkshire Supertram Ltd	<p>TPWS is fitted to new tram-train vehicles that will operate on the mainline. However this technology will not be active on existing tramway infrastructure.</p> <p>SYSL have held initial discussion regarding the practicalities of installing TPWS with Thales.</p>	<p>SYPTTE/SYSL are considering options to address this recommendation, based on their own research and the output from the UKTram research when completed.</p> <p>Status: Progressing.</p>
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Information in support of ORR decision

48. See Annex B paras 43 to 63 for end implementer responses.

Recommendation 4

The intent of this recommendation is to reduce the likelihood of serious accidents due to tram drivers becoming inattentive because of fatigue or other effects. Existing tram systems relying on drivers applying forces to driving controls (driver safety devices) do not necessarily detect an inattentive driver. Implementation of this recommendation may be assisted by work in this area already underway by Croydon tramway organisations.

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.

If found to be effective, a time-bound plan should be developed for such devices to be introduced onto UK tramway.

ORR decision

49. UK Tram have appointed Ian Rowe Associates Ltd (IRAL) to review and evaluate systems capable of reliably detecting driver attention state and initiating appropriate automatic responses if a low level of alertness is identified.

50. As with recommendation 3, we are encouraged by the cross industry approach and use of independent, expert advice to address this recommendation.

51. IRAL used Transport Research Laboratory (TRL) research for TfL as a starting point, which had identified 31 suitable technologies. Information on 29

systems was supplied to IRAL, from which 7 systems have been identified to be demonstrated and trialled in more detail.

52. The initial long list of 29 systems were assessed against the following criteria:

- How is the driver alerted when they become inattentive? (e.g. Audio or visual alert, voice alert, seat vibration)
- Does the system record data for playback/review?
- If so, is the data available in real time (i.e. on demand vs end of service download)?
- Does the system notify a local control centre in real time?
- Does the system intervene and apply the brakes where necessary?
- Which industries is the system currently used in?
- Has the system been used in the Tram/Light Rail industry?

53. The working group will produce a report (in conjunction with the speed control systems report) for December 2018 recommending appropriate systems. The report will analyse the potential impacts, benefits and drawbacks of each system.

54. Three tram systems – Blackpool, Edinburgh, and West Midlands already have fleets (or proportion of fleet dependent on age) fitted with and using a driver vigilance device; on completion of the IRAL work an assessment will be made to establish if they meet the specified criteria, and scale of any gap.

55. As with recommendation 3, individual tram operators are doing their own research into systems that can detect driver inattention. The action taken by each duty holder and the ORR view on if it addresses the recommendation is summarized in the table below.

End Implementer	Summary of response	Status
Tram Operations Ltd	<p>LT/TOL have installed the Guardian system on the Croydon tram fleet.</p> <p>The system monitors eye and face movements to detect the onset of fatigue or distraction and then alerts the driver, either with a vibration motor or an alarm. Alarm events are relayed to TOL's control centre. The work was completed in October 2017.</p> <p>LT/TOL have demonstrated the system and shared their experience a number of tram owners and operators and also supported the UK Tram research.</p>	<p>ORR recognises the safety benefits of the Guardian system in the context of this recommendation. ORR notes that Guardian is a system designed to detect driver inattentiveness and provide an alert, but does not apply the brakes, as suggested as an option in the recommendation. ORR also notes that research work being</p>

		<p>undertaken on behalf of UK Tram is exploring what an appropriate automatic response is if a low level of driver attentiveness is detected, such as application of vehicle brakes. ORR will await the outcome of the industry's research work that is coming to a conclusion before considering if the Guardian system fully implements recommendation 4.</p> <p>Status: Implementation on-going.</p>
London Trams	<p>LT/TOL installed the Guardian system on the Croydon tram fleet, which was completed in October 2017.</p> <p>The system monitors eye and face movements to detect the onset of fatigue or distraction and then alerts the driver, either with a vibration motor or an alarm. Alarm events are relayed to TOL's control centre, via the Guardian Safeguard centre.</p> <p>LT/TOL have demonstrated the system and shared their experience with the tram industry and fed into the UK Tram research.</p>	<p>ORR recognises the safety benefits of the Guardian system, but is awaiting the outcome of industry research before deciding if the London Trams have implemented the recommendation.</p> <p>Status: Implementation on-going.</p>
Transport for West Midlands	<p>The trams used on the West Midlands network have a Driver Vigilance Device (DVD) which will automatically apply the tram brakes if a driver fails to respond to a warning within a set time period. The system is set to fail safe by applying the</p>	<p>TfWM/WMM are reviewing the operation of their existing DVD system and awaiting the outcome of the UKTram research.</p>

	<p>emergency brakes in the event of a DVD system failure.</p> <p>Currently the DVD is set to test for driver attention every 30s, with brakes being applied if the driver fails to respond by movement of the thumb on the Traction Brake Controller (TBC) within 4s of the alert.</p> <p>ORR has asked West Midlands Metro to consider reducing the alert interval to 15s and this request is under consideration noting that human factors impacts of a higher frequency of alert.</p> <p>TfWM are monitoring the work being done by UK Tram to review Driver Vigilance Devices and how this may impact on their own work.</p>	<p>Status: Progressing.</p>
West Midlands Metro	<p>WMM are working with TfWM to consider whether to reduce the frequency of the DVD fitted to their tram fleet from 30s to 15s. An assessment has been completed which included driver behaviour and workload monitoring and a report is currently awaited.</p>	<p>TfWM/WMM are reviewing the operation of their existing DVD system and awaiting the outcome of the UKTram research.</p> <p>Status: Progressing.</p>
Blackpool Borough Council	<p>Blackpool Borough Council will appraise the outcome of the UK Tram research before making a decision whether to replace or supplement their current vigilance system</p>	<p>Blackpool Borough Council/BTS are awaiting the outcome of the UKTram research before taking action to address the recommendation.</p> <p>Status: Progressing.</p>
Blackpool Transport Services	<p>BTS will appraise the outcome of the UK Tram research before making a decision whether to replace or supplement their current vigilance system</p>	<p>Blackpool Borough Council/BTS are awaiting the outcome of the UKTram research before taking action to</p>

