

Summary of end implementer correspondence

Recommendation 1

1. In Its response of 30 May 2018 Blackpool Transport stated the following:

The Shadow Light Rapid Transit Steering Group was formed following the ORR Summit on 22nd January. Ian Middlemiss, Blackpool Transport Head of Tramway, represents the company on this group as an industry expert and heritage.

The LRT SSB Working Group was set up to work on the Constitution of the establishment of the LRTSSB – Three options analysed. Option 3 was presented as the most viable option with the best scenarios for industry. Duty Holder meeting called for Industry consultation.

In option 3 the safety Standards Body would be a subsidiary company of UKTram, which is ring fenced. It would have a separate governing body from the main UKTram Board, with an independent chair, who would possess a safety related background (from industry – not tramway or Light rail or heavy rail), with the board comprising of Industry decision making representatives. The body would sit alongside UKTram and be able to share resource for peer reviews and administration. The body along with UKTram would be funded through one channel. A consultation meeting has been called by UKTram on behalf of the LRTSSB for 21st May with Duty Holders and another meeting for to update members on 16th July 2018.

2. In Its response of 29 May 2018 Blackpool Council stated the following:

The safe operation of Blackpool's system is overseen by the Tramway Safety Management Group (TSMG). The group comprises of Blackpool Council Tramway Safety Officer, Blackpool Council HSE officer, LCC Engineering, ORR representative and BTS's representatives, whom also sit on Shadow Light Rapid Transit Steering Group, UKTram sub-committee 1 and UKTram Heads of Safety. At the TSMG bi-monthly meetings any new safety issues/recommendations/improvements raised through the industry are discussed and agreed and implemented if appropriate.

The Shadow Light Rapid Transit Steering Group was formed following the ORR led meeting in January 2018 in response to the recommendations. Following these recommendations within the LRT SSB working group, option 3 was proposed as the most effective solution. The Safety Standards Body would be a subsidiary of UKTram, having a separate governing body with an independent Chair and a focused specialist board.

Following the recent track upgrade in 2012, Blackpool's Track Standard Document was created to ensure the entire tramway system is maintained to a suitable level to ensure the safe day to day operation. All defects are recorded, graded and acted upon accordingly in accordance with the policy. It clearly states wear limit/intervention limits and action timescales to affect repair to ensure a safe system.

Any new guidance issued by the industry, ORR or RAIB report recommendations that are appropriate to our system are incorporated into the Track Standard

Documents or BTS's operational systems, following discussion and agreement at the TSMG.

3. In Its response of 30 May 2018 Edinburgh Trams stated the following:

Edinburgh Trams fully supports the UKTram approach in responding to this recommendation, and are represented at various levels (e.g. working group and shadow board).

4. In Its response of 31 May 2018 Edinburgh City Council stated the following:

I agree that recommendations 1 – 8 are applicable to this Council, as owner of Edinburgh's trams, tramline and associated infrastructure. We are working closely with our Operator, Edinburgh Trams Ltd and our tram manufacturer and maintainer, CAF, to fully investigate options that can be implemented to satisfy the report recommendations and enhance the safety of our tram operation. Edinburgh Trams are submitting a response to you that details what actions have already been implemented, or are currently in consideration for each recommendation. We are supporting their involvement in UKTram initiatives including, for example, the steering group for the Light Rail Safety & Standards Board, Risk Model Analysis. Edinburgh Trams are also in discussion with the vehicle maintainer CAF regarding some potential solutions that, if appropriate, could address recommendations 3,4,6,7 & 8.

Edinburgh Trams, as Transport Operator and Infrastructure Manager [ROGS] has staff with the relevant qualifications and experience to represent Edinburgh's tram system at the ongoing working group discussions but we will attend the group when able and will certainly work closely with Edinburgh Trams to understand the details and implications of all subsequent recommendations. Under our current contract governance and operating agreement regime, the Council is responsible for the contracts for asset maintenance, renewals and enhancements. As such, it is recognised that we must continue to work closely with Edinburgh Trams and UKTram to ensure that necessary and recommended safety enhancements can be budgeted for.

I look forward to monitoring the conclusion of the working group and in the meantime, will set up a regular update meeting between my team and Edinburgh Tram. I found the RAIB report to be very interesting, although it did make uncomfortable reading and certainly highlighted the tragic consequences that can occur from a momentary lapse in concentration. We are currently supporting the Edinburgh Tram innovation challenge with project management resource. This innovation is to find a suitable product that is wearable and can give an early alarm to the controllers in the event of increasing fatigue of the driver. Additionally there is a proposal from an eminent professor to deliver fatigue awareness training to help drivers understand the relevant symptoms in themselves. This has been forwarded to UKTram for rolling out to the industry.

All reasonable measures to assess and reduce the risk are being considered and Edinburgh Trams has already implemented many. I give you my assurance that we will assist with the ongoing work and implementation of safety enhancements wherever reasonably practicable.

5. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

The development of the Light Rapid Transport Safety and Standards Board (LRTSSB) continues to progress with representatives from both Keolis and Transport for Greater Manchester on the steering group. The development of standards, guidance and sharing of best practice will meet the requirements of this recommendation and provide a step change in the governance within the light rail sector, which KAM fully supports.

KAM are fully involved in the working groups, co-ordinated through UK Tram to deliver this recommendation.

6. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

TfGM is represented on the “LRTSSB Steering Group” and the group have been meeting monthly since February. The remit of the group is essentially to deliver on this recommendation and recommendation 2 (see below). Good progress has been made in terms of narrowing down the options. The emerging preferred option is to establish a tramway safety and standards body as a subsidiary of UKTram. TfGM supports this option, subject to further detail emerging and consultation with the wider industry.

Full consideration has yet to be given to the funding of such a body, the mandating of membership and the governance arrangements, which we expect to form part of the future work of the steering group.

It is worth noting that Metrolink’s Operator and Duty Holder, KAM, is represented on the group through the Keolis member.

7. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *22 Jan 18 NX attended the ORR summit meeting regarding the outcome of the RAIB report.*
- *NX Metro maintains their membership with UK Tram and recognises the vital role that they play as the organisation representing tram operators in UK.*
- *NX Metro is represented on the LRTSSB by TfWM the owners of the system.*
- *NX Metro QHSE Manager is a member of the Heads of Safety working group chaired by UK Tram.*

8. In Its response of 31 May 2018 Transport for West Midlands stated the following:

With regards to recommendations 1 and 2 of the RAIB's report we can confirm that Transport for West Midlands, National Express (operator of Midland Metro until 23

June 2018) and Midland Metro Limited (operator from 24 June 2018) have worked together and with UKTram to support the industry wide response to the report.

In particular we have supported the development of proposals for both a national tramway safety and standards body and an industry standard risk model. We are represented on the UKTram / DfT / ORR steering group and have taken a leading role in the development of proposals for the Light Rail Safety and Standards Body. We have, with National Express also made the Midland Metro risk model available to UKTram for consideration in development of the industry standard risk model proposed to be delivered in 2019.

9. Transport for West Midlands provided the following update on 1 October 2018:

West Midlands Metro ("WMM") is represented on the Light Rail Safety and Standards Board steering group organised by UKTram and WMM representatives have taken a leading role in developing the remit for the LRSSB. MML's Head of Safety is an active participant in the UKTram Heads of Safety forum.

WMCA has, together with the Board of MML agreed to financially contribute to the cost of establishing and running the LRSSB for an initial period of 3 years.

10. In Its response of 29 May 2018 Nottingham Trams stated the following:

An industry working group is currently reviewing the vehicle which can deliver the Light Rapid Transit Safety Body (LRTSB). This group will lead in agreeing and setting the standards for the implementation of measures required to satisfy recommendations from the Sandilands RAIB report. Key to success will be the regulatory framework around the LRTSB and standards compliance.

NTL are actively involved in UK Tram led working groups to implement the aims i - ix detailed in this recommendation.

Having appropriate standards and regulation in place applying to duty holders and system owners will be a critical factor for successful and consistent implementation of the recommendations in this report.

11. In Its response of 30 May 2018 Nottingham City Council stated the following:

In relation to the recommendations made by the RAIB in their report, I would like to reassure you that the City Council is fully supportive of, and engaged with, the current activities of UK Tram and the establishment of the shadow Light Rail Transit Safety and Standards Board (LRTSSB), in accordance with Recommendation 1. We also recognise the importance of the shadow LRTSSB in undertaking activities across the industry to determine appropriate actions in response to the other recommendations that have been identified as being applicable to tram owners. Notwithstanding this, we are fully engaged with NTL in the activities that it has already undertaken in Nottingham since the publication of the report.

12. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

In relation to the recommendations made by the RAIB in their report, I would like to reassure you that TNL is fully supportive of, and appropriately engaged with, the current activities of UK Tram and the establishment of the shadow Light Rail Safety and Standards Board (LRSSB), in accordance with Recommendation 1. We also recognise the importance of the shadow LRSSB in undertaking activities across the industry to determine appropriate actions in response to the other recommendations that have been identified as being applicable to tram owners. Notwithstanding this, we are fully engaged with NTL in the activities that it has already undertaken in Nottingham since the publication of the report.

13. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

We welcome this recommendation to develop an industry body committed to safety and common standards under which best practice is shared. Following the UK Tram Safety Conference in Manchester on 22nd January 2018 we agreed with the SYPTE representative it was important to have representation for Sheffield on the proposed steering group. A decision was taken that both parties would offer a member to the steering group with one being accepted dependant on the owner/operator balance of the steering group. As such our MD Tim Bilby has become a member of the LRTSSB Steering Group and is an active supporter of the developments.

14. Stagecoach Supertram provided the following update on 26 September 2018:

The development of the Light Rail Safety Standards Board continues to progress with support from all systems, the DfT and ORR. Supertram's Managing Director continues to contribute through the Steering Group.

15. In Its response of 31 May 2018 South Yorkshire PTE stated the following:

In terms of Recommendations 1 and 2 SYPTE is an active member of UKTram and as such is keeping apprised of the development of the LRTSSB and the development of the risk model through this forum. Where requested we will be happy to provide support.

Due to the restriction in numbers attending the LRTSSB steering group, SYPTE was unsuccessful in gaining a place on the steering group. We are however in close contact with the Managing Director of Supertram as the Sheffield representative and are feeding our comments back through him as required. In addition to this our Executive Director, Stephen Edwards is representing the Urban Transport Group (UTG) on the LRTSSB Steering Group.

16. South Yorkshire PTE provided the following update on 28 September 2018:

SYPTE has now approved our funding contribution towards the set up and operation of the Light Rail Safety and Standards Board (LRSSB). SYPTE's Executive Director, Stephen Edwards continues to represent UTG on this group.

17. In its response of 30 May 2018 Transport for London (London Trams) stated the following:

The Shadow Light Rapid Transit Steering Group was formed by the Office of Rail and Road (ORR) following the ORR Summit on 22nd January. LT is a member. All Tram systems are represented by either the owner/authority or operator. The remit of this Steering Group includes setting up of a shadow Light Rapid Transit Safety Standards Board (LRT SSB). A Working Group, formed from four members of the Steering Group, has been set up to work on the constitution of the establishment of the LRT SSB. LT is a member of this working group.

This working group has prepared and analysed the options for a LRT SSB and presented the recommended option to the Steering Group. The Steering Group endorsed this option. Next steps are for a Duty Holder meeting for industry consultation. This is being arranged by UK Tram on behalf of the Steering Group.

In the proposed option the LRT SSB would be a subsidiary company of UKTram, which is ring fenced. It would have a separate governing body from the main UKTram Board, with an independent chair, who would possess a safety related background (from industry – not tramway or light rail or heavy rail), with the board comprising of Industry decision making representatives. The body would sit alongside UKTram and be able to share resource for peer reviews and administration. The body along with UKTram would be funded through one channel. A consultation meeting was held with Duty Holders on 21 May 2018 by UKTram on behalf of the Steering Group to discuss this proposal. Another meeting to update members is to be held on 16th July 2018. The overall aim is to set up the shadow LRT SSB by the end of the year.

18. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 1 (work with ORR and the UK Tram industry to develop a body to enable UK wide cooperation on matters related to safety) – we continue to be a key part of the steering group set up to establish an industry body responsible for ensuring better cooperation on safety and standards. We have formally agreed to the setting up the Light Rail Safety and Standards Board (LRSSB) and to our allocation of the funding needed for the first three years of operation. We have agreed to its governance arrangements and potential future work plan and have responded to UKTram to confirm this. The timescales for setting up the LRSSB remain unchanged at the end of the year. We will continue to support the setting up on this Board.

19. In its response of 31 May 2018 Tram Operations Ltd stated the following:

UKTram has established a Steering Committee and TOL is a Member. UKTram has provided TOL with a copy of its response (dated 22 May 2018).

The remit of the Light Rapid Transit Safety Standards Board (LRTSSB) has been established, a Chairman elected, and Members identified.

All monthly Steering Committee meetings are attended by TOL's Head of Safety.

TOL will continue to attend and contribute at the monthly Steering Committee meeting to support more effective UK-wide cooperation on safety matters in line with their proposed timescales.

TOL has begun implementation of measures necessary to address this recommendation through its participation in the LRTSSB and will continue to do so.

20. Tram Operations Ltd provided the following update on 28 September 2018:

UKTram has established a shadow Light Rail Safety and Standards Board (LRSSB) in response to Recommendation 1. TOL are represented on this Board.

The Chair of the Board wrote to TOL in August outlining the LRSSB's Business Plan and strategic objectives; and requesting funding to support set up and operation of the new company. TOL has formally responded to the Chair committing funding over the first 3 years of the programme.

TOL's Head of Safety continues to attend all LRSSB Steering Group meetings.

21. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

UKTram is in the process of setting up a joint industry body, to be called Light Rail Safety and Standards Board (LRSSB). In order to make immediate progress, it currently exists in shadow form, with a registered company name and a Shadow Board. It has developed a Business Plan setting out the functions of the LRSSB. Sources of funding are being explored, following which UKTram will proceed with electing a substantive Board and recruiting a Chief Executive Officer.

Many of the recommendations require the industry to cooperate and exchange information, especially to co-operate on safety matters and review standards and guidance for tramways, taking into account standards and guidance elsewhere in Europe and standards for trains and buses. Recommendation 1, in particular, asks UKTram to set up what is essentially an equivalent to the Rail Safety and Standards Board (RSSB) for the light rail industry.

It was acknowledged that this cooperation process already takes place through UKTram's Light Rail Operators' Committee and Light Rail Engineers' Group, and it was believed that the recommendation to undertake industry risk analysis (Recommendation 2) could be carried out through Subcommittee 1 and UKTram's

Functional Groups.

Initially, therefore, the industry response was to investigate expanding the role of UKTram, if the correct funding stream could be secured. A meeting of UKTram with the Office of Rail and Road in November 2017 decided to establish an Independent Review Group to consider how UKTram could adapt to become an industry body for ensuring better co-operation on safety and standards. There was a desire from

UKTram members for it to fulfil this role, but the major limiting factor would be funding.

As ideas developed, it became clear that there was a need for a new organisation with its own function, structure and budget, particularly with regard to funding. It would have close links with UKTram, but not be functionally part of it.

Accordingly, the Independent Review Group set up a Steering Group to oversee the establishment of the new joint industry body, to be called the Light Rail Safety and Standards Board (LRSSB). The Steering Group has developed a Business Plan setting out the functions of the LRSSB. Sources of funding are being explored, following which UKTram will proceed to elect a substantive Board and recruit a Chief Executive Officer. A summary of the proposed structure and duties of the LRSSB is given in this section.

At the same time, the Independent Review Group set up a Shadow Board to get on with the work needed to undertake an analysis of industry-wide risks. This work, which is in response to Recommendation 2, is summarised in section 6.

Scope and remit of the LRSSB

The Light Rail Safety & Standards board (LRSSB) has been created to provide expert support to the light rail industry of the British Isles (the United Kingdom and Republic of Ireland, to include the Luas system in Dublin) driving sustainable improvements in safety and efficiency of the tramways and light rail systems.

The primary functions of the organisation are summarised below:

- *Industry risk model informing industry decisions and sharing best practice.*

The LRSSB will develop and implement an industry-wide risk model for adoption by all relevant LRT systems in the British Isles (see Section 6 below).

- *Standards*

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

- *As a standards body the LRSSB should not be involved in the assessment or approval of derogations from standards or guidance, which should remain the responsibility of duty holders. All such derogations, however, should be reported to LRTSSB and recorded so as to inform the future review and ongoing maintenance of standards and guidance.*
- *Interface with International bodies*

LRSSB will develop and oversee mutually beneficial relationships with relevant international bodies, to include as a minimum:

- *UITP (Union International des Transports Publiques – International Association of Public Transport.,*

- VDV (*Verband Deutscher Verkehrsunternehmen - Association of German Transport Companies*)
- STRMTG (*Service Technique des Remontées Mécaniques et des Transports Guidés – French Technical Service for Guided Transport and Mechanical Ropeways*)
- TII (*Transport Infrastructure Ireland*)
- EBA (*Eisenbahn-Bundesamt - German Federal Railway Authority*)

LRSSB will develop system benchmarking processes for comparison with UK and international systems worldwide, for mutual benefit both within UK and overseas.

- *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.

UKTram will continue to research examples from light rail construction and operation (including the continuation of the low cost light rail workstream) with a view to reducing initial set up cost and whole life cost with emphasis upon efficiency and environmental impact. The results will also help support business cases for future LRT schemes. There will, however, be crossover of relevant subject matter and findings between UKTram and LRSSB, to be shared within both organisations for the benefit of the members.

- *Interface with Government bodies*

LRSSB will develop and oversee mutually beneficial relationships with relevant government departments and governmental bodies, to include as a minimum the Department for Transport (DfT), the Office of Rail and Road (ORR), the Department for Business, Energy & Industrial Strategy (BEIS), and the Department for Work and Pensions (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. Incident and accident reporting information will be reviewed to ensure dissemination within the industry especially with regards to lessons learned.

- *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 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 (see below), and the spread of best practice in training methods. LRTSSB will work with RAIB and ORR to develop sector-specific competencies.

UK Tram will continue to focus on training related to other disciplines. 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.

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.

LRSSB Workstreams

Initial Workstream – Setting up the organisation

The priority workstream is to develop and secure initial funding for the LRSSB for its first years of operation. In conjunction with this, a number of other tasks are relevant to setting up the organisation:

- Review insurance and indemnity requirements for the LRSSB, and review options for accommodation,
- Recruitment of key posts and additional support roles,
- Commence work on Phase 1 (Risk Model) and Phase 2 (Standards Development and Safety Verification),
- Review the industry's available resources and assess commitment required/available from the UK tram industry,
- Assess and agree input required from ORR and other regulatory bodies,
- Establish initial links with Government, European and other bodies.

