

# Wandle Park Tram Incident – Traction granted with tram door open at RVC06S

13<sup>th</sup> September 2021

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### 1.0 Executive Summary

Transport for London (“TfL”) conducts Formal Investigations into the most serious incidents that occur across its transport network. These investigations are undertaken by trained investigators in accordance with approved procedures. The outcomes of these investigations allow TfL to understand the cause of any such incident and implement suitable action to prevent reoccurrence.

On the 13th September 2021 at 05:55 Tram 2562, after departing Church Street tramstop, proceeded westbound towards signal RVC06S in advance of Wandle Park tram stop, at which point the driver stopped, awaiting a proceed signal. Whilst the tram was stationary, an Emergency Door Release (EDR) was operated by a member of the public travelling on the tram. The passenger disembarked the tram at a non-platform location and walked eastbound towards the rear of the tram towards Reeves Corner tramstop. A short time afterwards a tram, travelling eastbound, passed close to where the passenger was standing at the rear of the tram.

[REDACTED]

The FIR panel identified the root causes as:

- A: A modification to the [REDACTED] similar to that of the CR4000 has not been adopted
- B: The specification and design of the SVT tram
- C: A possible failure to apply existing standards and/or failings in the assurance and testing process

The FIR made 8 recommendations to address these root causes and observations made in the course of the investigation.

### 2.0 Preface

The purpose of the Formal Investigation is to determine the causes of the incident and to identify any measures necessary to prevent a reoccurrence. The investigation is not to establish blame or liability.

### 3.0 Terms of Reference

A formal investigation has been commissioned for a review into the circumstances around the incident. The purpose of this investigation is to determine the causes of the incident and to identify any measures necessary to suitably minimise the risk of recurrence (not to establish blame or liability).

The investigation should:

- Establish the sequence of events that led to the incident.
- Identify why the incident occurred in terms of immediate cause, causal factors and root causes.
- Identify any actions already underway to address the root causes.
- Develop reasonably practicable recommendations to address the root causes.
- Consider previous or similar incidents

The investigation should pay particular attention to:

- Establish the difference in design of the Stadler and the CR4000 trams reviewing 2016 Engineering risk assessment.
- Look at the design of the emergency door release (EDR) system and explore potential modifications to mitigate the risk of passengers exiting the tram in unsuitable locations after an EDR handle has been operated. Compare to the similar operation on the CR4000
- Review the customer risk assessments in relation to this type of incident
- Operational procedures
- Reporting procedures – specifically within London Trams and Surface Transport

## 4.0 Summary of Incident

Time	05:55
Date	13/09/21
Organisations involved and their business units /departments	Tram Operations Limited London Trams Transport for London
Location	At signal RVC06S between Church Street and Wandle Park tram stops
What Happened	The driver of tram 2562 [REDACTED] [REDACTED] [REDACTED] whilst the tram was stationary at the signal and that the door pair had been pushed open manually. [REDACTED] [REDACTED] The tram was detained at Wandle Park and taken back to the depot for testing
Consequences	No injuries to staff or passengers  No asset damage
Incident Report Number	IRF 145261
Enforcement Authority Involvement	N/A

## 5.0 Location of the Incident

Signal RVC06S between Church Street and Wandle Park tram stops westbound.

## 6.0 Weather and Environmental Conditions

It was dry, mild, and dark. Visibility was good and weather and environmental conditions are not considered to be a factor in this incident.

## 7.0 Pre-Incident Details

The Tram Operator was working his duty as per the roster on the day of the incident. There are no relevant factors of note, nor areas of concern regarding the driver. The tram had been passed for service during a routine inspection at the depot and no relevant issues with the performance of the tram are noted.

## 8.0 Incident Timeline

Time	Event
05:53:58	Tram 2562 (The Incident Tram) takes traction and moves off from Church Street Tram Stop heading Westbound.
05:55:16	Holding brake applied with tram travelling at 4kph
05:55:17	Tram reaches signal RVC06S and stops
05:55:19	Brakes applied by the driver
05:55:35	EDR operated on door 2L
05:55:35	The Green Loop signal is lost but driver is unaware of this initially
05:56:27	[REDACTED]
05:56:28	Holding Brake released
05:56:28 –	[REDACTED] [REDACTED]

05:57:24	indicating a loss of green loop and the green loop indication is also lost and contacts the Controller who works through available procedures, liaising with the driver who continues towards Wandle Park.
05:58:38	Brakes again applied by driver until tram reaches standstill at Wandle Park stop when parking brakes are applied. Tram is detrained.
06:01:49	Driver manually resets EDR of door
06:03:16	Green Loop restored
06:03:18	Green loop briefly lost for unknown reason
06:03:18	Tram continues out of service to depot for testing.