		address the recommendation. Status: Progressing.
City of Edinburgh Council	City of Edinburgh Council are supporting the Edinburgh Trams position on recommendation 4.	City of Edinburgh Council support the Edinburgh Tram position. Status: Progressing.
Edinburgh Tram	ET are reviewing potential solutions and proposals in relation to this recommendation from their vehicle supplier. The outcome of this review will be considered in conjunction with the outputs of the UKTram research.	Edinburgh Trams are reviewing options with their vehicle supplier and awaiting the outcome of the UKTram research. Status: Progressing.
Transport for Greater Manchester	TfGM intend to work with KAM to consider the options for a driver vigilance device once the UKTram research is complete. TfGM and KAM attended a workshop with TfL to review devices for detecting inattention. TfGM is exploring options to improve the existing “deadman” system by moving to a vigilance based system, similar to heavy rail rolling stock.	TfGM/KAM are awaiting the outcome of the UKTram research before taking action to address the recommendation. Status: Progressing.
Manchester Metrolink	KAM are awaiting the completion of the UKTram research into speed control and vigilance devices, as well as the development of the industry risk model (rec 2).	TfGM/KAM are awaiting the outcome of the UKTram research before taking action to address the recommendation. Status: Progressing.
Nottingham Council/ Tramlink	Nottingham Council/TNL/NTL will make a decision whether to continue with the existing driver safety device or replace it, based on the output from the UKTram	Nottingham Council/TNL/NTL are awaiting the outcome of the UKTram research before

Nottingham Ltd	research and the industry-wide risk model (rec 2).	taking action to address the recommendation. Status: Progressing.
Nottingham Trams	Nottingham Council/TNL/NTL will make a decision whether to continue with the existing driver safety device or replace it, based on the output from the UKTram research and the industry-wide risk model (rec 2).	Nottingham Council/TNL/NTL are awaiting the outcome of the UKTram research before taking action to address the recommendation. Status: Progressing.
South Yorkshire PTE	SYLTE are awaiting the outcome of the UKTram research and will make a decision on fitment of driver vigilance device in collaboration with SYSL.	SYLTE are awaiting the outcome of the UKTram research before taking action to address the recommendation. Status: Progressing.
South Yorkshire Supertram Ltd	Of the two tram fleets operated by SYSL, the Citylink (including tram train) fleet has a vigilance device fitted, which is designed to apply service brakes in the event of driver inattentiveness.	SYSL are awaiting the outcome of the UKTram research before considering if action needs to be taken to address the recommendation. For the Citylink fleet the recommendation has been implemented. Status: Progressing.

Information in support of ORR decision

56. See Annex B paras 64 to 84 for end implementer responses.

Recommendation 5

The recommendation is intended to provide tram drivers operating on line-of-sight with signage giving visual information cues comparable to those for bus drivers. This recommendation builds on the RAIB's Urgent Safety Advice issued in November 2016 and recognises that driving a tram on line-of-sight has considerable similarities with driving a bus on a public road.

UK tram operators, owners and infrastructure managers, in consultation with the DfT, should work together to review signage, lighting and other visual information cues available on segregated and off-track areas based on an understanding of the information required by drivers on the approach to high risk locations such as tight curves. Comparison should be made with the cues provided to road vehicle drivers on highways that are designed in accordance with current UK highway standards. Prior to the installation of suitable measures to automatically reduce tram speeds at higher risk locations (Recommendation 3) consideration should also be given to providing in-cab warnings to tram drivers on the approach to high risk locations.

The findings of this review should then be used by UK tram operators and tramway owners to improve the information and/or warnings provided to drivers at high risk locations in segregated and off-track areas

ORR decision

57. Following the Sandilands accident, RAIB issued Urgent Safety Advice (USA) on 15 November 2016 to London Trams/TOL to take action to reduce the speed of trams approaching Sandilands Junction from New Addington, where the accident occurred.

58. In response to the USA, all tram operators carried out their own assessment of signage provision at higher-risk locations, such as tight curves. Changes to signage, including the provision of new signage have been made on all networks based on the output from route risk assessments.

59. UK Tram subcommittee 1 is reviewing existing signage requirements for tram operators in the UK and may make further recommendations. If changes to signage for tramways are identified, UKTram will lead the engagement with DfT on behalf of the tram industry regarding possible legislative changes.

60. We are satisfied with the action taken by individual network owners, operators and infrastructure managers in response to the USA and subsequent recommendation. We are also encouraged by UKTram taking the industry lead on any legislative changes to signage with DfT. The status of the recommendation for all relevant network owners, operators and infrastructure managers is 'implementation on-going', subject to any legislative changes being identified and actioned.

61. The action taken by each duty holder and the ORR view on if it addresses the recommendation is summarized in the table below.

End implementer	Summary of response	Status

Tram Operations Ltd	TfL are implementing the iTram system to provide in-cab over speed alerts. Following a successful pilot study TfL have started fitment of the system across the Croydon fleet to be completed by December 2019.	London Trams/TOL have identified an in-cab system to alert the driver to over speeding and have a time-bound plan for fleet fitment by December 2019. Status: Implementation on-going.
London Trams	<p>Following Sandilands, LT installed additional step down speed signage in place in all locations where speeds reduced by 30kph.</p> <p>Maximum speed on the network was reduced from 80kph to 70kph.</p> <p>Where speed signs are located immediately in advance of locations such as tram stops or a marked curve, the sign has been enhanced with the addition of a high visibility outer boarder as an additional cue to drivers of an approaching hazard. Chevrons have been added at sharp curves and installed digital signage at high risk locations to inform drivers if they are speeding.</p> <p>LT/TOL have carried out a route hazard analysis which concluded that the additional speed signage and visual cuing is sufficient.</p> <p>Following the Sandilands incident, additional temporary lighting was installed on the approach to the Sandilands tunnel, while TfL road tunnel lighting experts develop a permanent solution. Work is expected to be complete on the improved tunnel lighting in early 2019.</p> <p>London Trams/TOL are working together to install the iTram system by December 2019</p>	London Trams/TOL have identified an in-cab system for alert the driver to over speeding and have a time-bound plan for fleet fitment by December 2019. Status: Implementation on-going.