The UKTram Steering Group identified a potential benefit for the wider light rail industry of including the 3 non-tramway systems (DLR, Tyne & Wear and SPT Subway) within the LRSSB, and requested that they be invited (through ORR) to discuss their potential involvement. The Group also requested that Luas in Dublin and the Isle of Man Railways be approached.

Phase 1 workstream – Risk analysis

Phase 1 of LRSSB's work would comprise the development and implementation of an industry wide risk model for adoption by all LRT systems in the UK, together with overseeing the timely discharge of the RAIB Sandilands recommendations. This work is described under Risk Analysis below.

Phase 2 workstream – Standards and ICP Accreditation

Phase 2 of LRSSB's work would address the following areas:

- **Standards:** Establish a list, then a library of current standards, guidelines and best practice in the UK, including those used by existing UK tramways. Establish definitive lists of standards and best practice from European bodies.

*Prioritise key subject areas for adoption of UK and non-UK standards.
Conduct detailed gap analysis to identify other areas.*

- *Establish technical working groups in key engineering, maintenance and operational safety disciplines for tram vehicles and infrastructure.*
- *Identify gaps in the highway legislation related to safety affecting tramways, and engage with highways authorities in areas where there is an existing or planned tramway regarding safety issues around tramways.*
- *Establish an initial register of accredited ICP's to address the requirements for safety verification, and develop system for their ongoing training and development.*

Future workstreams

Future workstreams beyond Phase 2 will be developed by the CEO of LRSSB when in post, having regard to resources and budget.

Recommendation 2

22. In Its response of 30 May 2018 Blackpool Transport stated the following:

Risk Analysis work (Working Group 2) – LRTSSB appointed a team of Industry experts to Working Group 2, the group have carried out analysis of current Industry Risk models and investigated the development of an Industry Wide Risk model. The work has been split into two phases. Firstly, all operating systems were visited, the WG reviewed how each system assessed and managed risk with Heads of Safety and key staff members.

A terms of reference for providing a Risk Model has been set in conjunction with UKTram's Safety and Assurance Group (Tram Heads of Safety). Blackpool Transport is represented on this group by Chris Davies, Head of Safety and Facilities. Atkins have been appointed to carry out this initial task.

The Industry Risk Model could be developed by October 2018 providing funding is secured from DfT. Post October, The Risk Model could be rolled out to each system, which would require several training sessions (potentially over a six-month period). The Industry Risk model could be implemented in full by April 2019 to each duty holder. To date all operators/Duty Holders have been fully engaged with the process. Once in place individual systems and whole industry Risk Analysis will be able to be generated by the data and information in the Risk Model.

In addition, Blackpool Transport have reviewed our route risk analysis and have moved a 30km sign further North at Bispham. This sign was located coming out of a 50km zone and was just prior to a set of forward facing points with a 15km speed restriction. By moving the 30km speed sign further North means this works as a speed step down giving drivers plenty of time to reduce speed for the points.

23. In Its response of 29 May 2018 Blackpool Council stated the following:

Speed risk profiles of on-street, off-street and segregated areas clearly identified the appropriate restrictions for the corresponding areas. Where the likelihood of pedestrian interaction is high (promenade for instance), the speed was restricted to 30 kph. This lower speed limit is also applied to shared space running. In addition to the speed limits, numerous other factors assist in controlling/reducing the speed, such as platforms (compulsory stop), controlled crossings etc. The maximum speed limit of 50 kph is only permitted on the fenced off segregated areas that run adjacent to the main promenade that also provides illumination on our system comparable to the required Highway lighting levels. The Speed Risk profile was undertaken by the stakeholders (with consultation with the ORR) prior to the up-graded system becoming operational.

Where visibility is reduced in isolated areas, this item was raised through the TSMG by ORR. The trams were appraised based on the light cast to speed operating to ensure adequate illumination in these isolated areas ensuring the line of sight principal is maintained.

The development of an industry wide risk model is being investigated through working groups appointed by LRTSSB. Terms of Reference for providing a risk model has been set in conjunction with UKTram's Safety and Assurance group. The industry risk model could be developed by October 2018 and rolled out to each system.

BTS operate the tramway having the benefit of being an award winning bus service provider. This in-depth knowledge of operating a bus service also feeds into the safe operation of the tram service from experiences gained.

24. In Its response of 30 May 2018 Edinburgh Trams stated the following:

Edinburgh Trams fully supports the UKTram approach in responding to this recommendation, and are represented on the industry steering group for LRTSSB and UKTram's Safety and Assurance Group (Tram Heads of Safety).

25. In Its response of 31 May 2018 Edinburgh City Council stated the following:

See response to Rec 1 above.

26. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

KAM has been monitoring the working group appointed by the LRTSSB, who have been carrying out an analysis of current industry risk models in preparation for the delivery of an industry wide risk model. KAM has been involved in the development of a terms of reference, through UK Tram's Safety and Assurance Group and support the decision to engage Atkins to further develop the proposal, which will allow a consistent and integrated approach to managing system risk.

27. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

TfGM understands the reasons for and intent of this recommendation and will fully support the delivery this through cooperation with wider industry.

The LRTSSB Steering Group has been tasked with taking this recommendation forward. To date experts have been appointed to conduct assessments of risks are understood and managed across all operators and a recommended common risk model has emerged from this work. It is anticipated that this model could be rolled out to all tramways starting late in 2018. TfGM will work with KAM to ensure that this model is implemented and used effectively in Greater Manchester.

Separately to the LRTSSB Steering Group, TfGM has carried out a network risk review (generic and site specific HAZID) to ensure the inputs to the risk profile are clearly understood. This review includes risk profiling tram, signalling and infrastructure. This work will feed into the emerging risk model.

We have also advised the specialists on techniques TfGM along with our infrastructure contractors and operator have recently adopted for design and construction of new or enhanced infrastructure utilising BIM technology and driver simulation tools to identify risks using a formal HAZID process so that they can be mitigated throughout the design process, which we believe is unique to Manchester and represents best practice for new infrastructure.

28. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *NX Metro commissioned a review of the risk register in 2015 and as a result of this work adopted a risk profile based system.*
- *NX Metro was audited by an external safety consultant as part of the termination process and the SMS was passed as fit for purpose.*
- *NX Metro QHSE Manager is a member of the UK Tram working group looking at an industry wide risk profile for generic risks.*
- *NX Metro QHSE Manager is a member of the Heads of Safety working group chaired by UK Tram.*
- *Tramway Principles & Guidance has been updated and released, this is being considered against the current SMS to see where improvements are offered under the new guidance.*

29. In Its response of 31 May 2018 Transport for West Midlands stated the following:

See response to Rec 1 above.

30. Transport for West Midlands provided the following update on 1 October 2018:

On 28 August MML hosted a visit by ORR representatives to demonstrate the functionality of the WMM risk model. The event was supported by UKTram and

Atkins Rail who developed the risk model for WMM. This risk model has now been confirmed as the preferred model to be developed by the LRSSB as a national standard model to meet RAIB's recommendation 2.

31. In Its response of 29 May 2018 Nottingham Trams stated the following:

The Heads of Safety (HoS) for all UK tram operators in conjunction with UK Tram have held joint discussions regarding risk profile models. The HoS have populated a Safety Risk Model as a cross industry document, while work continues to populate the pre-cursor model and further meetings continue to finalise this. Subsequently, the risk profiles will be shared with the LRTSB to identify what is appropriate as an industry national standard. While recognising each tram system has differing risk profiles the SRM will provide a consistent approach and facilitate common reporting and data sharing.

32. In Its response of 30 May 2018 Nottingham City Council stated the following:

We support the shadow LRTSSB in their appointment of a team of industry experts to carry out an analysis of current industry risk models and to investigate the development of an industry-wide risk model. It is intended that the output of this analysis will be used, in consultation with ORR, to publish guidance with regard to the mitigation of risk associated with the design, maintenance and operation of UK tramways, recognising that each tram system has individual risk profiles.

33. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

We support the shadow LRSSB in their appointment of a team of industry experts to carry out an analysis of current industry risk models and to investigate the development of an industry-wide risk model. It is intended that the output of this analysis will be used, in consultation with ORR, to publish guidance with regard to the mitigation of risk associated with the design, maintenance and operation of UK tramways, recognising that each tram system has individual risk profiles.

34. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

Similar to Recommendation 1, we welcome the opportunity for cross-industry work to develop a safety risk profile for UK Tramways. Stagecoach Supertram, is directly involved with this recommendation through the Head of Safety role being part of the UK Tram Heads of Safety Group, which is supporting UK Tram Working Group 2 tasked with developing an industrywide risk model. At a meeting on 22/03/18 a draft list of system hazards for the industry was identified amongst safety professionals. At the next scheduled Heads of Safety Group meeting there will be further discussion on 'common ground' between Operators that can help populate any risk model adopted.

The outcome of both recommendations 1 & 2 will provide the industry (and individual operators) with meaningful risk analysis data which we intend to use to help determine the practicability of solutions for recommendations 3, 4, 6, 7, and 8.

However we would note that progress on these two recommendations will be increasingly at risk if funding confirmation to support these industry developments is not forthcoming; at the time of writing we understand that discussions have taken place with DfT and a decision on funding is expected shortly.

35. Stagecoach Supertram provided the following update on 26 September 2018:

Our response to this recommendation echoes that of recommendation 1 through the Head of Safety role contributing to the development of an industry Safety Risk Model.

36. In its response of 31 May 2018 South Yorkshire PTE stated the following:
See response to Rec 1 above.

37. South Yorkshire PTE provided the following update on 28 September 2018:
SYPTe continues to support this through the LRSSB and our membership of UKTram. SYPTe understands that much of the work to date has been undertaken by the Heads of Safety Group, as such SYPTe is asking for greater involvement for owners in the development of this work. A meeting was held with Peter Cushing on the 28 September 2018 to understand work to date and opportunities to feed into this work.

38. In its response of 30 May 2018 Transport for London (London Trams) stated the following:

The remit of the LRT SSB Steering Group includes coordination of the industry response to RAIB's recommendation 2. The Steering Group appointed a team of Industry experts to a second Working Group, the group have carried out analysis of the current Industry risk models, including that of LT, and investigated the development of an Industry wide risk model. The work has been split into two phases. Firstly, all operating systems were visited, the working group reviewed how each system assessed and managed risk with the Heads of Safety and key staff members for each system.

A terms of reference for providing an Industry Risk Model has been set in conjunction with UKTram's Safety and Assurance Group (Tram Heads of Safety). Atkins has been appointed to carry out this initial task.

The Industry Risk Model could be developed by October 2018 providing funding is secured from the Department of Transport, DfT. The Risk Model would then be rolled out to each system, which would require several training sessions. The Industry Risk Model could be implemented in full to each duty holder six months after it has been developed. The model would assist in addressing the bullet points i to vi of this recommendation.

To date LT and all Operators/Duty Holders have been fully engaged with the process. Once in place individual system and whole industry Risk Analysis will be able to be generated by the data and information in the Risk Model.

39. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 2 – we have agreed the basis of the industry wide risk model and the work has been scoped out and a preferred bidder agreed. This work forms part of the programme of work for the LRSSB. The work will progress once funding for the LRSSB is agreed across the UK Tram industry and with DfT. This is expected to be October 2018.

40. In its response of 31 May 2018 Tram Operations Ltd stated the following:

Route Risk Assessment

TOL has recently completed a Route Risk Assessment (RRA). The objective was to enhance understanding and control of route risk across the entire tramway.

As part of the review TOL conducted a detailed assessment of the risks to passengers, staff and members of the public from the operation of trams and the infrastructure they run upon in service. TOL also identified the specific hazards associated with all routes across the tram network, the potential for harm and the appropriate risk control measures to be implemented in relation to them.

The training of new drivers now incorporates enhanced Route Hazard information. TOL have updated driver materials and are working with the training team and Health & Safety representatives to explore the best method to share the output of the RRA with drivers. Options TOL are looking at with London Trams include using simulator technology, interactive scenarios and simulated events.

The findings from the RRA have been used to update the Joint Safety Model.

Joint Risk Model

TOL and LT have jointly reviewed the safety risks associated with operation of the Croydon Tramlink system. The review examined tram operation, asset management and maintenance activities. Specific areas of focus included process management, the competence of our people, management systems, assets, infrastructure and external influences.

As a result, the Hazard Event List from the previous Safety Risk Model has been updated and risk associated with each hazardous event type (and their corresponding controls) have been catalogued.

A safety bow-tie risk assessment has been completed for each hazardous event to identify risk mitigations and safety controls. These are linked within the model to help make cross-referencing easier for the user. In total 71 bow-ties were developed. Training and awareness of the model and its use has been carried out in both Organisations.

Work on the Risk Model has now been completed.

The Joint Risk Model was presented to UKTram and shared with UK tram operators and infrastructure managers on 16th February 2018 at the UKTram's Head of Safety meeting.

The first risk profiling workshop held with UK tram operators and infrastructure managers on 22nd March 2018.

Following this work UKTram through the Light Rapid Transit Safety Standards Board (LRTSSB) has engaged Atkins to use the model developed in Croydon as a template for industry.

The joint risk model has been shared with ORR.

Route Risk Assessment

Appropriate safety controls have been identified from the RRA and are being considered by LT and TOL.

The final stage is to independently validate the RRA. Rail Operations Group (ROG) has been engaged as a competent organisation to carry out this work. Updated RRA information is presently with ROG for review and TOL Head of Safety has confirmed that the final RRA will be shared with ORR Inspectors after external validation.

Risk assessment is an iterative process and TOL will conduct reviews at planned intervals in line with safety management arrangements following network change; and after significant incidents to ensure it reflects significant risks and mitigations.

The methodology and output from the Route Risk Assessment will be shared with the various UK tram operators over the coming months.

TOL is currently reviewing these risk assessments and incorporating in both our driver training and competency assessments. This work will be completed by Autumn 2018.

Joint Risk Model

The Model will form part of the change control process, ensuring that modifications to assets, infrastructure and procedures are properly evaluated so that risk is managed to a level as low as reasonably practicable (ALARP).

TOL and LT are integrating use of the Model into their change management process.

TOL has begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

41. Tram Operations Ltd provided the following update on 28 September 2018:

TOL has completed an extensive review of its Route Risk Assessment Procedure for the Croydon Tramway and worked with LT to update the Joint Risk Model. The procedure for the Joint Risk Model has been updated and approved through the joint governance process and is actively in use to support the management of Risk.

Outputs from this review have been shared with the wider tram industry through UK Tram.

Route Risk Assessment

TOL has recently completed a Route Risk Assessment (RRA). The objective was to enhance understanding and control of route risk across the entire Croydon tramway. As part of the assessment TOL introduced new driver route knowledge arrangements based upon the guidance given in RSSB's Rail Industry Standards: RIS-3702-TOM (Management of Route Knowledge for Drivers, Train Managers, Guards and Driver Managers; and examples of existing arrangements used in mainline Train Operating Companies - set at a level appropriate for tram operations.

As part of the review TOL conducted a detailed assessment of the risks to passengers, staff and members of the public from the operation of trams and the infrastructure they run upon in service. TOL also identified the specific hazards associated with all routes across the tram network, the potential for harm and the appropriate risk control measures to be implemented in relation to them.

The training of new drivers now incorporates enhanced Route Hazard information. TOL have updated driver materials and are working with the training team and Health & Safety representatives to explore the best method to share the output of the RRA with drivers.

The lessons plans for the drivers have been updated to reflect the updated RRA. All the TOL Trainers and Assessors have also been trained on the Route Risk Assessment.

The findings from the RRA has been used to update the joint Safety Model, appropriate safety controls have been identified and are being considered by LT and TOL.

The RRA's have been independently reviewed by Rail Operations Group (a competent organisation) for sufficiency and content. Feedback from this review has been considered and amendments made where appropriate.

Outputs from this assessment have been used to update TOL's driver route knowledge DVD's and develop a driver route handbook. These developments are in the final stages of review and consultation prior to issue.

Risk assessment is an iterative process. TOL continue to conduct reviews at planned intervals in line with safety management arrangements following network change; and after significant incidents to ensure it reflects current risks and mitigations. An example of this continual review is the recent work carried out to identify locations where Physical Prevention of Over Speeding (PPOS) equipment and improved visual cueing for drivers within Croydon Town Centre is required.

Joint Risk Model

TOL and LT have jointly reviewed the safety risks associated with operation of the Croydon Tramlink system. The review examined tram operation, asset management and maintenance activities. Specific areas of focus included process management, the competence of our people, management systems, assets, infrastructure and external influences. As a result, the Hazard Event List from the previous Safety Risk Model has been updated and risk associated with each hazardous event type (and their corresponding controls) have been catalogued.

The new model uses the former Trams Safety Risk Model as a basis and builds upon the information it contained. The other risk models used within TfL (London Underground's QRA, DLR Safety Risk Model and the East London Line Safety Risk Model) have been referred to as part of a benchmarking exercise along with RSSB's Safety Risk Model to identify any foreseeable hazardous events not previously included in the Trams Safety Risk Model.

To enhance the benchmarking, notwithstanding the inherent differences with light rail, TOL and LT looked to heavy rail, for good practice given that the tram network is a guided transport system. By taking an external view and discussing each hazard in detail at workshops, the hazard list has been expanded and new hazards captured

in the Joint Risk Model. Tram incidents from other networks (including those abroad) have also been considered.

A safety bow-tie risk assessment has been completed for each hazardous event to identify risk mitigations and safety controls. These are linked within the model to help make cross-referencing easier for the user. In total 71 bow-ties were developed. Training and awareness of the model and its use has been carried out in both Organisations.

Work on the Joint Risk Model has now been completed and the model is in use on a day-to-day basis, as required. TOL and LT have integrated the use of the Model into their change management process.

The Joint Risk Model and review report have been shared with UK Tram's Subcommittee 1 who are working to develop a common Risk Model for use by Industry.

42. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

In order to fulfil the requirements of Recommendation 2, UKTram has defined a programme to develop a Risk Analysis Model which can be applied to all UK tramway systems and, where appropriate, to other light rail systems. The programme is being conducted in two main phases: an exploratory phase (Phase 1) to agree on a suitable model that can be applied to all systems, and a development phase (Phase 2) in which the model will be developed, tested and monitored on one tramway system, then rolled out to other systems nationally. Phase 2 comprises six sub-phases (2a to 2f).

At the present time, Phase 1 has been completed and Phase 2a, the definition of Terms of Reference for the project, is in progress. When completed, these Terms of Reference will be included in the LRSSB Business Case.

UKTram is also taking part in shaping a light rail section of the Railway Safety and Standards Board's (RSSB) Risk Model 3 (RM3) on behalf of the ORR. RM3 is an audit/healthcheck tool used by railway operators to assess how the management of key risks is being handled and how this fits with their current Safety Management System. UKTram has the opportunity to develop a light rail version of RM3 which will provide a templated 'Safety Management System healthcheck methodology' for the light rail industry.