## 9.0 Incident Management and Recovery

There is a specific procedure for C81001 – “Green Loop Interrupted” when no other error codes are shown in the TOL Operational Procedures Manual (Version 2, Oct 2016, OP0030 Appendices, page 113) which states that, if a tram is stopped at any location other than a tramstop a check of all the doors must be undertaken as a first step before any other actions are undertaken. The procedure is Controller led. A review of the radio recordings identifies the driver contacted the Controller after receiving a “Green Loop Interrupted” indication on the HMI, with CCTV footage confirming this was initially done whilst the tram was moving.

The Controller initially gives advice on a loss of Green Loop based on an assumption that the tram was at a platform and the cause was likely a temporary obstruction during the door close cycle. The driver confirms that he is not at a platform, but at a signal. The time from the driver making the Controller aware of the issue and the tram reaching Wandle Park is approximately 1 minute 30 seconds. However, a review of the CCTV footage demonstrates the single open set of doors (2L) close very quickly after the driver reaches 3KPH – approximately at the same time the driver becomes aware of the loss of his Green Loop indication. The Controller asks several clarifying questions, including whether the driver has lost his “Green Loop” indications, which the driver confirms he has.

When the tram reaches Wandle Park the radio recordings demonstrate the Controller followed Procedure C81001 as written, for dealing with a “Green Loop Interrupted” indication at a platform.

[REDACTED]

[REDACTED]

[REDACTED]

When the tram reached Wandle Park, classed as a position of safety, the procedure states the controller should instruct the driver to check the rear-view displays for any sign of an open door. In fact, the Controller requested the driver physically check the doors. Whilst a variance to the procedure, it is likely more thorough as a check using the rear-view displays may not have highlighted the small amount that doors 2L were open and time may have been wasted.

The procedure then requires the controller to instruct the driver to perform a door integrity test on the platform side only. If the test fails to resolve the problem, then the passengers should be detrained and the tram taken out of service. In actuality, the passengers were detrained at Wandle Park and then door integrity tests on both the platform and non-platform sides were carried out. Whilst a variance of procedure, there are no safety implications from this action. If anything, it demonstrates a thoroughness on the part of the controller and driver.

During the door integrity tests and physical check of the doors, the driver became aware that the EDR adjacent to doors 2L had been [REDACTED]. After confirming that the Green Loop had been restored the driver was initially told he could carry on. Very shortly afterwards the Controller calls the driver again and asks if anyone had got off when the EDR had been pulled, which the driver confirms in the affirmative. At this point the Controller instructs the driver to detrain the tram and proceed out of service to depot.

Fleet, in conjunction with a TOL driver assessor performed several tests on the tram within the depot environment in a variety of scenarios. [REDACTED], tests conducted during the investigation identified no safety implications from this misalignment. The conclusion was that the tram was performing to its specification.

### 10.0 Immediate Actions Taken

- Tram was withdrawn from service as a precautionary measure and returned to depot
- Fleet were informed of the issue with the tram and this incident was logged in the Incident Log for 13/09/21 (ref: 144730).
- Checks were undertaken by Fleet and the findings set out as part of "The 48 Hour Report".
- CCTV footage and other relevant evidence was gathered and secured, and a decision made to conduct a joint internal formal investigation into the incident

### 11.0 Causal Factors

- Immediate Causes

The investigation identified two Immediate Causes of Tram 2562 travelling between Reeves Corner Signal RVC06S and Wandle Park tram stop with door 2L open:

A) Possibly intoxicated male operates Emergency Door Release handle whilst tram is stationary at signal RVC06S

B) [REDACTED]  
[REDACTED]

If either one of these immediate causes had not occurred, then the incident would not have happened.