<p>Transport for West Midlands</p>	<p>TfWM and NX Metro had installed step down speed restriction at all locations with a speed reduction of 30km/h or greater.</p> <p>TfWM will consider the output from the UKTram subcommittee 1 and the results of active signage trials before making any further changes.</p>	<p>TfWM/WMM have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before making further changes.</p> <p>Status: Implementation on-going.</p>
<p>West Midlands Metro</p>	<p>WMM reviewed existing signage provision following publication of the report. A further review of signage is underway and any further recommended changes will be considered in light of this and the results of the active signage trails.</p>	<p>TfWM/WMM have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>
<p>Blackpool Borough Council</p>	<p>In response to the USA, one sign was moved. Having reviewed all speed limits, signs and high risk areas BCC/BTS concluded that no additional signage was required.</p> <p>Consultation with DfT was not considered necessary as signs on the Blackpool network comply with the applicable guidelines in TSRGD issued by OfT as well as RSP2 /(TGN3) and the ORR Technical Guidance 4. However, changes to signage may be made in future if necessary.</p>	<p>Blackpool Borough Council/BTS have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>

Blackpool Transport Services	In addition to the collaboration with Blackpool Borough Council, BTS are monitoring the London Tram's trial of illuminated warning signs.	<p>Blackpool Borough Council/BTS have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>
City of Edinburgh Council	City of Edinburgh Council are supporting the Edinburgh Trams position on recommendation 5.	<p>Edinburgh Tram have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>
Edinburgh Trams	<p>Edinburgh Trams has reviewed the signage and visual cues at three locations where trams brake from 70kph to less than 30kph. Revised signage was installed at one of the locations.</p> <p>Edinburgh Trams are introducing the SmartDrive system. The system uses route modelling analysis to identify optimum movement sequences - such as where the driver should coast and brake, or be travelling at an optimum speed - that is passed on to driver teams through bespoke training.</p>	<p>Edinburgh Tram have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>ORR consider the SmartDrive system to be for energy</p>

	<p>Edinburgh Trams support the work currently being undertaken by Subcommittee 1 and will act on any recommendations accordingly. Edinburgh Trams are considering appropriate locations for chevrons but do not consider that active speed signs are required.</p>	<p>efficiency and passenger comfort rather than to provide a safety warning.</p> <p>Status: Implementation on-going.</p>
<p>Transport for Greater Manchester</p>	<p>TfGM supported the KAM review (see below or move) of speed limits and signage and the actions taken as a result.</p> <p>In-cab warnings are being considered as part of discussions with a supplier which will also be relevant to addressing recommendation 3.</p>	<p>TfGM/KAM have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>
<p>Manchester Metrolink</p>	<p>KAM identified four locations to install drop-down speed signage.</p> <p>KAM has also introduced a new role of Driver Analyst, to audit driving behaviours, including the identification of any over speeding events with trends monitored through the monthly franchise report, provided to both the KAM and TfGM Senior Management Teams.</p>	<p>TfGM/KAM have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>
<p>Nottingham Council/ Tramlink Nottingham Ltd</p>	<p>On the Nottingham network NET, drop down speed markers have been installed at three locations.</p> <p>Further to this, NTL also undertake random speed checks, using radar guns, and review on-vehicle speed monitoring reports</p>	<p>Nottingham Council/TNL/NTL have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram</p>

	to assess signed speed compliance by drivers.	research and active signage trials before considering if any further changes are needed. Status: Implementation on-going.
Nottingham Trams	On the Nottingham network NET, drop down speed markers have been installed at three locations. NTL also undertake random speed checks using radar guns, downloads from OTMR and analysis of driving behaviours, with priority given to over speeding events.	Nottingham Council/TNL/NTL have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed. Status: Implementation on-going.
South Yorkshire PTE	SYPTTE have supported the SYSL work installing new signage at locations identified in their review.	SYSL/SYPTTE have made changes to signage provision in response to the USA and are awaiting the outcome of the UKTram research and active signage trials before considering if any further changes are needed. Status: Implementation on-going.
South Yorkshire Supertram Ltd	SYSL made no changes to speed limits on curves following their review, but the position of a speed reduction sign was moved.	SYSL/SYPTTE have made changes to signage provision in response to the USA and are awaiting the outcome of the

	<p>A Route Risk Assessment identified further opportunities to reposition speed limit signs to allow more reaction time prior to higher risk locations such as curves, pedestrian crossings and tramstops. A curve that would benefit from the placement of chevrons visible on approach has also been identified.</p> <p>The review also identified some new risk areas where driver's line of sight has been affected by third parties (for example neighbouring fencing reducing sight lines at a road crossing), the risk assessment is being updated and the information will be fed through to drivers through training (including refresher) and assessment.</p>	<p>UKTram research and active signage trials before considering if any further changes are needed.</p> <p>Status: Implementation on-going.</p>
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Information in support of ORR decision

62. See Annex B paras 85 to 105 for end implementer responses.

Recommendation 6

The intent of this recommendation is to reduce the likelihood of people being seriously injured or killed by being ejected through tram doors and windows (i.e. to provide better containment). Although it is not expected that ejection can always be prevented in case of overturning, the improvement of containment will deliver improved safety in a range of different scenarios such as collision with road vehicles. Any improvement to containment is dependent on the ability of passengers to easily open doors in an emergency. It is expected that implementation will build on similar research already undertaken by RSSB in respect of railway carriage windows.

UK tram operators and owners should, in consultation with appropriate tram manufacturers and other European tramways, review existing research and, if necessary, undertake further research to identify means of improving the passenger containment provided by tram windows and doors. The findings should then be used to:

- i. provide a time-bound plan to modify doors and windows on existing trams when practical to do so (e.g. during planned refurbishment);
- ii. promote changes to the specifications and standards governing the doors and windows of new trams; and
- iii. inform the Department for Transport of the findings to allow implementation of the safety advice at paragraph 492.

ORR decision

63. This recommendation focuses on investigating means of improving containment and use such findings to improve containment during activity such as refurbishment and procurement of new trams. The sector has commenced this work, and TfL, on behalf of the sector is additionally researching to identify if there are reasonably practicable solutions to address this recommendation for existing tram fleets. TfGM are in the process of procuring a new tram fleet and is considering this recommendation in that context.

64. TfL is carrying out research into different glazing options to understand the implications of stronger glazing or additional film protection. The results will be shared with industry through UKTram subcommittee 1. Depending on the outcome of the TfL glazing tests any engagement with relevant standards bodies (CEN/BSI) will be led by UKTram. The need for containment in the event of overturning needs to be balanced by the need for means of rapid escape in other eventualities, such as fire or collision.

65. Four options were initially considered:

- Option 1 – Internal strengthening film, applied to the existing tempered side glazing.
- Option 2 – Internal and external strengthening film, applied to the existing tempered side glazing.
- Option 3 – Internal edge retained strengthening film, applied to the existing tempered side glazing.
- Option 4 – Laminate glazing in various configurations.