RM3 also enables a pictorial view of the current state of safety and risk management competence to be developed on a "spider's web" basis. This will enable us to spread best practice across all systems by benchmarking and sharing results and methodology.

Using this light rail version of RM3 will enable all involved to review their safety management systems as a whole, to become more aware of their duties and liabilities and to see how well they are managing their risk from both the operator's and owner's/authority's position, thus raising the standard of safety management for each light rail system.

Phase 1: Explore available models

An expert team working on behalf of UK Tram has reviewed existing risk models across the light rail industry and concluded that the quantitative risk model adopted by Midland Metro fully meets the requirements of the RAIB recommendations. The model was initially developed by Atkins, being a subset of a model used by the Railway Safety and Standards Board (RSSB) for mainline railways. The model has been verified over a period of 12 months and been used for the risk analysis of the Midland Metro extension to Birmingham New Street.

This model has been shared with the Safety Managers of all UK systems, with general acceptance that it could be adopted across the industry; to develop another model would mean starting from scratch incurring significant cost and time penalties. This work has been completed and reported to UKTram Steering Board.

Phase 2a: Terms of Reference development

The objective of Phase 2a is to develop an agreed framework to direct later phases of the Light Rail Risk Analysis. Consultants Atkins, who developed the Midland Metro model being used as a basis for the work, have been engaged to develop this framework, and this work is currently on-going.

Phase 2a will build on the risk model tool option set out in Phase 1. Terms of Reference for the project are being produced through reviews with UK Tram and comparisons with information from the national incident reporting database and the Phase 1 analysis of the individual systems.

Atkins will use the Midland Metro safety risk model review tool as the basis for Phase 2a. Atkins will review the outputs of Phase 1 and information regarding the national incident reporting database such as the categories used. This will feed into draft proposals using information from other UK tramways and light rail systems for the six topics detailed below. The proposed approach will be discussed and agreed with UKTram.

The work, to be delivered in a brief report, will:

- *Recommend an approach to be taken when developing a risk model tool to close the gaps identified during Phase 1, including the consideration of a web-based application.;*
- *Identify and agree any further key preliminary decisions that could impact the approach for developing a risk model tool;*
- *Define how the interface between safety risk monitoring and safety risk review will function in the tool(s);*
- *Agree definitions to measure harm and the approach to take for safety targets. These will include:*
 - *Using Fatalities and Weighted Injuries for tramway accident consequences so as not to ignore major and minor injuries;*
 - *Defining 'fatality' as meaning death within a year of accident;*
 - *Defining 'major Injury' as per RIDDOR 95.*
- *Define the generic category lists for precursors, hazardous events and exposed populations. These will include:*
 - *Hazardous events, precursors - split by:*
 - o *tram accidents (eg derailment, collision, tram fire),*
 - o *low frequency-high consequence (credible worst case) accidents;*

- o movement accidents (eg person hit by tram, tram/stop interface);
- o non-movement accidents (eg assault, slips trips falls, depot accidents).
- Exposed populations: Agreement has been reached on a definition of:
 - o Passenger,
 - o Member of Public,
 - o Trespasser,
 - o Suicide,
 - o Staff, split into drivers, conductors, infrastructure maintainers, depot staff etc with numbers of each.
- Passenger journey statistics and tram distances travelled, network size and track lengths, number of crossings and split of segregated and other alignment characteristics.
- Agree the tool parameters which can be tailored at the individual system level.

Remaining phases of the Risk Analysis project

Following the development of an agreed framework for the Light Rail Risk Analysis project, the project will continue with the subsequent phases in order to develop the tool for specific systems, starting with one test tramway, and roll it out to other tramways and light rail systems. The phases which are envisaged are as follows:

- *Phase 2b: Development of the Monitoring and Review Tool and training material at the system level*

The objective of Phase 2b is to deliver the developed tool(s) and associated training material ready for application to an individual tramway system. . Using the terms of reference as scope, with the relevant requirements apportioned, it is proposed that monitoring and review tool functions are prioritised with national level and control assessment to follow on. It is expected that passive provision be made at the system level to cater for any national level requirements.

Training material will be developed in the form of presentation slides for use during training delivery and a basic manual detailing key processes used in the tool(s), troubleshooting and layouts. Training will cover the range of roles from those needing an appreciation of their use, those who will act as practitioners and those using the results.

- *Phase 2c: Application and delivery of the Monitoring and Review Tool and training material at the system level*

Phase 2c will see the tool(s) applied to each of the tramway and light railway systems and provide training to all required staff, starting with one 'test' tramway system. The operator will be supported through the application of the tool(s) to their individual system.

The remaining, agreed systems will then be supported in the same manner on a package by package basis.

Further work phases of the Risk Analysis project

Following the successful roll-out of development of the Monitoring and Review Tool and training material to all existing UK tramway and light rail systems, further phases are envisaged as follows:

- *Phase 2d: National Level Integration This phase would look to put in place the items needed for maintaining a national level overview. The existing national Tram Accident and Incident Reporting (TAIR) database will be updated and used as the input tool into the risk model to reflect the agreed definitions of parameters and categories. Training will be provided as per Phase 2c, subject to UKTram agreement to its adoption and use by all systems.*

It is acknowledged that a key risk for the tools is that they are inadequately used once they are rolled out, resulting in an inconsistent application. This will be mitigated by engagement with the operators in development, to ensure that the

tools are fit for purpose, their use is seen as beneficial rather than a duplicate or additional activity, and training is targeted to create the required awareness across the organisations.

- *Phase 2e: Control Measure Assessment Guidance It is key that those involved in the industry first understand the principles of the process expected of them, both to eliminate and mitigate risk when introducing a change to the system and also as an ongoing process to manage the existing safety risk to a level that is As Low As Reasonably Practicable (ALARP). For this reason, the primary focus of Phase 2e should be to deliver a high-level guidance document and briefings to promote consistency and adequacy in the assessment and application of control measures.*

A control measure assessment tool is required and will provide a template form suitable for recording an assessment of control measure options.

It should be recognised that there is a significant amount of guidance, training and tools already available to those in the industry and therefore care should be taken not to duplicate existing material.

- *Phase 2f: Low Frequency, High Consequence Events Guidance Existing UK and international risk models and accident data should be used to form a consensus of each hazardous event. Key objectives will be for the results to provide frequencies, contributions of precursors and expected injuries of outcomes.*

Guidance of methodology taken and use of the output in the context of use at system level will need to be developed, then output can then be provided to

those at system level for use in their models. It is suggested that the operators should be encouraged to evaluate the data to inform inputs to their specific review tool according to their systems' distinctive characteristics.

- **Phase 2g: Safety Target Guidance**

The approach for safety targets is comparable to that of control measure assessment and therefore a similar approach to Phase 2e is suggested. Safety targets are likely to come to the forefront during earlier phases when considering monitoring and the approach at national and system level. The decision could be either to accelerate this phase or to use an agreed interim solution with provision for updates later. Again, existing guidance would need to be reviewed and care should be taken not to duplicate existing material.

Recommendation 3

43. In Its response of 30 May 2018 Blackpool Transport stated the following:

A review of currently available speed control systems is currently being undertaken by a UKTram appointed team. The team will produce report (in conjunction with a vigilance device/systems report) for November 2018 with options that are available to operators, with the benefits, drawbacks and potential impacts of each system, as well as the Human factor impact of each. This will allow Blackpool Transport to determine what speed control measures are appropriate for their system if any.

Recommendation 3 will be considered based on output of the industry risk model from Recommendation 2 for Blackpool Transport.

Trials of technologies are planned as part of this investigation and subsequent report issued, Blackpool Transport will participate in a trial of a Bombardier system.

44. In Its response of 29 May 2018 Blackpool Council stated the following:

Our system operates at relatively low speeds, the maximum being 50 kph. The tightest curves on the mainline, segregated areas (50kph) are 124m radius. At these locations there are natural speed enforcement elements, such as controlled crossings, S&C or a platform. Due to the close proximity of these lower speed areas, this reinforces the speed of the trams at "high risk" locations. Additionally, unannounced speed checks are regularly conducted by BTS management to ensure compliance. This heightens driver awareness regarding line speed.

Following the recommendations from the RAIB report, it was noted on the south bound approach Bispham station involved a potential sharp decrease from 50 to 15 kph with a 30 kph a short distance away from the 15kph zone. Following an assessment it was agreed and acted upon to move the 30 kph sign further north achieving a speed reduction distance of 60m to enhance the stepped down approach to the 15kph limit.

45. In Its response of 30 May 2018 Edinburgh Trams stated the following:

ET has enhanced the settings of the Driver Vigilance and Driver Safety Device to mitigate this to the extent that every 400 metres the driver must take a positive action to reset the hardware or an automatically controlled braking of the vehicle will occur. Additionally ET also carries out sample review of the vehicle data recorder to ensure drivers are driving to the correct speed limit and appropriate use of traction demand and braking is being followed. We would argue that this significantly reduces an already small risk that the driver is not aware and so mitigates the risk associated with this recommendation SFAIRP.

ET fully support the work currently being undertaken by Subcommittee 1 and await the actions that may arise from the report that is due in November 2018.

In the meantime, we have received and are reviewing potential solutions and proposals in relation to this recommendation from our tram manufacturer/ maintainer; and these will be considered in conjunction with the outputs of the UKTram Subcommittee work.

46. In Its response of 31 May 2018 Edinburgh City Council stated the following:
See response to Rec 1 above.

47. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

Automatic reduction of tram speed as trams approach higher risk locations.

A review of currently available speed control systems is currently being undertaken by a UK Tram appointed team and a report is anticipated to be delivered in November 2018. The report will also consider the benefits, drawbacks and potential impacts of each of the systems, which will support KAM in any subsequent assessment to determine what, if any, additional speed control measures are to be introduced, in addition to current controls.

48. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

TfGM will make a decision on this recommendation following the outputs of a UKTram study of available options, the outputs of the risk model outlined above and developments in Croydon where we believe a tender exercise is being performed with a view to installing such a system on its fleet and infrastructure.

TfGM has had some discussions with a supplier who could provide a speed warning or advisory system. This system could possibly be linked to the tram braking systems. We are exploring the possibility of conducting an initial trial to assess the feasibility of a system.

In addition to this, TfGM are in the process of procuring new trams. As part of our discussions with the tram supplier we explored options to implement such a system by augmenting their video obstacle detection system which is currently being trialled in Europe.

It is too early to tell whether the above solutions are feasible for Metrolink but we will continue exploring options and align to the work being undertaken by UKTram.

49. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *NX Metro has introduced step down signage and removed any decrease in speed greater than 30 Kph.*
- *NX Metro route risk assessment identifies the only high risk curve on the network is between Stephenson Place and Stephenson Street in Birmingham which has a 10kph speed restriction in place.*
- *NX commissioned a report by Huddersfield University in 2016 into the derailment risk at Stephenson curve and the derailment risk was at speeds in excess of 18 kph. However the risk of overturn is 37 kph and there is significant infrastructure to minimise the risk of overturn.*
- *In 2017 NX MM commissioned a RSA 3 audit of the system, less Bilston Rd section, the only outstanding action is the replacement of some signage which will be completed after the whole route risk assessment is completed to ensure that all work is only carried out once.*
- *NX MM are carrying out a whole route risk assessment, approx 50% complete to ensure that all the risks are still current.*

50. In Its response of 31 May 2018 Transport for West Midlands stated the following:

It is our opinion that the primary focus of the duty holders should be to reduce so far as is reasonably practicable the risk of a tram derailing /overturning as a result of the design of the infrastructure.

We have supported National Express in their review of the existing infrastructure and are satisfied that there are no locations on Midland Metro that are analogous to Croydon (i.e. low speed curve approached from a "high" speed straight). Our highest risk of derailment has been identified by National Express on the highway section in Birmingham at Stephenson Place curve at which the overturning speed has been calculated by CAF as 37km/h. This curve has a permanent speed restriction of 10km/h; is provided with derailment containment; is on street and is approached at low speed from the Grand Central and Corporation Street compulsory tramstops.

In conjunction with Edinburgh Trams, TfU1IM has written to our tram supplier, CAF, to seek their views on this recommendation. In discussions with TfWM and National Express CAF have advised that a system to automatically limit /reduce the speed of trams could be developed for use at high risk locations using Balogh tags and a PLC interfacing with the trams Traction Control Unit, HMI, Speedometer and event recorder. A system similar to this is currently being introduced by CAF on the Midland Metro vehicles to automatically control the pantograph on the entry /exit of catenary free sections of infrastructure and could in theory be adapted to provide this additional functionality.

Together with our new Operator, Midland Metro Limited, we will re-evaluate the risks of derailment /overturning on Line One and on the Metro extensions being developed by the Midland Metro Alliance using the industry standard risk model being developed by UKTram and will also assess the human factors implications of

implementation of automatic speed management systems. Where deemed appropriate to reduce risk to So Far As Reasonably Practicable levels we will implement the change.

CAF have indicated that if the decision were made to adopt their solution they do not consider this additional functionality would impact upon the SIL approval requirements for the vehicle. We are however also aware and supportive of the industry wide review being undertaken by UKTram of currently available vehicle speed management systems and we will assess the findings of this review to ensure that if it is determined a speed management system is appropriate we apply solutions that are consistent with industry best practice recommendations for both the vehicle and our operational systems.

We will shortly be commencing procurement of additional vehicles for the Midland Metro network and we have sought the views of the supply sector on this recommendation as part of our pre-tender market testing review.

51. Transport for West Midlands provided the following update on 1 October 2018:

WMM has now received information from CAF relating to their proposal to adapt the Balogh tag based pantograph control system (currently being implemented on the Urbos 3 fleet as part of the catenary free operation modifications) as a means of setting and controlling maximum tram speeds at critical locations. As previously noted a decision on what if any locations would benefit from the implementation of such additional driver aids, taking account of the human factors impacts of such a change to the vehicle control systems will be made once the industry standard risk model is available to aid the assessment.

WMM has attended meetings organised by UKTram with Ian Rowe Associates to assess the various systems identified as potential means to meet RAIB's recommendation 3.

52. In its response of 29 May 2018 Nottingham Trams stated the following:

NTL are cooperating with the UK Tram working group investigation into appropriate technologies to provide train speed monitoring and control systems including detailed tram system risk assessments and the consequent need for automatic speed control as a risk mitigation. The timescale for the initial industry assessment is estimated to be between 18-24 months. While this work is undertaken NTL have implemented the control measures as described in Recommendation 5 below.

53. In its response of 30 May 2018 Nottingham City Council stated the following:

A working group has been appointed by UK Tram to review currently available speed control systems that can be used in trams. A report on the options that are available to owners and operators, with the benefits, drawbacks and potential impacts of each system, is due to be completed in November 2018, in conjunction with a vigilance device / systems report, which will allow operators to determine what speed control systems are appropriate for their system, if any. It is proposed that the outcomes of

this review will be considered alongside the industry-wide risk model, referred to under Recommendation 2.

54. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

A working group has been appointed by UK Tram to review currently available speed control systems that can be used in trams. A report on the options that are available to owners and operators, with the benefits, drawbacks and potential impacts of each system, is due to be completed in November 2018, in conjunction with a vigilance device I systems report, which will allow operators to determine what speed control systems are appropriate for their system, if any. It is proposed that the outcomes of this review will be considered alongside the industry-wide risk model, referred to under Recommendation 2.

55. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

Automatic speed reduction technology is already fitted to the new Citylink vehicles in the form of TPWS equipment, allowing it to operate on the mainline rail, however this technology will not be active on any part of the existing tramway infrastructure.

Automatic speed reduction could involve a significant and disruptive change to the current fleet and infrastructure. We will continue to consider solutions identified within the industry for their suitability and practicality for Sheffield, following ALARP principles.

An initial meeting has been held with Thales to explore the practicalities of TPWS and we are awaiting some initial indicative costs. However, initial discussions have suggested that the technology more sensibly aligns with any change to the signalling and control system that may be included as part of the Sheffield Mass Transit Strategy (for Sheffield City Region up to 2040). Implementation would also likely need to consider transferability to any new fleet.

56. Stagecoach Supertram provided the following update on 26 September 2018:

Supertram have further explored potential options for automatic speed reduction technology that would be suitable for the Sheffield network and trams. The indicative costs received for TPWS on only some parts of the tramway indicated that this technology is not a feasible option to control speed on the tramway. We are meeting with London Trams to understand if any of the technology-related work already conducted there can be of benefit to Sheffield. We continue to monitor the progress of the UK Tram Working Group researching suitable technologies for tramway driver vigilance and speed control. Finally we are also looking at potential technologies within the Stagecoach Group that may have some transferability onto tramway.

57. In Its response of 31 May 2018 South Yorkshire PTE stated the following:

Regarding recommendations 3 to 8 South Yorkshire Supertram is operated under a Concession Agreement with South Yorkshire Supertram Limited (SYSL). SYPTE is

being kept updated on the work that SYSL is doing in order to understand the implications of the Sandilands incident on Supertram and supporting this work as required.

We will continue to work with SYSL to understand what practicable changes can be made regarding recommendation 5 following a review of their route risk assessments. SYSL has also approached potential suppliers that may form part of a response to recommendations 3 and 4. We along with SYSL 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 in order to ensure that such control measures are practicable.

58. South Yorkshire PTE provided the following update on 28 September 2018:

We continue to monitor the progress of the UKTram Working Group researching suitable technologies. On the 10 October we will be sitting with our Concessionaire South Yorkshire Supertram Limited to review work to-date and potential way forward on this from a South Yorkshire perspective.

59. In its response of 30 May 2018 Transport for London (London Trams) stated the following:

In order to determine a suitable automated braking system for retrospective fitment to the LT fleet, LT has engaged a specialised consultancy and conducted a global search into appropriate proven technologies.

LT briefed other UK Tram owners and operators on this process and intent at various UKTram Summits, and has shared the documented outcome of this research with UKTram.

This research has enabled LT to prepare a Technical Specification for a suitable automatic braking product, and a competitive procurement competition has now been launched via OJEU to find and select a compliant automatic braking system. The target date contract award for delivery of the system is December 2018, with full fleet roll out and implementation planned by December 2019.

First Group's Tram Operations Limited (TOL) who operate trams on our behalf has been an active stakeholder on this initiative.

LT also supports UKTram's subcommittee 1 which is undertaking a review of currently available speed control systems. The UK Tram appointed team will produce a report (in conjunction with a vigilance device/systems report) for November 2018 with options that are available to operators, with the benefits, drawbacks and potential impacts of each system, as well as the Human Factors impact of each. This will allow LT/TOL as well as other Duty Holder/Operators to determine what speed control measures are appropriate for their system, if any. Recommendation 3 should be considered based on the output of the Industry Risk Model from Recommendation 2 for each individual operation.