- Immediate Cause A - Causal Factors

The FIR identified two causal factors with regard to Immediate Cause A

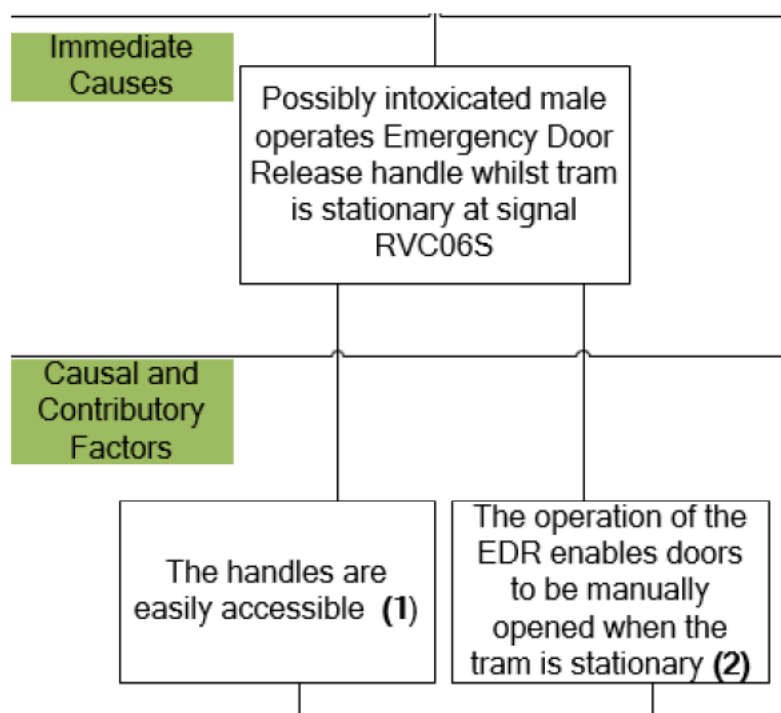


Figure 1 – The Causal Factors for Immediate Cause A

- Immediate Cause B – Causal factors

The FIR identified there were three causal factors with regard to Immediate Cause B