66. Ejection of passengers through tram doors, as occurred at Sandilands, is considered less likely on modern trams as they are fitted with doors of a fully welded construction, with greater structural integrity than the bolted construction doors that failed in the Sandilands accident. Most UK tramway systems have more modern vehicles with better designed doors which will aid containment compared to older models, such as the one involved in the Sandilands accident.

67. The action taken by each duty holder and the ORR view on if it addresses the recommendation is summarized in the table below.

End implementer	Summary of response	Status
Transport for London	<p>TfL are assessing a number of glazing options which they plan to complete by October 2018. When a preferred option has been identified, the findings will be shared with UK Tram and a programme developed for fleet fitment.</p> <p>The evaluation includes assessing of any impact on passenger emergency egress. The outcome of the evaluation will be</p>	<p>TfL are carrying out research into possible glazing options for the Croydon tram fleet</p> <p>Status: Progressing.</p>

	shared with UKTram to inform their work under RAIB Recommendation 8.	
Tram Operations Ltd	TOL are awaiting the outcome of the TfL research and a decision on whether any changes will be made to the glazing in the Croydon tram fleet.	TOL are supporting the TfL research and a decision on whether any changes will be made to the glazing in the Croydon tram fleet. Status: Progressing.
Transport for West Midlands	TfWM are awaiting the publication of industry guidance and standards on glazing/containment (informed by the TfL research) before committing to any changes. The manufacture of trams used on the West Midlands network thinks it may be possible to equip the fleet with laminated glass and is also exploring the possibility of fitting an external film to existing windows.	TfWM/WMM are awaiting the outcome of the TfL research and industry risk assessment before making any changes to glazing in their trams Status: Progressing.
West Midlands Metro	WMM are awaiting the outcome of industry risk assessment and research before considering any changes to existing fleets or new ones.	TfWM/WMM are awaiting the outcome of the TfL research before making any changes to glazing in their trams Status: Progressing.
Blackpool Borough Council	Blackpool Borough Council is awaiting the outcome of TfL research into tramcar glazing before considering any changes to the glazing on their tram fleet.	Blackpool Borough Council/BTS are awaiting the outcome of the TfL research before making any changes to glazing in their trams Status: Progressing.
Blackpool Transport Services	BTS is awaiting the outcome of TfL research into tramcar glazing and how it feeds into UKTram subcommittee 1.	Blackpool Borough Council/BTS are awaiting the outcome of the TfL research

		<p>before making any changes to glazing in their trams</p> <p>Status: Progressing.</p>
City of Edinburgh Council	City of Edinburgh Council are supporting the Edinburgh Trams position on recommendation 6.	<p>City of Edinburgh Council/Edinburgh Tram are awaiting the outcome of the TfL research before making any changes to glazing in their trams</p> <p>Status: Progressing.</p>
Edinburgh Tram	Edinburgh Trams are awaiting the outcome of the TfL research before taking action to address this recommendation. ET have held discussions with their vehicle supplier/maintainer which will be considered in conjunction with the outputs of the UKTram Subcommittee work.	<p>City of Edinburgh Council/Edinburgh Tram are awaiting the outcome of the TfL research before making any changes to glazing in their trams</p> <p>Status: Progressing.</p>
Transport for Greater Manchester	TfGM are awaiting the outcome of the TfL research before taking action to address this recommendation. TfGM have held discussions with their vehicle supplier which will be considered in conjunction with the outputs of the UKTram Subcommittee work.	<p>TfGM/KAM are awaiting the outcome of the TfL research before making any changes to glazing in their trams</p> <p>Status: Progressing.</p>
Manchester Metrolink	<p>KAM will review the outputs of the research into glazing by TfL and Subcommittee 1, and consider that it would be difficult to retrospectively replace glazed panels on the existing fleet.</p> <p>KAM will support TfGM procurement of new trams for the Metrolink system and will review the output of the TfL led glazing</p>	<p>TfGM/KAM are awaiting the outcome of the TfL research before making any changes to glazing in their trams</p> <p>Status: Progressing.</p>

	tests and assess, at the design stage, the impact of a revised standard for glazing.	
Nottingham Council/ Tramlink Nottingham Ltd	Nottingham Council are awaiting the outcome of the TfL research before taking action to address this recommendation.	Nottingham Council/TNL/NTL are awaiting the outcome of the TfL research before making any changes to glazing in their trams Status: Progressing.
Nottingham Trams	NTL are awaiting the outcome of the TfL research before taking action to address this recommendation. NTL note it may be difficult to retrospectively replace glazed panels on the existing fleet and may more easily be addressed through the design of new tram fleets by the manufacturers.	Nottingham Council/TNL/NTL are awaiting the outcome of the TfL research before making any changes to glazing in their trams Status: Progressing.
South Yorkshire PTE	SYLTE are awaiting the outcome of the TfL research before taking action to address this recommendation	SYLTE/SYSL are awaiting the outcome of the TfL research before making any changes to glazing in their trams Status: Progressing.
South Yorkshire Supertram Ltd	The Citylink (including tram-train) fleet is fully compliant with mainline rail standards for doors and windows in regards to containment. The older Siemens fleet is compliant with Highway standards and any changes to the glazing may not be reasonably practicable. The asset owner SYLTE will be able to specify a suitable window and door standard (as has been done with Citylink) in the new fleet specification, which is likely to be issued within the next five years.	SYLTE/SYSL are awaiting the outcome of the TfL research before making any changes to glazing in their trams Status: Progressing.

Information in support of ORR decision

68. See Annex B paras 106 to 126 for end implementer responses.

Recommendation 7

The intent of this recommendation is to provide emergency lighting which will operate without connection to remote power supplies such as the tram's main batteries and the overhead electrical supply. Implementation may involve tram operators seeking input from appropriate tram manufacturers.

UK tram operators and owners should install (or modify existing) emergency lighting so that the lighting cannot be unintentionally switched off or disconnected during an emergency

ORR decision

69. All operators have reviewed their emergency lighting arrangements. Suppliers were able to offer a cut-off switch which is covered and not exposed in the event of an impact. Most suppliers could also offer internal lighting with integral energy storage within the lighting units, although some were concerned that railway approved units may not be available. UKTram is working on developing best practice guidance for emergency lighting.

70. The action taken by each duty holder and the ORR view on if it addresses the recommendation is summarized in the table below.