Trials of technologies are planned as part of this investigation and subsequent report, operators will be asked to participate in these trials.

60. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 3 (automatic speed reduction) – In order to determine a suitable automated braking system for retrospective fitment to the London tram fleet, we engaged a specialised consultancy and conducted a global search into appropriate proven technologies. We briefed other UK Tram owners and operators on this process and intent at various UKTram Summits, and have shared the documented outcome of this research with UKTram. This research has enabled us to prepare a Technical Specification for a suitable automatic braking product, and a competitive procurement competition has now been launched via OJEU to find and select a compliant automatic braking system. The target date contract award for delivery of the system is December 2018, with full fleet roll out and implementation planned by December 2019. First Group's Tram Operations Limited (TOL) who operate trams on our behalf has been an active stakeholder on this initiative.

We also supports UKTram's subcommittee 1 which is undertaking a review of currently available speed control systems. The UK Tram appointed team will produce a report (in conjunction with a vigilance device/systems report, recommendation 4) for November 2018 with options that are available to operators, with the benefits, drawbacks and potential impacts of each system, as well as the Human Factors impact of each. This will allow all Duty Holder/Operators to determine what speed control measures are appropriate for their system, if any. Recommendation 3 should also be considered based on the output of the Industry Risk Model from Recommendation 2 for each individual operation. Trials of technologies are planned as part of this investigation and subsequent report, operators will be asked to participate in these trials.

61. In Its response of 31 May 2018 Tram Operations Ltd stated the following:

TOL / LT identified and completed speed signage and speed reduction activities.

Maximum speed levels across the tramway were reduced from 80 to 70 kmph. This is a permanent speed reduction.

Step-down speeds have been introduced 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. The intermediary speed-boards enable drivers to transition effectively and safely between different speeds without undue heavy braking.

TOL and LT reviewed speed signs on the tramway network and decided to increase visibility of a number speed signs. New signs have a yellow high visibility edge to them and were provided to indicate to the driver they are entering a curve or bend and a lower speed is required.

New chevrons have been put at locations deemed as high risk on the tramway indicating to drivers an upcoming sharp curve.

Lineside digital signage has also been installed at locations of high risk providing the driver with speed information should a violation occur.

The speed signage and speed reduction activities have been completed.

Increased Visibility of Speed Signs

As part of regular engagement with the drivers and controllers TOL has received feedback that the TAS signs do not appear to be calibrated as expected. TOL has shared this with LT whose team are reviewing the equipment with a view to propose recommendations, which may include alternative products or recalibration of the existing "TAS".

Physical Prevention of over-speeding (PPOS)

A project currently being led and managed by LT is looking at requirements for provision of a Physical Prevention of Over-speed System (PPOS). This device is anticipated to be installed over a 14-month period on the infrastructure (track and tram). Timelines to be confirmed.

TOL has begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

62. Tram Operations Ltd provided the following update on 28 September 2018:

TOL and LT identified two projects to support this recommendation:

- Signage and Speed Reduction*
- Physical Prevention of over-speeding (PPOS)*

The signage and speed reduction also support RAIB recommendation 5.

Signage and Speed Reduction

Following Sandilands one of the first activities carried out by LT and TOL looked at improving safety by providing further aids to support drivers to maintain and adhere to the various operating speeds across the Croydon tramway, this included:

- Reduction in maximum speed limits*
- Step-down speed boards*
- Increased visibility of speed signs*

TOL's involvement was to provide operational input and to consult with the recognised Trade Unions. These aids have been introduced to support the general day-to-day operations of the tram service and the drivers have accepted they enhance awareness of their surroundings.

- Reduction in maximum speed limits*

Maximum speed levels across the tramway have been reduced from 80 to 70 k/mph. This permanent speed reduction has been completed.

- Step-down speed boards*

Step-down speeds have been introduced 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. The intermediary speed-boards enable drivers to transition effectively and safely between different speeds without undue heavy braking.

The locations where step-down speed board have been placed are: Lovelane Curve, Larkham Close, Sandilands (both ways) and Addington Village.

TOL provided operational input, identified the high risk locations and engaged with the drivers and Trade Unions. This activity has been completed.

- *Increased visibility of speed signs*

TOL and LT reviewed speed signs on the tramway network and decided to increase visibility of a number speed signs. New signs have a yellow high visibility edge to them and were provided to indicate to the driver they are entering a curve or bend and a lower speed is required.

New chevrons have been put at locations deemed as high risk on the tramway indicating to drivers an upcoming sharp curve.

Lineside digital signage has also been installed at locations of high risk providing the driver with speed information should a violation occur.

As part of regular engagement with the drivers and controllers TOL has received feedback that the Tram Activated Signage (TAS) signs do not appear to be calibrated as expected. TOL has shared this information with LT and an alternative solution that draws on good practice from highways will be introduced. The technical specification for this solution is being prepared by LT for consideration by the Modifications Panel.

Physical Prevention of over-speeding (PPOS)

A project currently being led and managed by LT is looking at requirements for provision of a Physical Prevention of Over-speed System (PPOS). This device is anticipated to be installed over a 14-month period on the infrastructure (track and tram). Timescales for completion will be confirmed by LT.

To date TOL have been involved by providing operational input to the design specification, including assisting with identification of the high risk locations for potential speeding. A recent review of the visual cues in Croydon Town Centre was carried out, with some proposed changes to be made (see Recommendation 1.2 Route Risk Assessment).

LT have completed a competitive tender for design and supply of PPOS equipment. Once the full specification and operational impact is determined TOL will consult the options with its Trade Union Safety Representatives.

63. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

UKTram has reviewed the availability of technical devices for automatically monitoring and/or controlling the speed of a tram on the approach to junctions and other key locations.

Recommendation 4

64. In Its response of 30 May 2018 Blackpool Transport stated the following:

A review of currently available driver vigilance devices and systems are currently being undertaken by an UKTram appointed team. The team will produce report (in conjunction with the speed control systems report) for November 2018 with options that are available to operators, with the benefits, drawbacks and potential impacts of each system, as well as the Human Factor impacts of each system/device. This will allow Blackpool Transport to determine what vigilance devices are appropriate for their system if any, in addition to the current vigilance device currently installed in the drive brake controller.

Recommendation 4 will be considered based on output of the industry risk model from Recommendation 2 for Blackpool Transport.

Trials of technologies are planned as part of this investigation and subsequent report issued, Blackpool Transport will be willing to participate in these trials.

65. In Its response of 29 May 2018 Blackpool Council stated the following:

A UKTram appointed team is currently evaluating driver vigilance systems. The working group will produce a report (in conjunction with the speed control systems report) for November 2018. The report will analyse the potential impacts, benefits and drawbacks. This element will be led by Blackpool Transport Services with the support of Blackpool Council as this is more suited to system operators. Any future technologies available to safeguard for driver error/fatigue will be appraised by the Council and BTS, reported through the TSMG. This could supplement our current vigilance system or be a replacement.

66. In Its response of 30 May 2018 Edinburgh Trams stated the following:

ET fully support the work currently being undertaken by Subcommittee 1 and await the actions that arise from the report that is due in November 2018.

In the meantime, we have received and are reviewing potential solutions and proposals in relation to this recommendation from our tram manufacturer/ maintainer; and these will be considered in conjunction with the outputs of the UKTram Subcommittee work.

67. In Its response of 31 May 2018 Edinburgh City Council stated the following:

See response to Rec 1 above.

68. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

A review of currently available driver vigilance devices and systems are currently being undertaken by a UK Tram appointed team and a report is anticipated to be delivered in November 2018. The report will also consider the benefits, drawbacks

and potential impacts of each of the systems, which will support KAM and TFGM in any subsequent assessment on the feasibility of retrospectively fitting a device to the existing fleet.

KAM will support TFGM in the opportunity provided by the procurement of new trams for the Metrolink system to review potential solutions, associated with driver vigilance at the design stage, utilising the output from the industry risk model, recommendation 2.

69. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

UKTram is studying options for various systems through a review group and TfGM is awaiting the outputs of that work before deciding if a system is appropriate for use on Metrolink.

TfGM and the Metrolink Operator KAM attended a TfL “Lessons Learned” workshop which demonstrated some in cab solutions.

TfGM is exploring options to improve the existing “deadman” system by moving to a vigilance based system, similar to heavy rail rolling stock.

TfGM intend to work with KAM to consider the options once the UKTram work is complete.

70. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *NX Metro currently have a Driver Safety Device that requires a vigilance response from the driver every 30 secs, the driver has 4 seconds to acknowledge the alarm. In the event of the driver not monitoring the safety device or failing to respond to the alarm application of the emergency brakes is triggered. The failure mode of the system is “fail safe”, ie application of the emergency brakes.*
- *NX were briefed by the team from All Seeing Machines Guardian System. Although there are definitely positive aspects of the technology it does not interact with the vehicle so relies on the driver being alerted and taking action if they are inattentive.*
- *NX have sought advice from the ORR and are investigating a reduction in the 30 second dwell time on the DSD system currently fitted to the trams, there is a medium between 15 seconds, the original factory setting and 30 seconds where the system will not be a distraction to observation and distance travelled in a moment of inattention.*
- *NX Metro are investigating the potential for Driver vigilance being a distraction to drivers on highway operations, and whether this requires to be reviewed as the dynamic of the system changes with planned extensions.*

71. In Its response of 31 May 2018 Transport for West Midlands stated the following:

The Urbos 3 tram vehicles already incorporate an operational 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 Emergency brakes in the event of a DVD system failure.

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.

National Express have been requested by the ORR 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 (i.e. potential for drivers to develop an automatic response rhythm) need to be taken into account along with other potential risks such as driver distraction (particularly on street) and repetitive strain injury. This review will be concluded by Midland Metro Limited following transfer of the operation of the tramway on 24 June.

We are cognisant of the industry review being undertaken of current available driver vigilance devices and systems and will assess findings of the review taking into consideration the benefits, drawbacks and potential impacts of each system, as well as the human factor implications associated with each system/device in order to ensure application of appropriate and compatible best practice options to our vehicle systems if deemed applicable.

Subject to the results of the UKTram led review of driver vigilance systems and the conclusion of the review of the Urbos 3 DVD timings we believe Midland Metro's arrangements address the requirements of this recommendation.

72. Transport for West Midlands provided the following update on 1 October 2018:

MML has commissioned Ian Rowe Associates to undertake a human factors analysis of the proposal to reduce the frequency of the Driver Vigilance Device fitted by CAF to the Urbos 3 tram fleet from 30s to 15s. An assessment has been completed which included driver behaviour and workload monitoring and a report is currently awaited. If the report supports the proposed reduction in DVD interventions staff consultation will take place and subject to a satisfactory outcome the change will be implemented thereafter.

73. In its response of 29 May 2018 Nottingham Trams stated the following:

Both NTL trams types are currently fitted with a Driver Safety Devices. Systems to detect driver attention state are being investigated by UK Tram. When complete it is anticipated that a relevant standard will form part of the industry national standards. Subject to these requirements NTL will work with the tram manufacturers and subsystem suppliers to understand the feasibility of modifying the Citadis and Incentro fleets.

Additionally, UKTram are investigating driver fatigue and attentiveness monitoring systems that provide real-time alerts to both drivers and system controllers. Depending on the findings these systems might be preferable to traditional vigilance systems.

Also see response to Recommendation 11.

74. In Its response of 30 May 2018 Nottingham City Council stated the following:

Research and evaluation of systems capable of reliably detecting driver attention state and of initiating automatic responses when necessary, is included in the work that is being undertaken by UK Tram and the shadow LRTSSB, on behalf of owners and operators. A report into the benefits, drawbacks, and potential impacts of possible options, is due to be produced in November 2018. Trials of technologies, in which operators will be asked to participate in, are planned to be undertaken as part of this research. If a suitable technology is identified, it is intended that it would be considered against the industry-wide risk model, referred to under Recommendation 2, for each individual operator.

75. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

Research and evaluation of systems capable of reliably detecting driver attention state and of initiating automatic responses when necessary, is included in the work that is being undertaken by UK Tram and the shadow LRSSB, on behalf of owners and operators. A report into the benefits, drawbacks, and potential impacts of possible options, is due to be produced in November 2018. Trials of technologies, in which operators will be asked to participate in, are planned to be undertaken as part of this research. If a suitable technology is identified, it is intended that it would be considered against the industry-wide risk model, referred to under Recommendation 2, for each individual operator.

76. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

The Citylink fleet has a vigilance device fitted designed to apply service brakes in the event of driver inattentiveness. The driver has to regularly release and reapply pressure to demonstrate a level of focus on the task in hand. All Supertram drivers are given the opportunity to drive the newer Citylink fleet and this will continue to be the case in the future.

We have observed the Croydon driver alertness system in use during the UKTram Summit in January 2018. Since then we have also met with the supplier of this technology to introduce the concept to more of the senior management team.

There is a possibility that this technology could have potentially played a mitigating role in previous high risk incidents that have occurred on the Supertram network. Of further interest to Supertram are the added potential benefits of more proactive health and wellbeing data that could help our drivers, however this must be balanced with the resources needed to implement and manage this data. The feasibility of implementing this technology will be supported by the level of risk identified through Recommendation 2 (Safety Risk Modelling) and a cost benefit analysis.

77. Stagecoach Supertram provided the following update on 26 September 2018:

Supertram' 25 Siemens vehicles were fitted with in cab CCTV in March 2018. This vantage point has been extremely useful in understanding human behaviour in relation to numerous safety incidents involving drivers, including in the recent Middlewood incident.

A quote has also been obtained for installing CCTV into the 7 Citylink vehicles however the cost is prohibitively high and would likely be unusable on the mainline railway whilst vehicle deviations from standards were sought.

78. In Its response of 31 May 2018 South Yorkshire PTE stated the following:

See response to Rec 3 above.

79. South Yorkshire PTE provided the following update on 28 September 2018:

See updated response to Rec 3 above.

80. In Its response of 30 May 2018 Transport for London (London Trams) stated the following:

Working closely with our operator First Group's TOL, we have selected the Seeing Machines "Guardian" device as the optimum solution to ensure driver alertness. The Guardian device was fully implemented across the LT fleet in October 2017.

An additional feature of the Guardian system is that it is programmed to alert drivers if the vehicle speed goes above 70 kph.

TOL were closely involved in the selection and implementation of this system and played the major role in securing driver support.

LT and TOL have already hosted several delegations, including UKTram and others, to demonstrate the technology in operation. LT also supports the work of UK Tram subcommittee 1 noted below.

The UK Tram subcommittee 1 is undertaking a review of currently available driver vigilance devices and systems. The team will produce a report (in conjunction with the speed control systems report) for November 2018 with options that are available to operators, with the benefits, drawbacks and potential impacts of each system, as well as the Human Factor impacts of each system/device. This will allow each Duty Holder/Operators to determine what measures are appropriate for their system if any. Trials of technologies are planned as part of this investigation and subsequent report, operators will be asked to participate in these trials.

81. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 4 (driver attention) – working with our operator First's Group TOL we fully implemented the Seeing Machines 'Guardian' device which meets this

recommendation on our system. This was completed in October 2017. We have shared and demonstrated this technology with the UK Tram industry. We are working with UK Tram's subcommittee 1 which is undertaking a review of currently available driver vigilance devices and systems. The subcommittee has selected a number of devices for trial and will report on the options available in November 2018 such that each duty holder/operator can determine the most appropriate solution for their system, if any.

82. In Its response of 31 May 2018 Tram Operations Ltd stated the following:

LT and TOL have worked with Seeing Machines to implement the Guardian Device in all trams.

The system monitors eye and face movements to detect the onset of fatigue or distraction.

- Fatigue symptoms monitored include restlessness, yawning, drooping eyelids and microsleeps*
- Distraction is indicated by driver's head not pointing in a forward-facing direction.*

Fatigue alerts are made using a vibration motor / audible alarm directly mounted on the driver's seat.

Distraction alerts are made using an audible alarm if the driver's attention is diverted from the forward-facing eye position for more than four seconds at speeds over five kmph.

Physical and audible alerts are additionally monitored by Guardian's 24/7 SafeGuard Centre who contact TOL's Control Centre in real time if a fatigue event is detected.

Implementation of the system has gone well, and the Guardian is working as expected with drivers being alerted as appropriate by the in-cab device.

The Guardian Device has been demonstrated to ORR during a visit to the Tram Depot on 8th March 2018 and again on 15th May 2018 along with the General Secretary of ASLEF and the TOL full time officer.

TOL has shared the findings from the Public Health England report with its recognised Trade Unions and staff.

TOL will continue to monitor the performance of the Guardian Device.

TOL has begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

83. Tram Operations Ltd provided the following update on 28 September 2018:

TOL believe the implementation of the Guardian device addresses the requirements of this recommendation. The Guardian device was installed in October 2017 and is operating effectively.

TOL monitor the performance of the Guardian Device through daily reports that are produced (Tram Report and Incident Log), supported with information from the System status and activation reports provided daily to TOL from Seeing Machines.

This real-time data and customised reports from the Guardian Device provided TOL with the number, frequency and type of alerts for each driver. This information is used to help manage fatigue as part of our Just Culture programme.

Fatigue Management Policy.

TOL has reviewed and updated its existing fatigue management arrangements. Part of this work included development of a Standard Operating Procedure for management of Guardian Device alerts. This procedure was shared with staff representatives before implementation. The procedure explains how fatigue events are managed, including immediate actions to be taken by the driver and control room staff; and where appropriated putting in place a fatigue management plan.

Incidents of fatigue or distraction are captured and held in our central database. This detailed level of information enables TOL to support drivers manage contributory personal factors and allows for reviews of work schedules at an early stage.

Fatigue Training

TOL have enhanced their fatigue training for all tram drivers. The lesson plan structure has been refreshed to ensure for fatigue management to ensure key elements relating to fatigue management are covered:

- Stage 1 Definition and Causes*
- Stage 2 Effects of Fatigue*
- Stage 3 Lifestyle Advice.*

The aim is to encourage open discussion about fatigue, its causes, effects and to provide staff with the information to recognise its onset and techniques to effectively manage it. The lesson plan is supported using media that includes viewing 'The 21st Century Driver' DVD and a CIRAS DVD to help build awareness of key messages and promote a reporting culture.

Work to improve the quality of fatigue training materials continues (see below).

Fatigue Risk Management System

There are several elements that TOL has been working on with third parties. TOL has engaged Clockwork Research Ltd to support improvement of its Fatigue Risk Management System. Clockwork are recognised experts in this field with a strong reputation in the Aviation, Heavy Mining and Petrochemical Industries.