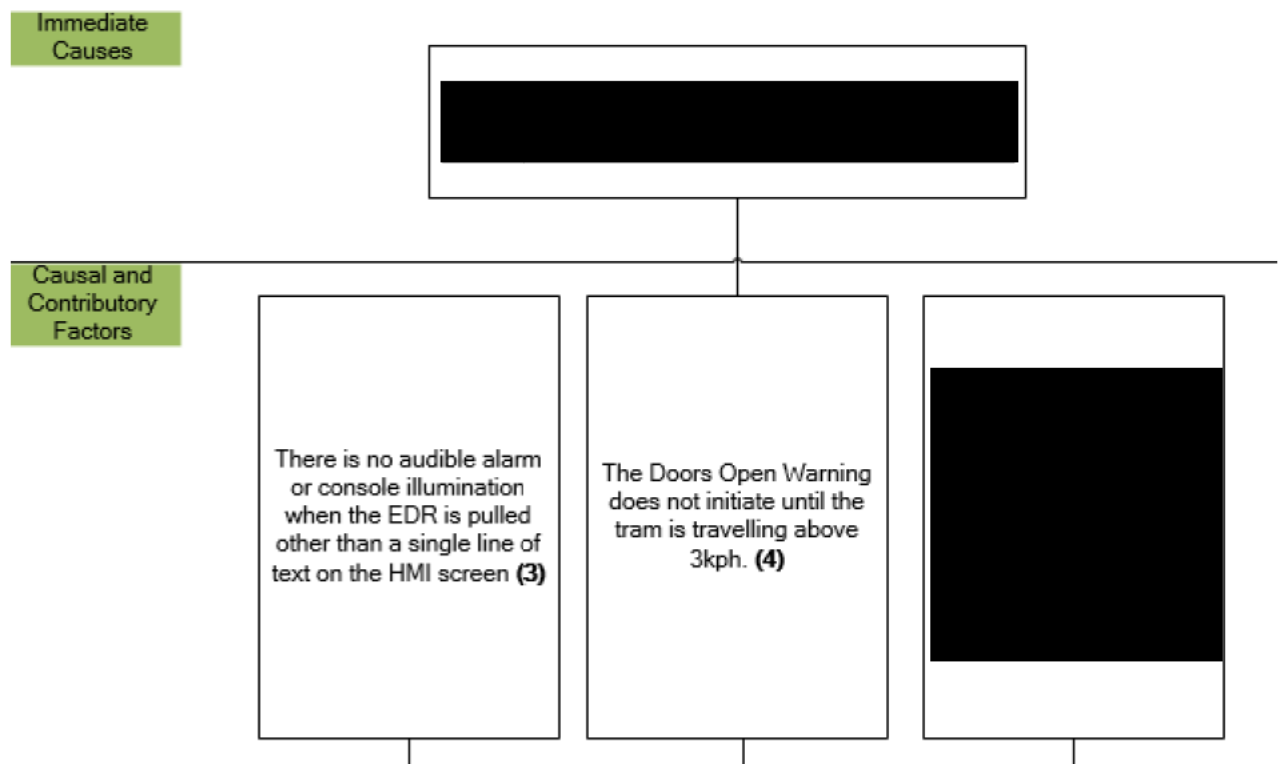


Figure 2 – The three causal factors for Immediate Cause B

## 12.0 Root Causes

### 12.1 Causal Factor 1 – The EDR handles are easily accessible

Unlike on the CR4000 tram which requires a cover to be lifted in order to access the EDR, there are no impediments on the SVT tram. The signage warning against improper use is muted in comparison to that of the CR4000 tram. Data indicates, in percentage terms that there have been a greater number of EDR incidents on the Stadler tram in comparison to the CR4000 since 2019.



Figure 2 & 3 – A CR4000 EDR panel (left) and a SVT EDR Panel (Right)

The investigation identified a single root cause for Causal Factor I – Root Cause A

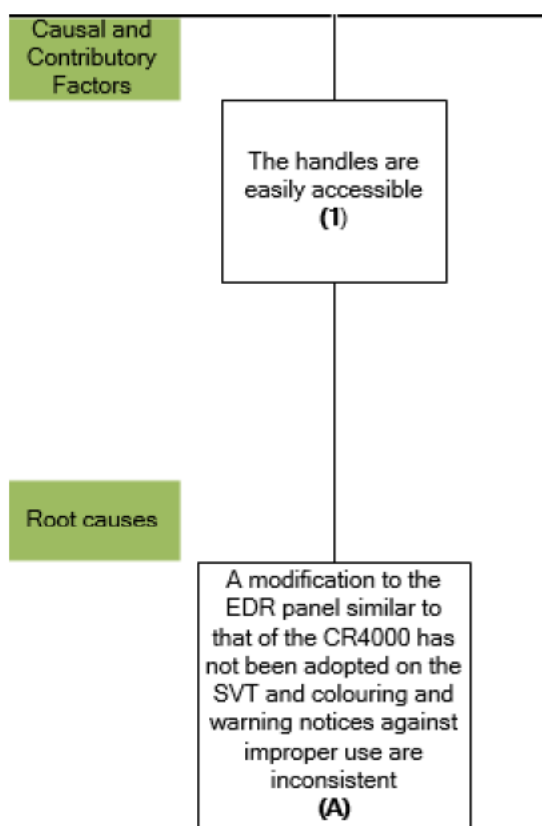


Figure 4 – Root Causes for Causal Factor I

- A. The EDR panel on the CR4000 appears to have been modified between 2015 and 2016 as a consequence of one of several recommendations made by the RAIB in their March 2014 investigation into a previous incident involving a tram on London Tramlink running with its doors open on 13<sup>th</sup> April 2013, to include a metal cover to be lifted before access to the EDR handle can be obtained and modify the associated signage. The SVT was brought into service from 2012. It appears to have been purchased “off the peg” and The EDR configuration seems to be part of the original design. It is not clear why a retrospective modification to the SVT EDR panel to bring it into line with that done on the CR4000 was not done, as the prevailing standards do not preclude such a modification being made.

Additionally, both tram stocks have clearly stated notices warning against improper use. However, whilst on the CR4000 tram the warning is white text on a red background, on the SVT tram the warning is written in white text on a green background – removing a subtle

additional warning against improper use. The actual EDR handle on the CR4000 is red, whilst the handle of the SVT EDR is green, further removing a visual indication that the EDR is for emergency use only. The LRSSB TPG document references BS EN 1752 which states that the devices should be red. LT appear to be at variance with this standard.