End Implementer	Summary of response	Status
Tram Operations Ltd	LT are leading a project to investigate options to replace the emergency lighting in the existing tram fleet, with operational and driver input from TOL as required. LT and TOL have developed a scope of requirements and an invitation to tender has been issued.	TOL/LT have a developed a programme for upgrading the emergency lighting on the Croydon fleet, but have not yet finalised a time-bound plan for completion of the work Status: Progressing.
London Trams	LT and TOL have developed a scope of requirements for retrofitting emergency lighting and an invitation to tender has been issued. The system will be fully autonomous, and will operate independently of the trams battery system	TOL/LT have a developed a programme for upgrading the emergency lighting on the Croydon fleet,

	in the event of an emergency. Findings will be shared with industry through UKTram subcommittee 1.	but have not yet finalised a time-bound plan for completion of the work Status: Progressing.
Transport for West Midlands	The manufacture of trams used on the West Midlands network have confirmed that it would be possible to implement a system of emergency lighting which is independent of the main battery on the tram. TfWM are awaiting the development of the industry risk model (rec 2) before going further. Any changes will inform the specification for additional vehicles for Midland Metro in 2021.	TfWM/WMM are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet Status: Progressing.
West Midlands Metro	WMM are awaiting the outcome of industry risk assessment before considering any changes to existing fleets or new ones.	TfWM/WMM are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet Status: Progressing.
Blackpool Borough Council	Blackpool Borough Council are supporting the BTS consideration of the recommendation.	Blackpool Borough Council/BTS are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet Status: Progressing.
Blackpool Transport Services	BTS, after completion of Recommendation 2 will review its current emergency lighting with a view to make any modifications in the overhaul of the tram in year 2019/20.	Blackpool Borough Council/BTS are awaiting the output of the industry risk model before making any changes to the

		<p>emergency lighting on their tram fleet</p> <p>Status: Progressing.</p>
City of Edinburgh Council	City of Edinburgh Council are supporting the Edinburgh Trams position on recommendation 7.	<p>City of Edinburgh Council/Edinburgh Trams are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet</p> <p>Status: Progressing.</p>
Edinburgh Tram	<p>ET are awaiting the outcome of UKTram Subcommittee 1 before taking action to address this recommendation.</p> <p>ET have held discussions with their vehicle supplier/maintainer which will be considered in conjunction with the outputs of the UKTram Subcommittee work.</p>	<p>City of Edinburgh Council/Edinburgh Trams are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet</p> <p>Status: Progressing.</p>
Transport for Greater Manchester	TfGM is exploring possibilities to modify the emergency on board lighting with the tram suppliers.	<p>TfGM/KAM are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet</p> <p>Status: Progressing.</p>
Manchester Metrolink	<p>The emergency lighting on the existing KAM fleet will remain lit, with a full set of batteries for approximately 45 minutes.</p> <p>KAM will review the recommendation with their vehicle supplier, to determine if any</p>	<p>TfGM/KAM are awaiting the output of the industry risk model before making any changes to the emergency lighting on their tram fleet</p>

	modifications can be made to make them more robust.	Status: Progressing.
Nottingham Council/ Tramlink Nottingham Ltd	NCC/TNL, have been advised to review the current emergency lighting systems in place on their tram-fleets and to modify them to make them more robust if required.	NCC/TNL/NTL have not provided evidence that there emergency lighting will not be switched off or disconnected in the event of an emergency NCC/TNL are awaiting the operators review of the current lighting systems in place on the tram fleet Status: Progressing
Nottingham Trams	Both the Incentro and Citadis tram fleets used by NTL have emergency lights that will run with a full set of batteries for a minimum of 45 minutes. While the tram manufacturers will be contacted to confirm the specification that would be required to implement this recommendation, NTL consider that the change would only be accommodated on new tram fleets.	NCC/TNL/NTL have not provided evidence that there emergency lighting will not be switched off or disconnected in the event of an emergency NCC/TNL are awaiting the operators review of the current lighting systems in place on the tram fleet Status: Progressing
South Yorkshire PTE	SYPTe are supporting the SYSL position on recommendation 7 (see below).	SYPTe/SYSL are discussing options with their vehicle supplier regarding changes to the

		<p>emergency lighting on their tram fleet</p> <p>Status: Progressing.</p>
South Yorkshire Supertram Ltd	<p>Citylink tram manufacturer Stadler have highlighted design differences (between Croydon Tram 2551 and Citylink) that suggest that the emergency push button location and integration into the vehicle offers greater protection (from unintended depression) in the event of an overturning vehicle. The Citylink emergency push button is located within a steel box under a flap, rather than being located under the bogie skirt. At the time of writing, Stadler are also investigating the possibility of the emergency lighting being disabled because of damage to any other equipment or cabling on the roof.</p> <p>For Siemens vehicles the battery manufacturer is no longer in business and as such, Supertram will likely be reliant on the findings of other Tram owners and operators if a viable solution is found. It is again likely that the position could be for SYPTE to specify emergency lighting requirements that satisfy this recommendation in the new fleet specification.</p>	<p>SYPTE/SYSL are discussing options with their vehicle supplier regarding changes to the emergency lighting on their tram fleet</p> <p>Status: Progressing.</p>

Information in support of ORR decision

71. See Annex B paras 127 to 147 for end implementer responses.

Recommendation 8

The intent of this recommendation is to minimise the risk of people being trapped in an overturned tram where side windows and doors are either facing the ground or facing the sky. Solutions could include the use of removable windscreens at the ends of trams. Implementation may involve tram operators seeking input from appropriate tram manufacturers.

UK tram operators and owners should review options for enabling the rapid evacuation of a tram which is lying on its side after an accident. If the review

identifies practical measures which would provide significant benefit to trapped passengers, UK tram operators and owners should:

- i. implement these measures on existing trams if practical to do so in the short term; or
- ii. provide a time-bound plan to implement these measures on existing trams when practical to do so (e.g. during planned refurbishment).

Such measures should then be promoted for inclusion in the specifications and standards governing the new builds of trams.

ORR decision

72. The LRSSB will identify what is appropriate as an industry standard with regard to options for enabling the rapid evacuation of a tram which is lying on its side following an accident. Any suggested changes to tram construction standards will be assessed and implemented as appropriate. ORR expects that as part of LRSSB's work they will consider the practicability of providing escape routes at each end of the tram. This work would need to consider the benefits and dis-benefits of such an idea.

73. ORR understands that, where tram owners and operators have discussed the option of fitting escape hatches with manufacturers as a potential way of discharging this recommendation, they have been told this is not practicable and has the potential to import risk. A hatch in the roof could lead to passengers coming into contact with overhead line equipment, and floor hatches would add a significant safety risk if passengers could gain access to safety critical components, running equipment and movable objects.