Clockwork Solutions Ltd

Three phases of work were identified:

Phase 1: *Assessment of current arrangements against good practice, enhanced biomathematical modelling of staff rosters using the SAFTE-FAST tool and delivery of a driver fatigue risk workshop programme. This phase has been completed.*

Phase 2: *Enhancement of Internal Fatigue Risk Management Capability – establishing a Fatigue Safety Action Group, improving fatigue risk management arrangements, reviewing staff rosters and developing enhanced fatigue training for safety critical staff, key safety personnel and those outside of the immediate work environment (improving knowledge of fatigue amongst workers families). This phase of work is ongoing.*

Phase 3: Provision of ongoing expert support to review the effectiveness of TOL's Fatigue Risk Management arrangements.

Outcome to date

Ahead of the conclusions of the Clockwork review from Phase 1, TOL implemented enhanced monitoring of driver overtime and rest day working; and training and briefing for drivers and those managing them. Safety critical staff maximum working hours were reduced and the safety rules for changing driver rosters were enhanced.

A series of Fatigue risk workshops took place in January 2018 during which time 60 drivers and revenue protection staff that regularly drive trams were engaged with. Driver feedback from the workshops is being used to develop and augment our existing Fatigue Risk Management arrangements.

One key output from Phase 1 was a Fatigue Risk Management System Recommendations and actions plan. This identifies 11 recommendations for TOL to implement. Phases 2 and 3 have been approved at the July TOL Board Meeting. Phase 2 of this work commenced on 10th September 2018.

84. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

Building on work by TfL, UKTram has reviewed the availability of Driver Vigilance Devices (now named Driver Inattention Devices) which could monitor the alertness of a driver, and detect when the driver is likely to lose concentration. Some devices could take action such as applying the brakes when loss of alertness is detected; some would simply sound an alarm.

Recommendation 5

85. In its response of 30 May 2018 Blackpool Transport stated the following:

Blackpool Transport have reviewed their signage and have not introduced additional signage. Illuminated warning signs are being trailed by London Tram's and they will feedback to Subcommittee 1 on the impact of these signs. On completion of the trial Blackpool Transport will review their signage again.

This subject was also addressed via the UK tramway industry questionnaire, and trials of active signage are being shared by all operators within the industry and incorporated into industry best practice guidance on signage and lighting.

Subcommittee 1 reminded all operators that any tramway signage must take into account the driver's existing line knowledge. The need for signage and technology enhanced signage continues to be reviewed by UK tramway operators through UKTram Subcommittee 1.

86. In its response of 29 May 2018 Blackpool Council stated the following:

Considerable investment is made into training and retaining experienced tram drivers. The system is operated on a line of sight and due to the topography of the

system (generally flat and straight) and its location (mainly in the close vicinity of a public highway) it is generally well lit and has a very good line of sight. In all the "high risk" areas (shared space) the track speed is a maximum of 30 kph, with frequent stops (platforms and crossings). All these factors contribute to self-enforced lower speeds, originally determined from the initial speed risk assessment.

Following the initial Sandilands Urgent Safety Advise, one sign position was adjusted (noted in recommendation 3). This resulted in Blackpool Council and BTS have reviewing all our speed limits, signs and "high risk" areas. It concluded that our system did not require any additional signage. However, if recommendations are made at a later date through any committees, then the system will be re-evaluated. Any alterations/improvements will be submitted to the TSMG for approval.

Consultation with DfT was considered as not necessary as all our signs comply with the applicable guidelines in TSRGD issued by Oft as well as RSP2 /(TGN3) and the ORR Technical Guidance 4. However, following any future appraisals on our system as a result of these recommendations highlighting any change in signage, the Council will fully support any appropriate changes required.

87. In its response of 30 May 2018 Edinburgh Trams stated the following:

In late 2016 Edinburgh Trams reviewed the locations where trams could potentially need to brake from 70kph to less than 30kph, of which there were three. Of these we were satisfied that existing measures were sufficient at two curves. At the third location (on the approach to IPR tram stop city bound) a red bordered '15kph' sign with an attention plate above has been added as a visual reminder to slow down to 15kph before the curve into IPR tram stop.

We are now comfortable that all speed limit signs are located sufficiently in advance of the curves so as to allow for reaction time and braking distance from the approach speed, and the ORR have been engaged on all of the above

In addition we are also rolling out SmartDrive in 2018. This has been developed in partnership with The University of Birmingham Centre for Rail Research and Education and uses detailed route modelling analysis to identify optimum movement sequences - such as points along the route where the driver should coast and brake, or be travelling at an optimum speed - that is passed on to driver teams through bespoke training.

The focus is more on empowering the drivers: rather than telling them what to do and when, allowing them to apply more safe and efficient behaviours as they see fit and as conditions allow. Obviously the risk assessed, approved line speeds have not been exceeded in any instance. In terms of training, a third party organisation rolled out the 'Train-the-Trainer' part earlier this year, and the first batch of drivers have now been trained (the deadline is August 2018). This has since been complemented by the addition of signage along the line of route ('coast here', or 'suggested speed here is 40kph' for example).

Finally, ET fully support the work currently being undertaken by Subcommittee 1 and will act on any recommendations accordingly. We are considering appropriate locations for chevrons but do not consider that active speed signs are required.

88. In Its response of 31 May 2018 Edinburgh City Council stated the following:
See response to Rec 1 above.

89. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

Following the handover from construction to operations of the Metrolink line from Oldham to Rochdale in 2013 an assessment was carried out which identified suitable controls, including drop down speed limits, chevron markers and dynamic speed signs.

A detailed review of the Metrolink network, following the Croydon incident, re-assessing signage, lighting and visual clues to provide information to drivers was carried out, which resulted in an additional four locations considered to require drop down speed signage and this has been installed.

In addition KAM has introduced a new role of Driver Analyst, who has a primary role of undertaking audits of 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.

This recommendation is now considered to be complete.

90. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

TfGM consider that this recommendation has been implemented on Metrolink following the work of the Operator who, immediately following the Sandilands incidents reviewed all speed limits and signage and installed “drop down” signage at an additional 4 locations. Metrolink already utilised chevron type signs to warn drivers of approaching tight curves.

In terms of in-cab warnings, this is being considered as part of our discussions with a supplier with regard to recommendation 3.

91. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *NX have adhered to RAIB urgent safety advice and introduced step down signage at high risk location and are undertaking a review of current speed signage to cater for the environmental aspects and track design rather than engineered design restriction signage.*

- *NX MM are carrying out a whole route risk assessment, approx. 50% complete to ensure that all the risks are still current.*

- *In 2017 NX MM commissioned a RSA 3 audit of the system, less Bilston Rd section, the only outstanding action is the replacement of some signage which will be completed after the whole route risk assessment is completed to ensure that all work is only carried out once.*

- *NX Metro route risk assessment identifies the only high risk curve on the network is between Stephenson Place and Stephenson Street in Birmingham which has a 10kph speed restriction in place.*

92. In Its response of 31 May 2018 Transport for West Midlands stated the following:

TfWM and National Express commissioned BWB to undertake a survey and review of existing signage along the existing Midland Metro operational corridor. This has addressed the introduction of additional signage where appropriate taking into account drivers existing route knowledge; including visual cues and transitional speed signage. Step down speed restriction signage has been provided by National Express at all locations where a speed reduction of 30km/h or greater exists.

BWB also undertook Road Safety Audits (stage 3 /4) along the whole corridor to assess the suitability of signage in line with highway design principles and National Express are undertaking a whole route risk assessment. The results of these audits and risk assessment will be used to inform an update of the network signage.

We are aware of trials of active signage that are currently being undertaken with findings being shared by all operators within the industry and incorporated into industry best practice guidance on signage and lighting. Following publication of the trials we will assess findings of the review to ensure application of appropriate best practice options related to lighting and signage to our operational corridor and infrastructure.

We would point out that the use of signage on the highway is prescribed by the Traffic Signs Regulations and General Directions 2016. We would suggest that, in the event that industry proposes changes to tramway signage in light of this recommendation, ORR's support will be necessary to ensure these proposals are incorporated into TSRGD

93. Transport for West Midlands provided the following update on 1 October 2018:

As previously advised actions was taken to review and provide additional signage 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.

94. In Its response of 29 May 2018 Nottingham Trams stated the following:

As part of the handover from construction to operations of NET Phase 2, assessment of the network took place with risks identified and control measures introduced. Following Sandilands, on the NET system, drop down speed markers and drop down speed limits were fitted on approach to curves identified as higher risk. Three locations were identified as requiring drop down speed signage.

NTL also undertake random speed checks using radar guns, downloads from OTMR and analysis of driving behaviours, with priority being overspeeding events. This recommendation has been completed.

95. In Its response of 30 May 2018 Nottingham City Council stated the following:
All operators, including NTL, have undertaken a review of their existing signage and have, where appropriate, introduced additional signage. Trials of active signage are being undertaken and shared with all operators within the industry, with recommendations ultimately being incorporated into industry best practice guidance. On NET, drop-down speed markers have been introduced on the approaches to curves at three locations that have been identified as higher risk. Further to this, NTL also undertake random speed checks, using radar guns, and review on-vehicle speed monitoring reports to assess signed speed compliance by drivers.

96. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

All operators, including NTL, have undertaken a review of their existing signage and have, where appropriate, introduced additional signage. Trials of active signage are being undertaken and shared with all operators within the industry, with recommendations ultimately being incorporated into industry best practice guidance. On NET, drop-down speed markers have been introduced on the approaches to curves at three locations that have been identified as higher risk. Further to this, NTL also undertake random speed checks, using radar guns, and review on-vehicle speed monitoring reports to assess signed speed compliance by drivers.

97. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

As soon as it became apparent that speed on approach to a junction on a curve was a factor at Sandilands, Supertram undertook a full system assessment of all curves to ensure speed limits were appropriate, with a safe margin of error. No changes were made to speed limits on curves following review, but the position of a speed reduction sign on the approach to the Meadowhall curve was brought forward to increase the distance.

A full Route Risk Assessment has also been undertaken, the most recent update was conducted on 20/04/18 which focussed on the route between Meadowhall and Nunnery Depot, which is almost entirely segregated and off street running. The update has 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. We have also identified a curve that would benefit from the placement of chevrons visible on approach.

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.

A handheld speed radar device has also been purchased and is randomly deployed on the system to check tram speeds. Any instances up to 10% over the applicable speed limit is a note to file, and any instances exceeding 10% over are investigated and can lead to disciplinary action. To date no instances over 10% have been recorded.

98. Stagecoach Supertram provided the following update on 26 September 2018:

All on street curves identified have been reassessed following the incident at Middlewood. A step down speed limit of 20mph has been introduced on the approach to the curve at Middlewood which has been communicated out to drivers. A similar on street curve has been identified (where the majority of road traffic continues straight on but trams turn on a tight radius) and this curve will also have a 20mph step down speed limit introduced to the approach.

99. In its response of 31 May 2018 South Yorkshire PTE stated the following:

See response to Rec 3 above.

100. South Yorkshire PTE provided the following update on 28 September 2018:

We continue to support our Concessionaire SYSL. SYPTE has recently provided comments to SYSL's proposed signage changes in light of their off-street route risk assessment process. SYSL has also reviewed the on-street curves in light of the incident at Middlewood on the 19 July 2018 and step down speeds have been introduced. Further discussions are to be held on the 10 October with SYSL to review work to-date and further work required to take this forward from a South Yorkshire perspective.

101. In its response of 30 May 2018 Transport for London (London Trams) stated the following:

Speed Signage

Following the Sandilands incident LT undertook a comprehensive review of tram speeds and speed signage across its network. As a result the following measures were put in place by September 2017:

- 1. The maximum tram speed on the network was reduced by 10kph, from 80kph to 70kph. The effect is that the potential for coasting in high speed areas has been removed.*
- 2. Additional step down speed signage was implemented in all locations where speeds reduced by more than 30kph, enhancing driver visual cueing and orientation.*
- 3. Where speed signs are located immediately in advance of certain locations such as a tram stop or a marked curve, the sign has been enhanced with the addition of a high visibility outer border as an additional visual cue to drivers of an approaching hazard.*

iTram

Prior to the implementation of an automatic braking system, (recommendation 3) LT will implement iTram to provide audible in-cab over speed alerts. iTram is a data monitoring tool that as well as driving safety improvements by trend analysis of tram speeds, also utilises GPS technology to provide over speed warnings to drivers at all points across the network. It is therefore an enhancement on the Guardian system which can only alert drivers if they exceed the maximum speed limit. iTram is a derivative of well proven technology used on buses.

It is envisaged that the iTram audible over speed alerts will continue to form a separate but complementary part of the automatic braking solution. This improves the safety and ride quality for passengers by applying a warning with time to speed reduction compared to only applying an emergency brake application. The expectation is it will reduce the number of automatic braking events by providing drivers with an advance warning of over speed, allowing modification of driver behaviour and tram speed before the need for automatic braking to be applied.

A pilot study will commence in June 2018 with a view to completing the Stadler fleet by December 2018 and the Bombardier fleet by March 2019.

Our operator First Group's TOL, are an active and engaged stakeholder on this initiative.

Review of Visual Cueing

LT and First Group's TOL have completed a comprehensive Route Hazard Analysis. The conclusion is that with the already completed installation of additional speed signage work driver visual cuing on the network is sufficient and poses no significant risk.

Tunnel Lighting

Post the Sandilands incident we installed additional temporary lighting on the approach to the Sandilands tunnel.

We are currently working with road tunnel lighting experts within TfL to design and implement an upgrade to the existing Sandilands tunnel lighting. Work is expected to be complete on the improved tunnel lighting in early 2019.

We are also trialling illuminated warning signs, similar to those used on roads to warn drivers their speed is above the limit. The effectiveness of these signs will be evaluated in summer 2018 and the feedback shared with the rest of the industry through the UK Tram subcommittee 1. The need for signage and technology enhanced signage continues to be reviewed by UK tramway operators through UKTram Subcommittee 1.

This subject was also addressed via a UK tramway industry questionnaire, and trials of active signage are being shared by all operators within the industry and incorporated into industry best practice guidance on signage and lighting.

Subcommittee 1 reminded all operators that any tramway signage must take into account the driver's existing line knowledge.

102. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 5 (visual cues) – following the tragic incident at Sandilands we put additional step down speed signage in place in all locations where speeds reduced by 30kph. We reduced the maximum speed on the network by 10kph from 80kph to 70kph. This removed the potential for coasting in high speed areas. 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. These changes were completed in September 2017 and have been shared with the UK Tram industry. In addition together with First Group's TOL we have completed a comprehensive route hazard analysis. The conclusion of this review is that with the already completed installation of additional speed signage work driver visual cuing on the network is sufficient and poses no significant risk.

Post the Sandilands incident we installed additional temporary lighting on the approach to the Sandilands tunnel. We are currently working with road tunnel lighting experts within TfL to design and implement an upgrade to the existing Sandilands tunnel lighting. Work is expected to be complete on the improved tunnel lighting in early 2019.

103. In its response of 31 May 2018 Tram Operations Ltd stated the following:
TOL / LT identified and completed three initiatives to support this recommendation.

Speed signage and speed reduction activities to support this RAIB recommendation can be seen in TOL's response to RAIB 3.

Update signage and other visual cues – such as directional (orientation) assistance and moving between different speed zones

Working with LT, TOL increased the visibility of a number of speed signs and placed chevrons in places of high risk, as detailed in RAIB 3.

Review of tunnel lighting

LT and TOL have also carried out a review of the lighting in the Sandilands tunnel.

Whilst this was not part of the original Sandilands findings, TOL and LT took a decision to review tunnel lighting levels following feedback from staff. A replacement solution will be developed by LT and TOL with input from TFL Highway.

iTram

LT are leading another project called iTram that may be suitable to support visual cueing. Using satellite

Lineside Digital Signage

Please refer to TOL's response to RAIB 3.

Other visual cues

LT plan to carry out a further assessment to confirm the adequacy of visual cues on the Croydon Trams network to establish whether there is a requirement for any additional visual cuing on the network. For example, directional 'cats eyes' in Sandilands tunnel.

Tunnel Lighting

LT and TOL, in conjunction with TFL Highway, are in the process of looking at additional ways to improve adequacy of the lighting in the Sandilands tunnel.

TOL are involved from an operational perspective and impact on drivers for any replacement solution. Once a solution is agreed upon, TOL will be involved to engage with drivers and Trade Unions to share the agreed solution.

iTram

It is anticipated iTram will be implemented later this year, but this is subject to change. As part of the regular engagement TOL will engage with the drivers, controllers and Trade Unions on the operational impact of the proposed i-Tram solution.

TOL has begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

104. Tram Operations Ltd provided the following update on 28 September 2018:

TOL believe there are three activities that will support this RAIB recommendation. All were project managed by LT with TOL providing operational input.

- Enhanced visibility of speed control signs*
- Update signage and other visual cues*
- Review of tunnel lighting*

Some of these activities also support RAIB recommendation 3.

Enhanced Visibility of Speed Control Signs

Please refer to TOL's response to RAIB 3 where this item is captured in detail, along with the updated status.

Update signage and other visual cues – such as directional (orientation) assistance and moving between different speed zones.

Working with LT, TOL increased the visibility of a number of speed signs and placed chevrons in places of high risk, as detailed in RAIB 3.

TOL have provided operational input to these projects to date and will continue to do so for further visual cues. Before and during the projects TOL engaged with drivers and Trade Unions on the operational change and impact these new aids would have.

LT have carried out a further assessment to confirm the adequacy of visual cues on the Croydon Trams network to establish whether there is a requirement for any additional visual cues on the network. For example, directional 'cats eyes' in Sandilands tunnel.

LT are leading a project to implement directional 'cats eyes'; TOL have provided LT with operational input. The work programme uses a basic premise that different coloured 'cats eyes' (for example red, amber and green) could be used to help orientate drivers in Sandilands Tunnel.

This project is still in development with timescales to be determined by LT however it is anticipated that these 'cats eyes' could be installed at the same time as the tunnel lighting upgrade is carried out.

Review of tunnel lighting

LT and TOL have also carried out a review of the lighting in the Sandilands tunnel. Whilst this was not part of the original Sandilands findings, TOL and LT took a decision to review tunnel lighting levels following feedback from staff and implemented a temporary solution. A replacement solution will be developed by LT and TOL with input from TfL Highway.

The solution is being finalised by LT with the relevant operational input from TOL. When the solution has been identified, TOL will engage with drivers and Trade Unions to gather feedback and gain their input.

TOL will provide operational and customer service input to the implementation phases to help reduce disruption to system users. Consideration is being given to reduce the length of the operating service, during the period of installation, however this is still being determined and is dependent upon understanding the time required to replace the lighting.

iTram

LT are leading another project called iTram that may be suitable to support visual cueing. Using satellite navigation, the iTram system would provide an alert to the driver when a hazard is approached. iTram is also planned to generate an overspeed alarm at any location across the network. TOL and LT continue to discuss the number and frequency of alarms or alerts being triggered. This is also linked to the Human Factors Study previously mentioned.