Trend analysis has shown that the number of incidences in percentage terms of the EDR being pulled is less in recent years on the CR4000's than it is on the SVT. This could suggest that the metal cover and warning notices acts as a deterrent towards improper use. However, it is possible that further analysis to include locations of EDR pulling, the frequency of services, passenger loadings, hot spots of anti-social behaviour and an array of other factors could also explain the differences. However, despite these caveats, it is an area worthy of further investigation, and forms the basis of Recommendation I

EDR Pulls by Tram Stock				
Year	CR4000	SVT	Total	SVT WEIGHTED %*
2012	204	6	210	UNAV
2013	239	7	246	UNAV
2014	223	10	233	UNAV
2015	76	8	84	20.48%
2016	33	7	40	37.63%
2017	23	6	29	44.48%
2018	22	5	27	39.81%
2019	14	10	24	89.58%
2020	14	5	19	56.58%
2021	12	8	20	86.00%
SVT Average of all EDR pulls 2019-2021				77.39%
* Latest data available showed the SVT fleet operated 1,025,000 KM approximately, whilst the CR4000 fleet operated 2,209,000 approximately in the 12 months to November 2021, equating to 2.15 times the KM's operated by the SVT. The weighting given to the actual number of incidents per KM driven of the SVT has accordingly been set at 2.15.				

Figure 5 – Weighted percentage of SVT EDR activations set against total number of EDR activations of whole fleet

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## Root Causes

The tram operates, in this regard, entirely to the relevant standard. Indeed, were it not to do so, it is possible that a passenger(s) needing to exit the tram quickly in the event of an emergency situation could be harmed by their inability to do so. However, it was noted that there is a lack of signage warning of the dangers of exiting a tram at a location other than a designated tram stop, nor any guidance given to passengers on how to exit a tram safely in such a location, should they need to do so. This issue is addressed in **Recommendation 2**.

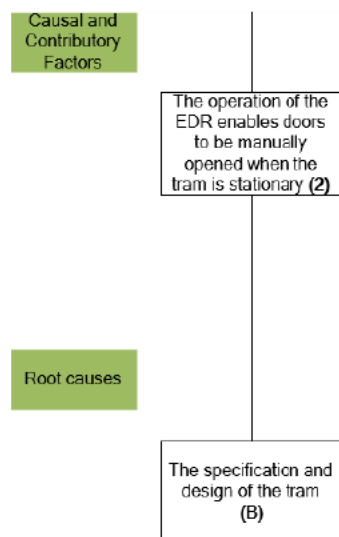


Figure 6 – Root Causes For Causal Factor 2

### 12.3 Causal Factor 3 - There is no audible alarm or console illumination when the EDR is pulled other than a single line of text on the HMI screen (3)

When the EDR is operated on a CR4000 tram three red warning lights illuminate indicating:

- Passenger Emergency Handle operated
- Doors Open
- Parking Brakes applied

Additionally, a siren sounds in the cab.

None of these indications are available on the SVT tram, although the Green Loop indication is lost.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Additionally, the radio recordings confirm the driver states he did have his Green Loop visuals at the previous tramstop. He states, after departing signal RVC06S that he has noticed they are no longer illuminated. [REDACTED]

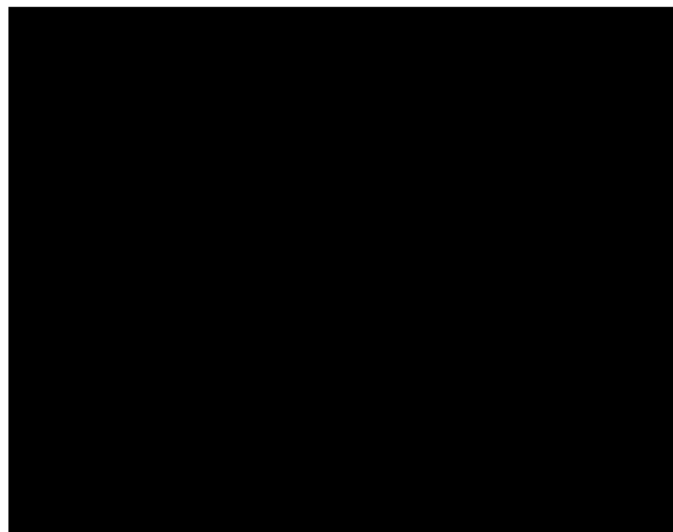


Figure 7 –

#### 12.4 Causal Factor 4 - The Doors Open Warning (Green Loop Interrupted) does not initiate until the tram is travelling above 3kph.