74. The action taken by each duty holder and the ORR view on if it addresses the recommendation is summarized in the table below.

End Implementer	Summary of response	Status
Tram Operations Ltd	When a possible solution is identified by UKTram, TOL will review its evacuation process to ensure staff are up-to-date for evacuation of an overturned tram.	London Trams/TOL are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.

London Trams	UKTram Subcommittee 1 on behalf of the Industry came to the collective view that installing escape hatches in the floor or roof of any Tramcar would import significant risk.	London Trams/TOL are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
Transport for West Midlands	TfWM will await the completion of the industry risk model and how this may impact on tram standards before taking any further action. Currently not considered to be reasonably practicable to fit escape hatches in the floor or ceiling of current fleet, nor fitting removable glass to the cab.	TfWM/WMM are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
West Midlands Metro	WMM are awaiting the outcome of industry risk assessment before considering any changes to existing fleets or new ones.	TfWM/WMM are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
Blackpool Borough Council	Blackpool Borough Council/BTS consider the risk of a tram overturning on the Blackpool system to be sufficiently low as to not warrant changes to vehicles to improve evacuation. No further action being taken.	On publication of tram safety risk model, ORR will discuss a risk based approach to consideration of emergency evacuation to ensure Blackpool trams are in line with the rest of the sector.

		Status: Progressing
Blackpool Transport Services	Blackpool Borough Council/BTS consider the risk of a tram overturning on the Blackpool system to be sufficiently low as to not warrant changes to vehicles to improve evacuation. No further action being taken.	On publication of tram safety risk model, ORR will discuss a risk based approach to consideration of emergency evacuation to ensure Blackpool trams are in line with the rest of the sector. Status: Progressing
City of Edinburgh Council	City of Edinburgh Council are supporting the Edinburgh Trams position on recommendation 8.	City of Edinburgh Council/Edinburgh Trams are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
Edinburgh Tram	Edinburgh Trams are awaiting the output from UKTram Subcommittee 1 before taking action in respect of this recommendation. In the meantime, ET are reviewing a potential solution which involves amending a side window in order to assist evacuation.	City of Edinburgh Council/Edinburgh Trams are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
Transport for Greater Manchester	TfGM consider it unlikely they will implement this recommendation as a readily accessible safety egress system that would not also be	TfGM/KAM are awaiting the output of the industry risk model

	vulnerable to misuse cannot be fitted to their trams.	before reviewing the evacuation arrangements on their trams Status: Progressing.
Manchester Metrolink	KAM will assess and implement changes to standards as appropriate.	TfGM/KAM are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
Nottingham Council/ Tramlink Nottingham Ltd	The shadow LRSSB will identify what is appropriate as an industry standard with regard to options for enabling the rapid evacuation of a tram which is lying on its side following an accident. Any suggested changes to tram construction standards will be assessed and implemented as appropriate.	Nottingham Council/TNL/NTL are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
Nottingham Trams	The LRSSB will identify what is appropriate as an industry standard with regard to this recommendation. Any changes to tram construction standards will be assessed and implemented as appropriate. Enforcement of any recommended change will rely on the regulatory framework of the LRTSB.	Nottingham Council/TNL/NTL are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams Status: Progressing.
South Yorkshire PTE	SYLTE are awaiting the output from UKTram Subcommittee 1 before taking action in respect of this recommendation.	SYLTE/SYSL are awaiting the output of the industry risk model before reviewing

		the evacuation arrangements on their trams Status: Progressing.
South Yorkshire Supertram Ltd	<p>SYSL has concluded that incorporation of escape hatches into existing vehicle designs is highly unlikely due to the inability to maintain structural integrity and ensure a safe exit route from the vehicle, considering the potential for live electricity and available space.</p> <p>For Citylink (including tram-train) vehicles the windscreen design was refused acceptance by RSSB due to its lack of antispalling properties that could result in injury/blindness to the driver. However the current windscreens are compliant and have anti-spall properties</p>	<p>SYPTTE/SYSL are awaiting the output of the industry risk model before reviewing the evacuation arrangements on their trams</p> <p>Status: Progressing.</p>

Information in support of ORR decision

75. See Annex B paras 148 to 167 for end implementer responses.

Recommendation 9

The intent of this recommendation is to ensure that the safety authority responsible for regulation of UK tramways maintains an appropriate, proportionate risk-based level of inspection and oversight to tramway operations.

The Office of Rail and Road should carry out a review of the regulatory framework for tramways and its long-term strategy for supervision of the sector. This should be informed by a new assessment of the risk associated with tramway operations (allowing for low frequency/high consequence events of the type witnessed at Sandilands junction) and consideration of the most effective means by which supervision can contribute to continuous improvement in passenger safety.

ORR decision

76. The consideration we gave to this recommendation was initially broken down into three work streams:

- Carrying out a prior role review of our previous supervision of the Croydon system, which recommended inter alia that we “continue to press UKTram to expedite central reporting and analysis of accident, incident and near miss-

data. Until that goes live, we generate enhanced statistical data from our RIDDOR reports with greater granularity for tramways. This would help inform future decisions about resourcing regulation of the sector”;

- Setting out a high-level overview of the strengths and weaknesses of the current legislative framework for tramway safety; and
- Strengthening our tramway inspection team and establishing a plan for risk-based proactive supervision of the sector during 2018/19.

77. To structure our thinking of the review of the regulatory framework, we identified the five key components of the framework and identified options for change by comparing tramway provision with relevant “reference systems” from the transport sector (rail and bus). We did not consider general health and safety legislation as this applies uniformly across the piece.

78. While our review concluded that the framework is sufficiently robust to support implementation of the safety improvements demanded by the Sandilands accident, we have also identified some proportionate recommendations to strengthen it. We have outlined the following with the LRSSB steering group:

1. **Safety management systems** – We should seek greater visibility and transparency of the sector’s own internal safety audits and build up our RM3 evidence base. We would only support extending mandatory safety certification to the sector if evidence emerges of a safety benefit and subject to our being resourced to carry out certification without abstracting resource from proactive inspection.
2. **Risk assessment** – We should encourage the sector to improve the rigour of its independent verification of new or significantly altered operations or technology, including through the voluntary use of the CSM risk assessment.
3. **Safety critical work including tram driving** – We have not identified any safety benefits associated with licensing of tram drivers, though we will revisit our position if further appraisal of the mainline train driver licensing system identifies such benefit.
4. **Authorisation of vehicles and infrastructure** – We have not identified a justification for overlaying new ORR authorisation requirements on top of existing statutory approvals for tram systems and their vehicles.
5. **Safety performance reporting** – We should make better use of existing RIDDOR data from the tram sector and we will continue to encourage sector duty holders to share more of the data they currently collect with us.