The iTram project is based on the iBus system and is an Automatic Vehicle Location (AVL) system to improve Croydon Trams performance tracking using GPS technology. The system will track both types of trams to provide passengers with audio visual announcements and improved information on tram arrivals. It will digitally provide the location of each in-service tram to the TOL Control Room who monitor daily tram performance and operations. This project is being scoped now by LT and TOL with the initial technical design and software requirements being considered. It is anticipated iTram will be implemented later this year, but this is subject to change.

TOL continue to be involved by providing operational considerations into the design specification, including assisting with identification of the high risk locations for potential speeding. The final specification has not been agreed as yet.

As part of the regular engagement TOL will engage with the drivers, controllers and Trade Unions on the operational impact of the proposed iTram solution. On occasions TOL Safety Representatives will be actively involved.

105. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

Immediately following the Sandilands accident, TfL/FTOL reviewed all bends and curves on the system, and introduced "count-down" speed restrictions and chevron signs on the approach to Sandilands junction and some other tight bends on the system. Other UK tramway operators also reviewed their systems and took similar action where appropriate.

Recommendation 6

106. In Its response of 30 May 2018 Blackpool Transport stated the following:

Tramcar glazing in the UK currently matches that of other passenger road vehicles and the majority of the Heavy Rail fleet. Research with manufacturers is being carried out by TfL who are feeding back the results and developments to Subcommittee 1. These tests are being carried out to understand the implications of stronger glazing or additional film protection.

Subcommittee 1 recommended that all areas of 'high risk' for derailment/overturning should be checked for potential points of collision with infrastructure and lineside equipment in such an event. This has been completed by Blackpool Transport.

Depending on the outcome of the TfL glazing tests any engagement with relevant standards bodies (CEN/BSI) will be led by UKTram. CEN/BSI can impose any required changes to standards, otherwise manufacturers and suppliers of tramcars will still continue to build to the current standards.

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.

107. In Its response of 29 May 2018 Blackpool Council stated the following:

Due to the relatively low speed on our system, the likelihood of over-turning is considered as very low risk. However, BTS have reassessed all our areas of "higher-risk" potential points of collision with infrastructure in such an event of overturning as recommended by sub-committee 1.

The standard of glazing in our current fleet is comparable to that in other public transport systems (busses, heavy rail etc). Research is ongoing with TfL who will feed back into UKtram sub-committee 1.

The need for containment will be evaluated in relation to the need for passenger escape in other emergencies requiring an efficient evacuation from the tram.

108. In Its response of 30 May 2018 Edinburgh Trams stated the following:

Edinburgh Trams are working with UK Tram in respect of the Subcommittee recommendation that all areas of 'high risk' for derailment/overturning should be checked for potential points of collision with infrastructure and lineside equipment in such an event.

Depending on the outcome of the testing we will respond appropriately.

In the meantime, we have received and are reviewing potential solutions and proposals in relation to this recommendation from our tram manufacturer/ maintainer; and these will be considered in conjunction with the outputs of the UKTram Subcommittee work.

109. In Its response of 31 May 2018 Edinburgh City Council stated the following:
See response to Rec 1 above.

110. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

KAM continue to review the outputs of the research into glazing by Transport for London (TfL) and Subcommittee 1, noting that it would be difficult to retrospectively replace glazed panels on the existing fleet.

KAM will support TFGM in the opportunity provided by the procurement of new trams for the Metrolink system to review the output of the TfL led glazing tests and assess, at the design stage, the impact of a revised standard for glazing.

111. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

Depending on the implementation or otherwise of the other recommendations, TfGM is of the view that this might not be necessary. However, it is our understanding that TfL is continuing to carry out tests on alternative glazing and we will await the outcome of those tests before making a decision.

We have also discussed possibilities with the vehicle supplier and our options are quite limited. For example a thicker glass would increase the weight of the vehicle, and have a negative effect on the tram stability in curves. Additionally a not insignificant redesign of the tram body would be required.

112. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *Awaiting industry advice but it is likely that TfWM will be the next owner to purchase trams we would expect that construction standards and guidance to advise of required change.*
- *TfWM have asked all bidding manufacturers to consider the recommendations of the Croydon report in the procurement documentation.*

- *Consideration of laminated side glass and more robust restraint methods*
- *need to be considered as part of the tram design process and on our current fleet of vehicles would push the vehicle over the maximum weight on one of the structures.*
- *Operators and the wider industry are proposing to wait and see if there will be change to construction standards before implementation, it is considered that laminated glass may cause entrapment issues and increase the likelihood of evacuation issues for more probable hazards such as fire.*

113. In its response of 31 May 2018 Transport for West Midlands stated the following:

As noted above, we believe the primary focus should be on minimising the risk of a tram overturning and that this recommendation is a secondary measure to address the consequences of a tram overturning.

Our existing vehicle manufacturer CAF currently constructs the vehicles to European Standards for operating on the highway. Additionally tram vehicle window glazing within the UK currently matches that of other passenger carrying road vehicles and indeed the majority of the national rail passenger carrying fleet. Following consultation with our tram manufacturer, CAF, it has been confirmed that it is feasible to fit laminated glass within the existing window frames of the Urbos 3 tram fleet, although this may affect the overall weight of the vehicle (c. 250kg) and could exceed the maximum permitted weight on Midland Metro Line One structures.

CAF have further proposed an alternative solution using an external film rather than the internal film used in Croydon. However we consider that clear national guidance is required from the RAIB as to what mass force the windows must be able to withstand before a proposal for changes to standards and guidance can be taken forward with the rolling stock suppliers and national /international standards bodies.

CAF have advised that the doors on the Urbos 3 are of a different design to those of the CR4000 trams and that they consider the risk of the doors opening in an uncontrolled manner in an overturning incident is reduced to a SFARP level.

We are aware and supportive of the industry review and research being undertaken in association with manufactures and standards bodies to further establish the implications of more robust glazing and film control applications. We consider that no changes should be made to existing tram vehicle glazing prior to publication of research findings and any subsequent changes to relevant standards.

We have through our pre-tender market engagement sought the views of the rolling stock supply industry on the implications of this recommendations. Whilst it would appear that suppliers can in theory introduce a higher containment glazing solution the full implications of such a change to their vehicle designs could only be established once clear guidance on the containment requirements has been established.

114. Transport for West Midlands provided the following update on 1 October 2018:

Refer to the market sounding report and our previous response. We remain of the opinion that clear industry wide guidance, based upon empirical research should be given on containment requirements if these are to vary from existing international standards before ad-hoc changes are made to individual tram fleets.

115. In its response of 29 May 2018 Nottingham Trams stated the following:

Tests to fit improving glazing that would improve containment have taken place on other systems and the results shared with NTL. It would be difficult to retrospectively replace glazed panels on the existing fleet. Implementation of this recommendation would be more appropriate through the design of new tram fleets by the manufacturers.

116. In its response of 30 May 2018 Nottingham City Council stated the following:

Research into tram glazing is being undertaken with manufacturers by Transport for London, with the results being fed-back to operators through UK Tram. These tests are being carried out in order to understand the implications of introducing stronger glazing or additional film protection, with the findings used to inform decisions on the possible modification of doors and windows, together with any necessary changes to standards and specifications.

117. In its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

Research into tram glazing is being undertaken with manufacturers by Transport for London, with the results being fed-back to operators through UK Tram. These tests are being carried out in order to understand the implications of introducing stronger glazing or additional film protection, with the findings used to inform decisions on the possible modification of doors and windows, together with any necessary changes to standards and specifications.

118. In its response of 22 April 2018 Stagecoach Supertram stated the following:

The Citylink 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. It is our understanding that there is a risk of this fleet not being able to accommodate strengthened glass in windows and doors due to the condition of bodywork holding the frames. Any solution would require major fleet overhaul and external assistance for design (and likely installation also). This level of overhaul would also require significant time on each tram to modify, which would place serious pressure on maintaining a timetable and would also likely continue into the fleet's life expiration in 5-10 years (max) time.

The asset owner SYPTE 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.

119. Stagecoach Supertram provided the following update on 26 September 2018:

On 19th July a Supertram driver entered a curve on the approach to Middlewood terminus at approximately 23mph, the speed limit for this curve is 10mph. The driver realised the overspeed just prior to entering the curve and applied the emergency brake, however the leading cab was subjected to high levels of force and a passenger was injured when she was thrown into a door which subsequently broke and swung open.

It was identified that a door ball joint sheared upon impacted by the passenger. A full fleet check of door ball joints was undertaken in August 2018 and a full set of joints were removed (from one tram) for non-destructive testing and replaced with new joints. No signs of metal fatigue were identified from testing of the removed ball joints. Supertram are now testing a new design of ball joint that has been strengthened and can absorb some shock without compromising the integrity of the joint. Following a successful testing period we are committed to replacing the full fleet of Siemens trams with the new stronger ball joint to reduce the risk of doors opening upon impact.

120. In Its response of 31 May 2018 South Yorkshire PTE stated the following:

See response to Rec 3 above.

121. South Yorkshire PTE provided the following update on 28 September 2018:

On the 10 October we will be sitting with our Concessionaire South Yorkshire Supertram Limited to review work to-date and potential way forward on this from a South Yorkshire perspective.

122. In Its response of 30 May 2018 Transport for London (London Trams) stated the following:

Enhanced Glazing

During the Sandilands incident the automotive standard tempered side glazing currently fitted in the LT fleet did not provide passenger containment under the conditions encountered.

LT have identified that mainline rail crash worthiness standard GM/RT2100 is more likely to offer protection against the conditions experienced during the Sandilands event.

LT have tested the following options: □ 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.

The results are being evaluated with the final glazing option selected by August 2018. The final option will be assessed to ensure that any impact on passenger emergency egress is fully understood, and the results shared with UKTram to inform their work under RAIB Recommendation 8 and to ensure bullet points i to iii of this recommendation are addressed.

Our operator First Group's TOL will be fully consulted in the decision making process.

Depending on the outcome of the glazing tests any engagement with relevant standards bodies (CEN/BSI) will be led by UKTram. CEN/BSI can impose any required changes to standards, otherwise manufacturers and suppliers of tramcars will still continue to build to the current standards. 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.

123. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 6 (enhanced glazing). In our original response we noted that the following glazing options were tested:

- 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.*

We are finalising our evaluation of these options including assessing them to ensure that any impact on passenger emergency egress is fully understood. We will then confirm our preferred option and share the results with UKTram to inform their work under RAIB Recommendation 8 and to ensure bullet points (i) to (iii) of this recommendation are addressed. This evaluation will be completed by the end of October 2018.

124. In its response of 31 May 2018 Tram Operations Ltd stated the following:

LT are leading a project to investigate options to replace the glass in the trams. They have engaged SNC Lavalin (SNCL) to investigate with manufacturers various suitable glazing options to test. LT have carried out two sets of glass testing with the most recent taking place in March 2018. TOL attended the first phase of glass testing.

When advised by LT on a solution, TOL will review its evacuation process to ensure staff are up-to-date for tram evacuation with the new designed glass. TOL will also engage with drivers and Trade Unions on the operational impact.

TOL has begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

125. Tram Operations Ltd provided the following update on 28 September 2018:

LT are leading a project to investigate options to replace the glass in the trams. They have engaged SNC Lavalin (SNCL) to investigate with manufacturers various suitable glazing options to test. LT have carried out two sets of glass testing with the most recent taking place in March 2018. TOL attended the first phase of glass testing.

When advised by LT on a solution, TOL will review its evacuation process to ensure staff are up-to-date for tram evacuation with the new designed glass. TOL will also engage with drivers and Trade Unions on the operational impact.

To date, TOL are awaiting a decision from LT on whether the glass will be replaced.

126. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

One cause of fatalities in the Sandilands accident was found to be windows broken and doors ripped off, allowing passengers to be ejected from the vehicle. UKTram has been in discussion with manufacturers to see if improvements could be made. Information gathered by West Midlands Combined Authority from vehicle manufacturers indicates that improved windows could be fitted, at extra cost and weight.

Regarding doors, most UK tramway systems have more modern vehicles with doors of fully welded construction, which offers far more structural integrity which will aid containment. Only the older Croydon trams and the Sheffield Siemens vehicles still have the older style doors.

This recommendation should also be aimed at manufacturers and the relevant standards bodies, including LRSSB. 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, collision or terrorist attack.

Recommendation 7

127. In its response of 30 May 2018 Blackpool Transport stated the following:

As installing additional or new emergency lighting systems would be costly and time consuming. The collective view of operators, owners and maintainers was to review the current systems in place and modifying the current emergency lighting systems to make them more robust if required.

Blackpool Transport, 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.

128. In Its response of 29 May 2018 Blackpool Council stated the following:

Please refer to Blackpool Transport's report. BTs are responsible for operating and maintaining rolling stock and excel in this expertise. Blackpool Council is the owner responsible for maintaining the permanent way.

129. In Its response of 30 May 2018 Edinburgh Trams stated the following:

Edinburgh Trams will fall in line with UKTram Subcommittee 1 in respect of this recommendation.

In the meantime, we have received and are reviewing potential solutions and proposals in relation to this recommendation from our tram manufacturer/ maintainer; and these will be considered in conjunction with the outputs of the UKTram Subcommittee work.

130. In Its response of 31 May 2018 Edinburgh City Council stated the following:

See response to Rec 1 above.

131. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

The emergency lighting on the existing fleet will remain lit, with a full set of batteries for approximately 45 minutes.

KAM will review the recommendation with Bombardier, the manufacturer of the vehicles and determine if any modifications can be made to make them more robust, including automatic switch on in the event of a tram overturning. Initial discussions with Bombardier will continue up to June 2018, following which any technical information provided will be reviewed.

132. In Its response of 30 May 2018 Transport for Greater Manchester stated the following:

TfGM is exploring possibilities to modify the emergency on board lighting with the tram suppliers.

133. In Its response of 28 May 2018 National Express Midland Metro stated the following:

- *Our current fleet of URBOS 3 trams rely on a power feed from the battery to provide power to the emergency lights.*
- *TfWM have asked the vehicle manufacturers to provide a cost for future fleet replacement which could also be retrofitted to the current fleet.*

134. In Its response of 31 May 2018 Transport for West Midlands stated the following:

The Urbos 3 trams are fitted with battery powered emergency lighting that will provide backup illumination for up to 60 minutes inside the tram car following an incident. Unlike the CR4000 vehicles the emergency cut off switch which would isolate the traction and backup power systems is protected against accidental activation.

Following a review with CAF of current emergency lighting systems installed on the Urbos 3 tram, it has been established that it would be possible to implement a system of emergency lighting which is independent of the main battery on the tram. Thereby providing redundancy in the event that tram lighting and primary emergency lighting were both disabled in an incident.

We will review the level of risk associated with the provision of emergency lighting using the proposed industry risk model. If it is found that implementation of an additional backup system would demonstrably assist in reducing risk So Far As Is Reasonably Practicable we will implement a change to the vehicle in line with CAF's advice.

Following our market consultation we expect this recommendation to be addressed by the manufacturers in the supply of additional vehicles for Midland Metro in 2021.

135. Transport for West Midlands provided the following update on 1 October 2018:

Please refer to our market sounding report and our previous response

136. In Its response of 29 May 2018 Nottingham Trams stated the following:

At present both the Incentro and Citadis emergency lights 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, the change would only be accommodated on new tram fleets.

137. In Its response of 30 May 2018 Nottingham City Council stated the following:

The shadow LRTSSB UK Tram has advised all operators and vehicle maintainers to review the current emergency lighting systems in place on their tram-fleets and to modify them to make them more robust if required.

138. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

All operators, including NTL, and vehicle maintainers 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.

139. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

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.

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 SYPTTE to specify emergency lighting requirements that satisfy this recommendation in the new fleet specification.

140. Stagecoach Supertram provided the following update on 26 September 2018:

Citylink manufacturer have since confirmed that they estimate a force in excess of 400N would be required to deform the secure flap that covers the emergency power button (that cuts power from the batteries if pressed).

141. In Its response of 31 May 2018 South Yorkshire PTE stated the following:

See response to Rec 3 above.

142. South Yorkshire PTE provided the following update on 28 September 2018:

On the 10 October we will be sitting with our Concessionaire South Yorkshire Supertram Limited to review work to-date and potential way forward on this from a South Yorkshire perspective.

143. In Its response of 30 May 2018 Transport for London (London Trams) stated the following:

Emergency Lighting

In conjunction with industry experts, LT have formulated a Technical Specification for the retrofitting emergency lighting to its fleet. The system will be fully autonomous, and will operate independently of the trams battery system in the event of an emergency.

Additionally, LT are aware of the conditions resulting in the failure of its existing standby lighting system during the Sandilands incident, and are investigating how the existing system may be modified in order to achieve the desired emergency lighting outcomes. .

Our operator First Group's TOL are an active and engaged stakeholder on this initiative.

Through UKTram subcommittee 1 we have shared our findings. As installing additional or new emergency lighting systems would be costly and time consuming, the collective view of operators, owners and maintainers was to review the current systems in place and modify the current emergency lighting systems to make them more robust if required. Subcommittee 1 advised all operators/vehicle maintainers to review the emergency lighting on all their Tramcar fleets.

144. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 7 (emergency lighting). In our original response we noted that we were aware of the conditions that resulted in the failure of our existing standby lighting system during the Sandilands incident, and were investigating how the existing system may be modified in order to achieve the desired emergency lighting outcomes. We now intend to issue an invitation to tender (ITT) to the market for the procurement of the preferred design in October 2018.

145. In its response of 31 May 2018 Tram Operations Ltd stated the following:

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. The two organisations have developed a scope of requirements.

LT have issued the Invitation to Tender (ITT) to the marketplace with the award of a contract expected during the summer.

When advised by LT on the lighting solution and as a part of their regular engagement TOL will review any operational impact with Trade Unions and drivers.

TOL has begun a review of measures necessary to address this recommendation and will alongside LT continue to do so as any new matters arise.

146. Tram Operations Ltd provided the following update on 28 September 2018:

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. The two organisations have developed a scope of requirements. LT has issued their Invitation to Tender (ITT) to the marketplace with the award of a contract expected during the summer.

A shortlist of suppliers has been determined by LT and a final appointment is pending.

When advised by LT on the lighting solution and as a part of their regular engagement TOL will review any operational impact with Trade Unions and drivers. TOL will also be involved to help minimise impact on customers and

operations of the service, when LT implement the chosen emergency lighting solution in the trams.

147. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

Information from vehicle manufacturers indicates that this could be supplied.

Recommendation 8

148. In Its response of 30 May 2018 Blackpool Transport stated the following:

UKTram advises that tramcars are excluded from having a safety hatch in the roof due to the presence of 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.