79. The analysis of the components of the regulatory framework that supported our decision making is explained in Annex B, para 168.

80. Our plans for 2018/19 now include resource and a structured programme to carry out more proactive supervision of the tram sector, based around key RM3

criteria and to develop and publish a new strategic risk chapter for trams based on our existing knowledge, evidence and risk analysis.

81. Significantly better cross-industry safety data and analysis will not be on-stream before mid-2019 and, equally, we need to build up our inspection evidence base significantly in order to make meaningful RM3 assessments of the tram sector. This means we will need to keep our analysis under review. We have been clear that we will not propose regulatory changes until and unless they are justified by much more detailed evidence of this nature.

82. ORR developed a programme to deliver the requirements of recommendation 9:

1. Undertake review of regulatory framework: COMPLETE; findings presented to ORR Health & Safety Regulation Committee (HSRC) & Rail Industry Health & Safety Advisory Committee (RIHSAC)¹
2. Commence discussions with tram sector concerning the recommendations that emerged from our review: COMMENCED, next steps formal consultation on proposed requirements commencing January 2019
3. Undertake a new assessment of the risk of the tramway sector
 - a. Undertake a regulatory review of ORR risk topics as applicable to the tramway sector (RARR process): COMPLETE
 - b. Produce strategic risk chapter that describes our approach and priorities for the tramway sector: COMMENCED, PRESENT DRAFT to RIHSAC January 2019, PUBLISH April 2019
 - c. First review output of LRSSB risk model AUTUMN 2019, to assess impact on RARR outcome
 - d. Review Strategic Risk chapter APRIL 2020
4. Consideration of the most effective means by which supervision can contribute to continuous improvement in passenger safety:
 - a. Approach will be informed by strategic risk chapter, but have already determined that proactive supervisory capability requires increased. PI appointed, increased inspector resource committed from April 2019.
 - b. Increase level of proactive engagement with sector, driven by formal annual inspection plan process. COMMENCED: 2017, approach continues to evolve into 2019
 - c. Application of RM3: COMMENCED in 2018, will continue to evolve into 2019

83. When the strategic risk chapter is published we will consider that the recommendation has been implemented. Steps 2, 3c and 3d, and 4 will be covered under BAU.

84. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, ORR has:

- taken the recommendation into consideration; and

¹ RIHSAC is held quarterly and is made up of representatives from Network Rail, mainline freight and passenger operators, TfL, trade unions, RSSB and BTP.

- is taking action to implement it, but is keeping the implementation outcome under review, subject to meeting the milestones in the work plan.

Status: Implementation on-going. ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Recommendation 10

This recommendation is intended to ensure that Tram Operations Limited's systems for identifying the hazards and assessing the risk associated with its operation are fit for purpose. The requirement for an independent review does not prevent it being carried out by other parts of TfL and FirstGroup provided the requisite expertise is available.

Tram Operations Limited and London Trams should commission an independent review of its process for assessing risk associated with the operation of trams (e.g. collision, derailment and overturning of trams). This review shall consider:

- i. the extent to which the process for risk assessments is capable of identifying and correctly assessing all significant risks, particularly those related to low frequency/high consequence events; and
- ii. the means by which potential mitigations are identified and evaluated.

The findings of the review shall be incorporated into a documented process for the assessment of operational risk. This should also be shared with other tramways.

ORR decision

85. The Tram Safety Risk Model for the Croydon system is owned and managed by London Trams. The model considers all aspects of system risk associated with operating trams on the Croydon Tramlink, using a series of hazardous events and precursors to record risk controls, potential consequences, FWI rating and distribution of harm. Where appropriate TOL's safety management procedures form inputs to the model and are recorded as risk controls. Following the Sandilands Accident, London Trams reviewed and updated the risk model, with the assistance of TOL.

86. TOL's key input to the model are Route Hazard Assessments. TOL are responsible for assessing and documenting hazards associated with line of sight driving; and communicating the findings of these assessments - including the risk controls, to its drivers. TOL have developed a safety management procedure (Route Knowledge for Tram Drivers) which specifies the process used.

87. The performance execution plan for review of the Route Hazard Assessments, safety management procedure and updated route hazard assessment information for each line of route driven over have been shared with ORR.

88. We have asked TOL to demonstrate how they are bringing together the output from this work with other work streams, such as Bow Tie analysis and general risk

assessments, in order to ensure the robustness of their processes for identifying the hazards and assessing the risks associated with its operation.

89. We will consider the recommendation to have been implemented once TOL have demonstrated how the different work streams deliver a single, robust process for identifying hazards and assessing operational risks.

90. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, TOL has:

- taken the recommendation into consideration; and
- has done a significant amount of work in this area across multiple work streams and is working to refine this into an over-arching process

Status: *Implementation on-going.* ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

91. See Annex B paras 169 to 170 for end implementer responses.

Recommendation 11

The intent of this recommendation is to minimise risk due to tram driver fatigue associated with both work and out-of-work activities.

Tram Operations Limited, drawing on expertise from elsewhere in the FirstGroup organisation, should review and, where necessary, improve the management of fatigue risk affecting its tram drivers with reference to ORR's good practice guidance. As a minimum this should include a review of:

- i. the base roster with particular reference to whether it is appropriate to use a shift rotation pattern of about a week;
- ii. the management and monitoring of overtime and rest day working;
- iii. training, briefings and support for tram drivers regarding lifestyle, sleep hygiene and their individual responsibilities regarding fatigue and fitness for duty (including reporting when they feel that fatigue may affect their driving performance); and
- iv. competence requirements for managers and supervisors that have a role in the management of fatigue risk

ORR decision

92. TOL commissioned an independent review of its fatigue management which was carried out by Clockwork Research. The report made a number of recommendations, which TOL have accepted and are now implementing.

93. We accept that implementation of the Clockwork Research recommendations is likely to take some time, particularly as it will involve significant changes to working patterns. We have asked TOL to keep us informed with progress against the Clockwork recommendations.

94. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, TOL has:

- has the recommendation into consideration; and
- is taking action to implement it.

Status: *Implementation on-going.* ORR will advise RAIB when further information is available regarding actions being taken to address this recommendation.