Subcommittee 1 came to the collective view that installing escape hatches in the floor or roof of any Tramcar would import significant risk. Blackpool Transport will not look to retro fit their current fleet of trams.

149. In Its response of 29 May 2018 Blackpool Council stated the following:

As previously stated, the likelihood of an overturned tram on Blackpool's system is highly unlikely due to the geometry of the system and the relatively low line speed.

For a more in depth response, please refer to Blackpool Transports report as they are our experts on this matter.

150. In Its response of 30 May 2018 Edinburgh Trams stated the following:

Edinburgh Trams will fall in line with UKTram Subcommittee 1 in respect of this recommendation.

In the meantime, we have received a potential solution which involves amending a side window in order to assist evacuation. We are reviewing the feasibility of this in conjunction with the aforementioned UKTram Subcommittee 1 work.

151. In Its response of 31 May 2018 Edinburgh City Council stated the following:

See response to Rec 1 above.

152. In Its response of 30 May 2018 KeolisAmey Metrolink (Manchester) stated the following:

The LRTSSB 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 LRTSSB.

KAM continue to support the work of the LRTSSB and supporting working groups to provide a regulatory framework to ensure consistency, innovation and sharing of best practice for all UK tramway operators and owners.

153. In its response of 30 May 2018 Transport for Greater Manchester stated the following:

It is difficult to envisage a readily accessible safety egress system that would not also be vulnerable to misuse. As such TfGM has not taken this recommendation forward in a meaningful way. The UKTram working group also points out that safety hatches in the floor or roof would import other significant risk.

It is therefore not likely that TfGM will implement this recommendation, however we will consult with colleagues in other networks to ascertain if there are good practice examples that would meet the intent of the recommendation.

The Metrolink system is a high floor system with tram doors and platforms installed at the standard heavy rail height throughout the network, therefore unsupervised detrainment has to be considered differently to other low floor systems.

154. In its response of 28 May 2018 National Express Midland Metro stated the following:

- *This is not an action that an operator can take forward in isolation as any breach of the structural integrity of the tram would have serious consequences.*
- *TfWM have asked all bidding manufacturers to consider the recommendations of the Croydon report in the procurement documentation.*

155. In its response of 31 May 2018 Transport for West Midlands stated the following:

Once again we would stress that the primary focus is on removing the risk of a tram overturning and that this recommendation is a means of addressing secondary consequences of an overturning incident. We consider that the need for an emergency escape route from the vehicle is fundamentally to allow passengers to exit in the event of a fire and that, in the absence of a fire on the tram the passengers are in most circumstances safest on the vehicle until such time as the electrical systems are isolated and traffic on adjacent tram /railway lines and carriageways has been brought to a stand.

The risk of a fire on a tram is low with vehicles designed to latest international standards and, unlike the majority of road vehicles and many trains having no internal combustion engines /fuel on board. Notwithstanding the above we have reviewed this recommendation with CAF, manufacturers of the Urbos 3 trams, and with prospective suppliers of additional trams for Midland Metro.

We are advised that the installation of an emergency exit hatch within the floor of the vehicle raises the possibility of compromising the vehicle body structure in addition to being both cost prohibitive and potentially introducing operational risks. The

additional risk factors identified in this initial review of the implications of the recommendation include:

- The risk posed to passengers by the presence of overhead line equipment and exposed live electrical surfaces within the roof area of a vehicle;*
- The significant safety risk if passengers were able to gain access to safety critical components, running equipment and movable objects;*
- Significant cost associated with structural modification to the vehicle (if practicable)*
- The risk of compromising the fire integrity of the vehicle*
- Risks associated with the malicious opening of the emergency hatch (particularly floor fitted) requiring the hatch to be linked to the emergency braking and or electrical control systems) ;*
- Operational railway /tramway and highway corridors.*

CAF have advised that there is insufficient roof space for the retrospective installation of an emergency exit hatch due to existing vehicle equipment and systems located within the roof area of the vehicle. Similarly the nature of the Urbos 3 cab design precludes provision of removable windscreen glazing without compromising visibility and requiring a full standard redesign of the cab.

Following our discussions with CAF we do not consider it will be reasonably practicable to modify the Urbos 3 vehicles as proposed by RAIB in this recommendation.

We have further discussed this recommendation with potential suppliers of additional trams for Midland Metro. The suppliers have consistently indicated that their vehicles comply with established international standards and that they do not consider modification of their existing, standard, products in the manner envisaged would be practicable or deliverable under their existing safety assurance processes.

We would suggest therefore that this recommendation should be considered at a national level using the proposed industry risk assessment model in order to determine the case for further development of an industry standard requirement and the to determine the willingness /ability of the supply sector to modify their standard products to meet this recommendation through the existing European standards ("EN") consultative forums.

156. Transport for West Midlands provided the following update on 1 October 2018:

Please refer to our market sounding response and our previous response. We would emphasise that neither our existing vehicle supplier nor any of the potential suppliers of vehicles for our 3rd Generation fleet consider they can comply with this recommendation.

157. In Its response of 29 May 2018 Nottingham Trams stated the following:

The LRTSB 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.

158. In Its response of 30 May 2018 Nottingham City Council stated the following:

The shadow LRTSSB 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.

Whilst it is acknowledged that other recommendations in your letter are not considered to be directly applicable to tram operators, owners and infrastructure managers, I would like to highlight that, with regard to Recommendation 11, NTL currently complies with working time regulations, in assessing rosters and shift patterns, using industry standard fatigue index methodologies, and that, with regard to Recommendation 12, NTL has drafted and is implementing “Just Culture” approach across its business, to augment current HR procedures.

159. In Its response of 12 October 2018 Tramlink Nottingham Limited stated the following:

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.

160. In Its response of 22 April 2018 Stagecoach Supertram stated the following:

Internal assessment from the Supertram Engineering Team 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. Containment may also be safer until the site is secured, due to a number of external hazards and risks, moving or static that may be present around the vehicle. Due to the location of the tramway within the city, there are less accessibility issues for the emergency services regarding response times.

It should also be noted that the original Citylink windscreen was refused acceptance by RSSB due to its lack of antispalling properties that could result in injury/blindness to the driver.

161. Stagecoach Supertram provided the following update on 26 September 2018:

Our response to recommendation remains unchanged at this time, we have however received further confirmation from Stadler that the vehicle windscreens of the Citylink vehicles would be very difficult to break from the inside.

162. In Its response of 31 May 2018 South Yorkshire PTE stated the following:

See response to Rec 3 above.

163. South Yorkshire PTE provided the following update on 28 September 2018:

No further update on this.

164. In its response of 30 May 2018 Transport for London (London Trams) stated the following:

UKTram advises that tramcars are excluded from having a safety hatch in the roof due to the presence of 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.

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.

165. Transport for London (London Trams) provided the following update on 27 September 2018:

Recommendation 8 (rapid evacuation of trams)- this recommendation is being led by UK tram on behalf of the industry. UKTram advises that tramcars are excluded from having a safety hatch in the roof due to the presence of 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.

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.

166. In its response of 31 May 2018 Tram Operations Ltd stated the following:

TOL is a Member of the LRTSSB as detailed in the response to RAIB 1, facilitates TOL's ability to provide support through sharing of information, good practice and proactive engagement with wider industry.

All LRTSSB meetings are attended by TOL's Head of Safety.

When a solution is identified TOL will review its evacuation process to ensure staff are up-to-date for evacuation of an overturned tram.

TOL has begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

167. Tram Operations Ltd provided the following update on 28 September 2018:

Supporting UK Tram to find a solution for rapid evacuation of an overturned tram.

As a member of the shadow LRSSB, TOL will continue to provide support across the industry to evaluation options and a solution and practical measures for rapid evacuation of passengers from an overturned tram.

When a solution is identified TOL will review its evacuation process to ensure all relevant staff members are trained and competent in any new procedures.

UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

The reaction from manufacturers to this proposal is negative because it would expose passengers to hazards from equipment on the roof or below the floor, because it would compromise the strength of the vehicle body, and because escape hatches could not be protected from malicious opening.

Recommendation 9

168. The following text is from an ORR Railway Safety Directorate management meeting paper (4 June 2018) exploring options for possible changes to the regulatory framework for tramways:

Components of the regulatory framework

The key components of the regulatory framework are:

- *Requirements for management of safety (safety management systems);*
- *Requirements for introducing change (risk assessment);*
- *Requirements for safety critical work (and the personnel carrying in out);*
- *Requirements for authorisation of vehicles and infrastructure;*
- *Requirements for reporting of safety performance.*

Two other key components of the regulatory framework are the regulator itself (ORR) and the arrangements for independent accident investigation. Our reading of the report is that it assumes these arrangements will continue so an assessment of alternative options was not within the scope of the review. Standards are another key part of the regulatory framework on other railways, but our consideration of the options here is being addressed through our work on Recommendation 1 of RAIB's report.

The "reference systems" for making relevant comparisons with the tramway framework, and therefore identifying potential options for change, are:

- *The mainline railway*
- *Non-mainline railways (for the purposes of this exercise, this does not include heritage)*
- *Buses*

Requirements for management of safety

Safety management system (SMS) requirements for tramways are more stringent than those for buses but less so than those for mainline or non-mainline railways. Bus

operators are subject to no SMS requirements additional to those in general health and safety legislation. Tramways must establish a written SMS, proportionate to the nature and extent of their activities, which has exactly the same minimum requirements as a railway SMS. Mainline and non-mainline railways must have their SMS certified by ORR before they start operation, at least every five years after that and whenever they change the type or extent of their operation. Mainline and non-mainline railways must also notify ORR of substantial changes to their SMS.

Options appraisal

- *No change – It does not seem tenable in the aftermath of a multiple fatality tram accident to contemplate reducing the SMS requirements of tramways to the lower level required of buses, so the minimum option here is to maintain the current arrangements. The advantages of no change are that the current requirements are well understood by the sector and set a clear legal expectation that safety management on trams must be capable of addressing a risk profile that is akin to that of a railway rather than a bus. The disadvantages of continuing with the current system is that it provides less structured regulatory scrutiny than mainline and non-mainline railways as ORR is not required to take a periodic overview (for the purposes of certification) of the capability of tramway management systems. While there is no direct link between certification and safety performance, it is possible that further evidence (from the risk analysis and supervision work currently being implemented) will call into question the fact that the safety permissioning arrangements for tramways align more closely with low-speed, low-density heritage operations than they do with more obviously comparable urban mass transport systems (including some like Tyne & Wear Metro and Glasgow Subway which carry far fewer passengers than the larger tram systems).*
- *Mandatory certification – The most obvious option here is to align the requirements of tramways with those of railways and introduce safety certification¹ under the Railways & Other Guided Transport Systems (Safety) Regulations 2006 (ROGS) Legislative change would be required to make this happen. This is assumed to entail aligning trams with non-mainline certification as full EU-portable mainline certification is clearly not necessary. The advantages of doing so would be to a) give ORR a stronger regulatory lever to, among other things, press for implementation of those Sandilands recommendations which are not obviously enforceable; b) require greater discipline from ORR in maintaining an overview of SMS capability in the sector; and c) enhance public confidence in tramway safety*

¹ For ease of reading, “certification” in this annex means either “safety certification” for a tram operator or “safety authorisation” for a tramway infrastructure manager or both.

by establishing beyond doubt that trams are regulated with the same rigour as railways. The principal disadvantage of introducing certification is that it would introduce administrative costs on the sector and there is no evidence it would lead to attendant direct safety benefit. (Previous impact studies of ROGS non-mainline certification indicate that each application for new or renewed certification costs comparable duty holders £20,000 - £25,000.) For ORR, ROGS certification would increase the burden of statutory work on the tramway inspection team at precisely the time we are seeking to refocus their activity on proactive inspection.

- *Voluntary certification or third party certification may offer an alternative approach. In this option, which could be effected without legislative change, we could encourage tram operators to seek certification of their SMS on a voluntary basis – either from ORR or from a third party certification body (similarly to certification of entities in charge of maintenance on the mainline railway). This approach could provide similar benefits to mandatory certification in terms of public confidence and providing greater ORR oversight of SMS capability in the sector (which has been one of the advantages of “entities in charge of maintenance” (ECM) certification on the mainline), without the associated disadvantages of occupying ORR resource in more statutory work (if the third party approach is pursued) or of needing to seek changes to the law. On the other hand, the ECM experience demonstrates that certification schemes of this nature take time (years) to set up and we would also need to understand the cost implications for ourselves and the tramways. Finally, of course, such an approach would require the voluntary co-operation of the individual operators – with a risk of further diversification between those systems that volunteer and those that do not.*

Recommendation for suggested ORR position:

- *At the present time, there is no safety evidence to justify introducing mandatory ROGS certification and it would introduce cost and resource commitments on ORR and the sector that would be better spent on other aspects of improving tram safety.*
- *Equally, we would not resist the introduction of mandatory or voluntary certification schemes if demanded by Ministers and/or the sector - subject to additional funding being secured in order that certification does not abstract ORR resource from proactive inspection.*
- *We will reconsider our position at the end of 2019 to include consideration of the further evidence available from the industry’s developing risk analysis work and our supervision of the sector.*

Requirements for introducing change (risk assessment)

Risk assessment requirements for making changes to tram operations are exactly the same as those that prevail on non-mainline railways. In particular, they include the specific requirements of ROGS to carry out and record all risk assessments and, for significant changes, to apply safety verification by independent competent persons. These requirements are more stringent than those which prevail in the bus sector (where general H&S risk assessment duties are all that applies) and only slightly less so than the mainline railway, where safety verification has been replaced by the EU Common Safety Method for Risk Assessment (CSM RA) (which also includes independent scrutiny by third party assessment bodies).

Options appraisal

- *No change – Continuing with the current arrangements would maintain alignment of tramways with comparable transport systems. Safety verification took time to embed in the tram sector and we would need clear evidence to support changing the system again. Greater third party involvement and challenge in risk assessment processes may help drive up the collective quality of risk assessments in the tram sector.*
- *Strengthen “Independent Competent Person” (ICP) arrangements – In this option, we would seek to bolster the independence and competence of “independent competent persons” (ICPs) by encouraging / requiring them to be accredited and registered in the same way as CSM RA assessment bodies. Requiring them to do so would require legal change. This approach could have benefits in terms of demonstrating and maintaining the competence of these independent assessors to ORR, operators and the public. An accreditation scheme would take time and money to set up, and the industry would incur the costs of gaining the necessary accreditations. We would also need to work through the potential implications for the “market” of ICPs – some may be driven out of doing this work by the perceived or actual costs and demands of accreditation or the advent of accreditation may stimulate the development of more genuinely independent assessment providers.*
- *Mandatory extension of CSM RA – In this option we would make legal changes to ROGS to replace safety verification on tramways with the CSM RA (as we did on the mainline railway when CSM RA was first introduced in 2010). We believe the CSM has improved the quality of risk assessment in some mainline duty holders, so we would expect to see the same benefits on tramways. Aside from the need for legislative change, the main challenges of this approach would be presentational (difficult to justify requiring something of trams that is not required of, for example, London Underground) and cost (Network Rail have asserted that the use of an accredited assessment body adds 1% to infrastructure project costs).*

- *Promote greater voluntary use of CSM RA – We have a general policy (in our guidance on the CSM RA) of encouraging mainline duty holders to apply the CSM to their risk assessments even when it is not strictly required by the regulations. In our recent statutory review of ROGS, we concluded that we should extend this policy beyond the mainline. In this option, we would actively promote use of the CSM RA on a voluntary basis in the tram sector. This approach would achieve some of the benefits of mandatory extension (depending on uptake) without attracting the disproportion challenge. It would add cost to some projects (depending on uptake) but could be focused on the projects where it is likely to have most benefit (rather than the blanket approach that applies on the mainline). The disadvantage is again the potential for further diversification in standards and quality between those who embrace the voluntary scheme and those who do not.*

Recommendation for suggested ORR position:

- *The tram sector recognises that it needs to improve its approach to risk assessment. The legal requirements that support this are rigorous and align with comparable systems.*
- *We think application of the CSM Risk Assessment has been beneficial to mainline railway projects and we encourage tramways to consider applying it when making changes to their systems.*

Requirements for managing safety critical work (and the personnel who carry it out)

Tramways have exactly the same specific legal duties (Part 4 of ROGS) to manage the competence and fitness of staff carrying out safety critical work as mainline and non-mainline railways. Bus companies are not subject to specific legislation of this nature. Given that the regulation of tramways is therefore already in the “do max” position on regulation of safety critical staff generally, we have focused our consideration on the related issue of the management and licensing of drivers where the picture is more nuanced.

Tram drivers (like non-mainline railway drivers) do not require a statutory licence to drive vehicles in passenger service. On the mainline railway, driver licensing has been progressively introduced since an EU Directive was established in 2007 – all UK mainline drivers had to be licensed by ORR by October 2018. When implementing the 2007 Directive, Government (with ORR’s support) did not extend the requirements to non-mainline, heritage or tram drivers. A train driving licence covers a driver’s fitness and general competence to drive trains. Bus drivers are required to hold a bus driving licence and to obtain and maintain a Certificate of Professional Competence (CPC) from the Driver & Vehicle Standards Agency. The bus licence covers fitness (an

application must be signed off by a recognised doctor) and the CPC concerns competence. So, tram drivers and non-mainline rail drivers are the only public service vehicle drivers in the UK who are not subject to any form of statutory licensing attesting to their competence and fitness.

Options appraisal

- *No change – It is worth stressing that train driver licensing was introduced primarily for reasons of labour mobility and interoperability of rail services in the EU, rather than to enhance safety. Our recent statutory review of the Train Driving Licence Regulations found no evidence of safety (or any other) benefit from its introduction. Maintaining the current situation in respect of tram drivers would avoid imposing this non-beneficial and costly (for ORR and regulated businesses) regime on another sector and would avoid posing the awkward challenge of why we were not also extending the regime to other non-mainline systems (such as London Underground). The disadvantage of the current arrangements is that it could become presentationally difficult to explain why tram drivers do not need a special licence whereas bus drivers do.*
- *Bring tram drivers in scope of road driving licence / CPC – It is perhaps surprising that the absence of any form of licensing for tram (or indeed London Underground) drivers has not been subject to greater public attention / concern particularly following the Sandilands accident. Fixing this apparent gap by at least aligning tram drivers with bus drivers may have benefits for public confidence in tram safety. From a narrow ORR perspective, this approach would be less likely to provoke challenges in relation to non-mainline drivers and we would also not have to set up and manage the regime (it would fall to DVSA to do this). However, it is very difficult to see any safety benefit of doing so: the competence requirements to obtain CPC are set at a fairly basic level, and retaining CPC requires only 35 hours of training to be undertaken every five years. Periodic medicals are not required to maintain a bus driving licence. Both are less rigorous than a tram driver working under an SMS that complies with Part 4 of ROGS would expect to experience. Legislative change, and changes to the CPC scheme to make it relevant to driving a tram (particularly off street), would also be needed.*
- *Bring tram drivers in scope of train driver licensing – Given that trams are generally treated as rail businesses in terms of safety regulation, a more obvious step would be to bring their drivers in scope of train driver (rather than bus driver) licensing. This would be a simple way of enhancing public confidence in the system and may indirectly encourage tram operators to modernise and standardise their driver management arrangements (little evidence of this on the mainline). It would not add*

much in relative terms to the overall administrative burden of train driver licensing as it would add only several hundred drivers to the current total of c.20,000 licensed drivers in GB. However, as noted previously, we have found no direct safety benefit from driver licensing elsewhere so it would be hard to justify on grounds of reasonable practicability. As well as requiring legislative change to expand the scope of licensing, a bespoke set of competence requirements would need to be developed to deal with the characteristics of driving on-street and on line-of-sight (the train driver requirements are based around lineside signal-controlled rail operations). Finally, it would be very difficult to extend the legislation to trams but not to other non-mainline systems – and doing this would bring an estimated additional 5,000 drivers within scope.