Information in support of ORR decision

95. See Annex B paras 171 to 172 for end implementer responses.

Recommendation 12

This recommendation is intended to encourage an organisational culture in which tram drivers feel able and willing to report safety incidents, and in which TOL takes suitable actions in response to information from both staff and the public. The requirement for an external expert does not preclude the review being carried out by other parts of TfL and/or FirstGroup provided the requisite expertise is available.

Tram Operations Limited should undertake a review, informed by expert input from external sources, covering the way that it learns from operational experience. The areas the review should address are:

- i. fostering the creation of a 'just culture' in which staff are more likely to report incidents and safety-related concerns;
- ii. establishing a common understanding of what constitutes a safety incident when reported by the public, or that should be reported by staff;
- iii. improving management systems to ensure that safety issues are properly identified from any reports, whether from staff or members of the public, and that appropriate and timely actions are taken in response; and
- iv. developing improved processes to ensure that suitable lessons are learned by TOL from such reports and that outcomes are fed back to the reporter

ORR decision

96. TOL have carried out a review of their safety culture, with support from external consultants. The review identified four key areas where changes would be made to deliver an improved safety culture:

1. Organisational capability to drive culture change
2. Sufficiency of incident reporting and investigation procedures
3. Management actions (how we do things around here)
4. Staff consultation and engagement

97. The recommendation also included a provision for TOL to improve their arrangements for dealing with safety issues when identified by members of the public.

98. TOL Customer Communications RP0021 standard describes how information is processed and can be acted upon promptly, whether it has come from the TfL central complaints management system, or is reported to TOL directly. ORR will monitor implementation of the new standard through our assurance work with TOL.

99. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, TOL has:

- Taken the recommendation into consideration; and
- Has taken action to implement it

Status: Implemented.

Information in support of ORR decision

100. See Annex B paras 173 to 174 for end implementer responses.

Recommendation 13

This recommendation is intended to achieve effective and timely responses to allegations of unsafe situations reported by members of the public, or employees. It takes account of CCTV, OTDR and other systems which record data by overwriting earlier information after a period of time. It also takes account of the fact that witnesses' recollection of events can degrade relatively quickly. London Trams is included in the recommendation as improvements to processes and/or equipment relating to on-tram recording systems may be necessary to ensure a sufficient period for information to be available for downloading. Including workforce comments/complaints in the same system may further improve safety. Effective implementation of this recommendation is likely to include separating safety related comments from customer care issues and prompting people making comments to provide (where possible) the date, time and location of events.

Tram Operations Limited and London Trams should, in conjunction with TfL, improve processes, and where necessary, equipment used for following up both public and

employee comments which indicate a possible safety risk. The improved process should ensure complaints are dealt with promptly and within time periods which:

- i. improve the effectiveness of identifying complaints that are safety related (e.g. time, date, location, safety or customer care event etc);
- ii. avoid the loss of technical evidence (e.g. CCTV recordings);
- iii. minimise the time before witness information is sought; and
- iv. ensure that appropriate action is taken without undue delay.

ORR decision

101. The revised standard for customer communication (RP0021) improves TOL's effectiveness in identifying safety-related complaints and includes timescales for ensuring they are dealt with promptly.

102. London trams has taken steps to improve the availability of CCTV footage by upgrading the system fitted to their Bombardier tram fleet, which includes an increase to storage capacity (see rec 14 response).

103. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, TOL and London Trams have:

- taken the recommendation into consideration; and
- have taken action to implement it

Status: Implemented.

Information in support of ORR decision

104. See Annex B paras 175 to 176 for end implementer responses.

Recommendation 14

The intent of this recommendation is to maximise the availability of CCTV images which could assist accident and incident investigation (and also the investigation of criminal acts and anti-social behaviour). It considers both technical reliability and processes used to recover images before they are over-written. It is probable that equipment installed since November 2016 on trams similar to that involved in the accident will assist implementation of this recommendation.

London Trams, in consultation with Tram Operations Limited, should review and, where necessary, improve its processes for inspecting and maintaining on-tram CCTV equipment to greatly reduce the likelihood of recorded images being unavailable for accident and incident investigation (paragraph 471).

This recommendation may apply to other UK tram operators.

ORR decision

105. ORR wrote to RAIB on 22 August 2018 to report that this recommendation had been implemented. For completeness we include our response here as well.

106. London Trams had begun work to improve the reliability and maintainability of the CCTV equipment on their Bombardier tram fleet prior to the Sandilands incident. The refit and upgrade work has now been completed, both to the trams and equipment to review CCTV footage at the London Trams depot. Storage capacity had also been improved, allowing CCTV images to be retained for longer before being overwritten, making them available for accident investigation if needed.

5. After reviewing the information provided ORR concluded in its 22 August 2018 response that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, London Trams had:

- taken the recommendation into consideration; and
- taken action to implement it.

Status: Implemented.

Information in support of ORR decision

107. See Annex B para 177 to 178.

Recommendation 15

The intent of this recommendation is to ensure that up-to-date and accurate maintenance and testing documentation is available to tram maintainers.

London Trams, in consultation with Tram Operations Limited should:

- i. review and, where necessary, revise existing tram maintenance and testing documentation to take account of experience gained, and modifications made, since the trams were brought into service; and
- ii. review and, where necessary, revise the processes for ensuring that these documents are kept up-to-date in future.

ORR decision

108. TfL have started a programme of work to develop sixteen new engineering standards, along with associated supporting procedures and forms. The programme of work is expected to be completed by December 2018. The sixteen standards cover:

- Civils - inspection & maintenance
- Depots - inspection & maintenance
- Engineering Management - degraded operations
- Engineering Management – maintenance assurance

- Engineering Management – maintenance regimes
- Fleet – inspection & Maintenance
- HV & Power – substations and circuit breakers
- HV & Power – inspection & maintenance
- OLE – inspection & maintenance
- OLE – performance alignment and configuration
- System integration – tram infrastructure interface (including gauging and clearances)
- Systems – signalling systems
- Systems – inspection & maintenance
- Track – performance & configuration
- Track – alignment & design
- Track – inspection & maintenance

109. After reviewing the information provided ORR has concluded that, in accordance with the Railways (Accident Investigation and Reporting) Regulations 2005, London Trams has:

- taken the recommendation into consideration; and
- is taking action to implement it by 31 December 2018.

Status: Implemented.

Information in support of ORR decision

110. See Annex B para 179 to 180.