Recommendation for suggested ORR position:

- *In the absence of any evidence of safety benefits associated with formal licensing of rail vehicle drivers, we do not support requiring tram drivers to be licensed.*
- *The underpinning legal requirements for the management of competence and fitness of tram drivers are the same as those which apply on all UK railways and we consider they are more demanding than those which prevail in the bus sector.*
- *We may revisit our position if future appraisal of driver licensing on the mainline railway provides evidence that it has been beneficial.*

Requirements for authorisation of vehicles and infrastructure

Similarly to all railways, tramways require statutory authorisation by Government before new systems are constructed (under either a Transport & Works Act Order; a specific enabling Private Act or a combination of the two). Tramways also have requirements to have some changes formally approved (although the extent of these requirements varies between Acts and Orders, and for more modern systems reflects the wider move away from statutory approvals of new railway works, plant and equipment). ORR is involved in these approvals - in practical terms, the varying approval requirements have always been carried out by Her Majesty's Railway Inspectorate (HMRI) on behalf of Ministers (either working directly for Ministers when HMRI was housed in the Board of Trade or DfT/DETR; by Agency Agreements between DfT and HSE / ORR; or between 1994 and 2008 under the Railways and Other Transport Systems (Approval of Works Plant & Equipment) Regulations 1994 (ROTS)). In common with the rest of the rail sector, general requirements for approval of vehicles and infrastructure were dispensed with on trams in 2008² when ROTS was repealed. On the mainline railway, authorisation of new

² The repeal of ROTS in 2006 was subject to an extended transition period in relation to the tramway and heritage sectors, meaning the requirements were maintained until 2008 in those areas.

(or major upgrades to or renewal of) vehicles and infrastructure has again been subject to authorisation by ORR since 2011 as a result of interoperability legislation. Buses and coaches are similarly subject to type approval and individual vehicle approvable by the DfT's Vehicle Certification Agency.

Options appraisal

- No change – There is no apparent desire or justification for making a change to approval arrangements for trams, which were not called into question by the RAIB investigation and which align very closely with what prevails elsewhere on rail and bus. It is important not to conflate the issue of standards (where there is a clear need for the tram sector to make improvements pursuant to Recommendations 1 and 2) with that of the approval process. The current arrangements provide for sufficient ORR oversight and in practice the specific Acts and Orders give us an explicit approval role for most technical changes. There could be a better regulation benefit from having a more clearly standardised set of approval requirements (but note we already address this in part by publishing a single guidance document on approvals under Acts and Orders).*
- Bolster third party assessment of technical changes – See the consideration at paragraph 16.*
- Restore a ROTS – style ORR approvals requirement – The tram sector (with the heritage sector) resisted the repeal of ROTS and it is conceivable that many in the sector would be instinctively comfortable with a return to formal ORR approval of new or altered equipment. Public confidence in the safety of tram equipment may be improved by a return to statutory approvals. But there are many reasons why doing so would not be desirable. There is no evidence of a rise in technical safety incidents following repeal of ROTS has materialised. One of the reasons we repealed ROTS was a concern that the regulations led parts of the rail and tram industry to perceive that ORR “owned” an element of its risk through our approvals – now is certainly not the time to revive that perception. We also repealed ROTS so as to reduce administrative burdens on the industry (and on ORR), these costs would be incurred again were an approvals regime to be restored.*
- Extend interoperability authorisation to trams – Interoperability regulation on the mainline railway has helped support standardisation (for wider reasons than safety) and an authorisation process for tramways could potentially help give the standards developed by the Recommendation 1 body more bite. The authorisation process also includes rigorous third party verification of compliance*

with standards, which parts of the mainline industry have found beneficial. This option would involve some complex legislative changes, however, especially given that the standards called up by the interoperability regulations are very specific to mainline rail. Similarly to driver licensing, we would also need to justify continuing to exclude non-mainline rail from the requirements. As with ROGS certification, it would also add to ORR's burden of statutory work if not carefully constructed so as to avoid duplication with requirements in existing Acts and Orders.

Recommendation for suggested ORR position:

- *Tram vehicles and infrastructure are already subject to sufficient approval requirements. There is no safety justification to overlay another authorisation or approval regime.*

Requirements for safety performance reporting

This section is specifically about reporting on safety incidents and performance to the regulator. It is not concerned with the industry's implementation of recommendations to improve, standardise and share the data it collects for its own safety management purposes.

In common with non-mainline railways and buses, there are no statutory safety reporting requirements on tramways additional to those set out in RIDDOR. Mainline railway businesses are required to submit an annual safety report to ORR, including a statistical return against EU Common Safety Indicators (CSIs).

On a voluntary basis, we receive much better safety data from mainline and some non-mainline railways than we do from the tram sector.

Options appraisal

- *No change – The tram sector's compliance with RIDDOR is good. The Prior Role Review recommended that make better use of this data. The tram sector has made tentative efforts, which they are bolstering following the RAIB recommendations, to improve its data collection beyond the requirements of RIDDOR. Discussions have implied that elements of this data would be shared with us in future and we ought to confirm that. The disadvantage or risk here is that this work does not deliver and we continue to have access only to minimal tram safety data.*
- *Extend mandatory reporting – Non-mainline railways (though not tramways) were previously subject to ROGS annual reporting. We repealed this requirement in 2011 because duty holders were finding it burdensome and we did not find the data valuable. In this option, we would reinstate annual reporting. This would at least give*

us a regular return of tram safety data supported by commentary about operational safety performance. However, we would need to support this with some better guidance (or list of required data) to ensure we received useful reports. Legislative change would be required and may be resisted on cost grounds by all those brought into scope. We would need to explain why we had changed our mind and decided annual reporting was useful.

- *Voluntary reporting – In this option we would challenge the tram sector to provide us with better data, noting that voluntarily sharing safety data with the regulator is common practice on the mainline (via SMIS) and for LU (via LUSEA). This could be formalised, if necessary, by updating our MoU with UK Tram. We know that the individual operators already collect more data than they share with us, so this approach would not necessarily need to await the development of the cross-industry safety database it is developing. We would need to work with the industry to define what we wanted, and there might be a small admin burden associated with providing the data (and processing / analysing it on our part).*

Recommendation for suggested ORR position:

- *We have formally recognised (through the PRR) that we need to make better use of the RIDDOR data we get from tramways.*
- *We will continue to work with the sector and UK Tram to encourage the sharing of more safety data to help inform our regulatory activities.*

Recommendation 10

169. On 13 April 2018 Transport for London (London Trams) and Tram Operations Ltd provided the following joint response:

Since the incident at Sandilands and commencing from before RAIB published its report, TOL and LT have been collaborating to enhance the assessment of risk associated with the operation of trams. This commenced with a review of the risk of collision, derailment, and overturning using the safety bow-tie risk assessment method.

Subsequently TOL and LT reviewed and updated their Joint Risk Model (the model) to check that all low frequency /high consequence events had been identified.

TOL and LT have prepared a Brief that explains the purpose of the model and how it works. The final method by which the model is updated and how often it is reviewed is currently under discussion.

Separately, TOL has reviewed and where appropriate updated its general processes for risk assessment specified in SM0011 and SM0019.

Where additional risks have been identified, TOL and LT have sought to implement measures to mitigate those risks accordingly. An example of where the model has assisted this process can be seen in development of a Correct Side Door Enabling solution where FWI data gleaned during development of the model was used to positively inform safety decision making.

TOL and LT believe that, as duty holders, the reviews have to be led by them (engaging their staff appropriately at all levels) but independent expert input and validation has been utilised where it adds value.

AbsTracked Solutions Limited (AbsTracked) have been engaged to lead the modelling process and ensure the final model identifies and evaluates all significant risks and potential mitigations.

TOL and LT have shared their model and safety bow tie risk assessment with other tram operators via the UK Heads of Safety Forum; the approach was well received and seen as a positive step by the attendees of that forum. An update on development and use of the model will be given by TOL and LT at the RSSB Risk Management Forum scheduled to take place on the 6th and 7th of June 2018.

170. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

This Recommendation relates to safety and risk assessments and are addressed to ORR, TfL and FTOL. As far as UKTram is concerned, the need for risk analysis in the industry as a whole is covered by Recommendation 2 above.

Recommendation 11

171. On 13 April 2018 Transport for London (London Trams) and Tram Operations Ltd provided the following joint response:

TOL has drawn on expertise from within FirstGroup heavy rail and from Clockwork Research Ltd (Clockwork) to support the review and development of its Fatigue Risk Management System (FRMS). Clockwork has substantial experience as a fatigue risk management consultant in high risk industries.

TOL is in the process of a three-phase review and development of its FRMS. Phase 1, which included a comprehensive gap analysis to ORR's good practice guidance and biomathematical assessment of roster patterns by Clockwork, has now been completed. This review encompassed each point of RAIB Recommendation 11.

Ahead of the conclusions of the Clockwork review, TOL has implemented enhanced monitoring of driver overtime and rest day working; and training and briefing for drivers and those managing them.

Furthermore, TOL and LT have drawn on experience within FirstGroup's Reading Rail-Air Bus operation to develop and implement the Guardian Device across all its trams. The Guardian Device monitors eye and face movements to detect and warn

against the onset of fatigue or distraction, and has been operational on Tramlink since October 2017.

Phases 2 and 3 (the enhancement of TOL's fatigue risk management capacity) is in progress. Clockwork are due to present their Phase 1 findings to TOL on the 30th April 2018.

The final scope of work in Phases 2 & 3; and the timings for that work, will depend on Clockwork's findings.

TOL and LT have begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

172. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

Although RAIB found no evidence that shift patterns contributed to the accident, operators clearly have an obligation to ensure that drivers and safety-critical staff are not fatigued.

Through its industry questionnaire, UKTram has undertaken a review of common best practice in fatigue management throughout the industry. There are some very good fatigue management systems already in place. UKTram is also reviewing technical aids to fatigue management, as described elsewhere in this briefing. This aim of this work, which is ongoing, is to share the results with all UKTram members.

Recommendation 12

173. On 13 April 2018 Transport for London (London Trams) and Tram Operations Ltd provided the following joint response:

Following the Sandilands incident, TOL undertook an organisational culture review. Specifically, this review has identified and commenced work on:

- *Fostering the creation of a just culture by working collaboratively with ASLEF and UNITE to agree application of company management procedures and by improving staff engagement in safety issues.*
- *Establishing agreed working definitions of "error" and "violation", to improve management and support of drivers following safety-related incidents.*
- *Rail Operations Group (ROG) has reviewed TOLs incident investigation process and made suggestions for improvement. TOL have acted on these comments as part of a planned documentation review.*
- *Assesstech Ltd have delivered a programme of enhanced incident investigation to Duty Managers to improve the identification of root cause and subsequent recommendations made to prevent recurrence.*
- *TOL's incident investigation process already seeks to identify the root cause(s) of incidents however TOL have additionally invested in a new electronic system to support management of the investigation process and analysis of any trends.*

- *Lessons learned are discussed at Health and Safety Meetings, shared with staff and reported to and considered by the Board.*
- *Information on current safety trends and the status of improvement initiatives is displayed prominently on posters around the depot and in staff notice cases.*

TOL continues to actively consider potential external experts on learning from operational experience. RSSB has offered to support a review of TOL's organisational safety culture. This offer has been accepted and work will form part of TOL's 2018 safety planning activities.

TOL expects to finalise with ASLEF and UNITE a non-punitive approach to managing safety related incidents where driver error is identified as a causal factor by May 2018.

TOL and LT have begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

174. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

This Recommendation was mainly addressed to TfL and FTOL. Liaison with other operators through LROC, LREG and HoSG.

Recommendation 13

175. On 13 April 2018 Transport for London (London Trams) and Tram Operations Ltd provided the following joint response:

Employee comments

TOL continues to encourage its staff to report near misses and identify any safety concerns they have, and is collaborating with ASLEF and UNITE to further encourage reporting by employees.

TOL provide access for all staff to FirstGroup's Confidential reporting facility and the Confidential Incident Reporting and Analysis System (CIRAS).

Customer comments

Since November 2016 the process of receiving, categorising, and escalating customer complaints to TOL for review is now wholly managed by TfL. The vast majority of customer complaints are now sent directly to TfL who will refer them to TOL for action in accordance with their own processes. TOL's review is therefore limited to that element of the process once the complaint is forwarded by TfL.

Where TOL directly receives a comment or complaint which is obviously of operational or safety concern, then it will of course take steps to deal with the

issue as appropriate whilst also relaying the information (along with details of any immediate action taken) to TfL.

TOL has appointed a dedicated customer service manager, who receives all customer complaints forwarded by TfL. Their remit includes ensuring that appropriate action in respect of complaints is taken without undue delay (including, where necessary, contacting witnesses for evidence and obtaining technical evidence).

Technical evidence

To minimise risk of loss of video evidence, CCTV was replaced in all CR4000 trams between May-October 2017.

The CCTV system in SVT trams remains unchanged.

The process by which complaints are sent to the customer service manager came into effect in April 2018.

TOL and LT have begun implementation of measures necessary to address this recommendation and will continue to do so as any new matters arise.

176. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

This Recommendation was mainly addressed to TfL and FTOL. Liaison with other operators through LROC, LREG and HoSG.

Recommendation 14

177. On 23 April 2018 London Trams provided the following initial response:

London Trams accepts this finding. Prior to the accident, London Trams had already commissioned work to renew and upgrade the CCTV recording facility on the Bombardier tram fleet, and to strengthen our procedures for checking that the system is working prior to trams entering service. This work is now complete and a summary of the changes and benefits realised is outlined below.

- *In December 2016, London Trams appointed Synectics to design, procure and install a new Digital Viewing Recorder (DVR) and cab monitors on-board our Bombardier trams and install new hardware to view CCTV recordings at the depot facility at Therapia Lane.*
- *The new DVR units were commissioned, tested and installed on the CR4000 fleet in May 2017. Work to upgrade and integrate the viewing facility at the depot was completed at the same time.*
- *An upgrade of the cameras was completed in October 2017.*

In addition to significantly improving the reliability and maintainability of the CCTV system, the added benefit of this work is that the status of the on-tram DVR unit can be monitored remotely by the Control Room on a daily basis. This enables us to identify and rectify any faults before the tram enters service, thus significantly reducing the possibility of a tram being in service without CCTV recording. The

capacity of the DVR unit has also been enhanced such that up to 30 days of data can be stored by the unit through additional storage capability.

The procedure for testing and reporting of audio/visual faults on the trams (TOL procedure OP 0045) has been reviewed and updated to take account of this enhanced functionality and testing requirement.

London Trams have shared full details of this work with UK Trams to assist other operators who may also be considering whether to adopt similar changes to the CCTV recording system on their vehicles.

The CCTV and DVR system on the Stadler fleet is not the same as that used on the Bombardier fleet and does not have the same limited data storage capacity, reliability and maintainability issues as the systems fitted on the Bombardier fleet at the time of the Sandilands accident. In addition, unlike the Bombardier trams, faults with the CCTV recording system in the Stadler vehicles are indicated in the drivers cab, enabling prompt action to be taken to rectify any issues found. A review is underway to establish whether similar remote monitoring capabilities can be introduced on the Stadler vehicles as is now used on the Bombardier vehicles, by making modifications to the current software to that fleet. That review will be completed by September 2018, and any enhancements considered necessary will be implemented as quickly as possible after that date.

178. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

This Recommendation arises from the RAIB findings that CCTV on the tram involved in the Sandilands accident was not functioning correctly.

UKTram has undertaken a review of CCTV usage throughout the industry through its industry questionnaire. Several operators are installing CCTV equipment to record data for use in the event of an accident. The majority of operators withdraw tramcars from service if CCTV is not working. Some older style systems are not easily downloadable or potentially create other recording issues, and this issue is being reviewed.

Recommendation 15

179. On 23 April 2018 London Trams provided the following initial response:

London Trams accepts this finding and is committed to continually improving the accuracy and usability of maintenance and testing instructions to all staff.

Following initial feedback from the RAIB, London Trams completed a feasibility and scoping exercise in August 2017 to map out the extent to which the maintenance and testing documentation for the tram fleet needs to be reviewed and updated. This work proposed a two phased approach to the improvements necessary.

The first phase of this work proposed the development of sixteen prioritised

engineering standards, each with associated work instructions, procedures and forms. Through a competitive tender exercise, London Trams appointed Xanta in March 2018 to design and deliver this work. A programme is currently being developed and will be completed by December 2018.

The purpose of this work is to ensure that engineering and maintenance requirements are accurate and comprehensive, reflect good industry practice and take into account all modifications and changes made to the fleet since their introduction to service. Outcomes of standards and work instructions are to be designed in such a way that requirements are clearly defined and measurable. Changes to working practices and methods arising from this review will be communicated to the staff affected and published in a controlled and managed environment. New staff joining the relevant teams will be briefed on the revised instructions and standards.

The second phase of works involves the review of a further number of engineering standards, which due to the nature of their content has been assessed as being a lower overall priority. This work will be completed by December 2019.

Improvements have also been implemented to the governance of management system content such as engineering standards and work instructions, amongst other documentation. All management system content has been reviewed and allocated to an accountable manager in London Trams. The role of that manager is to ensure that the documents assigned to their stewardship are reviewed to the required frequency and that content is current, accurate and relevant.

Management system content is controlled and managed such that documentation that is approaching its review date is escalated for review to the accountable manager. Reports by exception are produced where documentation has passed its review date without being confirmed as being fit for purpose. These reports are monitored and actioned as necessary, by the London Trams management team.

180. UK tram provide the following information on 12 October 2018 on work they have done on the recommendation:

This Recommendation was mainly addressed to TfL and FTOL. It is an on-going topic for LROC, LREG and HoSG.