However, as noted above, this is not something the driver would necessarily notice whilst focussing on the road ahead.

This is crucial to the understanding of this incident and the lack of driver awareness for several reasons:

- When the EDR was pulled the tram was stationary so the driver was unaware that it had been operated before pulling away
- The video evidence shows that the driver continued to operate the tram upon being aware that Green Loop Interrupted warning on the HMI had operated. However, the video evidence also shows that the doors powered closed very quickly after the tram set off. Factoring reaction time before a decision was made and following the procedure to perform a visual check of the doors (which could be done using the side cameras

available to the driver on the in cab monitor) the driver would have seen that the doors were now closed. The Green Loop Interrupted would remain present until the EDR was reset, which steers the driver (and indeed Controller) towards a different procedure, which was followed. [REDACTED]

[REDACTED]

[REDACTED] (See Section 9 for more information on these procedures).

## Observation I

It was noted that the guidance contained within C81001 regarding actions following a Green Loop Interrupted indication gives two scenarios:

- What to do if a tram is at a tram stop when the GLI visual occurs
- What to do if a tram is stopped at any location other than a tram stop.

In the first scenario it is very clear that the Controller directs the procedure. It states that the Controller should instruct the driver to check the rear-view displays for any sign of an open door. In the second scenario it is not clearly stated who controls the procedure and, although the procedure states that “you must satisfy yourself that all of the tram saloon doors are fully closed and that the tram is safe to continue”, it does state whether this should be done by a physical check by the driver, or by use of the rear-view displays.

It should also be noted that, in this incident, neither of these scenarios occurred. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

If an EDR is operated on a CR4000 tram traction is removed and the parking brakes apply. [REDACTED]

[REDACTED]

[REDACTED]

In the case of the SVT there are several scenarios, and the tram will behave differently dependant on which scenario is in place.

Scenario 1 – an EDR is operated at a designated tram stop and the doors have been cycled “release/close”.

In this scenario the green loop is lost, traction blocking is instigated, the parking brakes will apply, and the tram will not move until the driver has physically reset the relevant EDR.

Scenario 2 – An EDR is operated less than 36 metres from a designated tram stop with the tram in motion and where the saloon door open-close cycle as taken place as normal.

In this scenario the green loop is lost, traction blocking is instigated, the parking brakes will apply, and the tram will not move [REDACTED] In this scenario the doors only marginally open until the tram has stopped and present little customer risk.

Scenario 3 – An EDR is operated whilst the tram is moving and has travelled more than 36 metres from a designated tram stop where the saloon doors have been cycled normally.

[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED] With London Underground trains the operation of a Passenger Emergency Alarm will stop a train if the train is within platform limits and the brakes will apply. Traction cannot be demanded until the PEA is reset.

If the train is outside platform limits the driver will lose traction and have the option of overriding and continuing to the next station (a safer location) before investigating [REDACTED]  
[REDACTED]. However, it may also be a design flaw based on the assumption that there are no stops made by the tram other than at platforms. In this scenario the doors only marginally open until the tram has stopped, at which point they can be easily opened by a passenger. The level of potential risk is largely dependent on whether they attempt to disembark the tram and in which location.

Scenario 4 – An EDR is operated whilst the tram is stationary at a location more than 36 metres from a designated tram stop where the saloon doors have been cycled normally.

The door motor for the open door will start and will continually power closed when the tram moves above 3 KPH. The principle behind this is set out in Scenario 3. However, as the doors can be easily pulled open when the tram is stationary, there is a possibility of entrapment and injury when the doors attempt to power close.

Scenario 4 represents what happened during this incident if without the potentially serious consequences. If causal factor 5 was absent from the equation, then the incident would not have occurred.

### Root Causes

The investigation identified two root causes that were common to Causal factors 3, 4 & 5. Root Cause B and Root Cause C. Root Cause B is also the cause of Causal Factor 2 and the same conclusions should be applied.

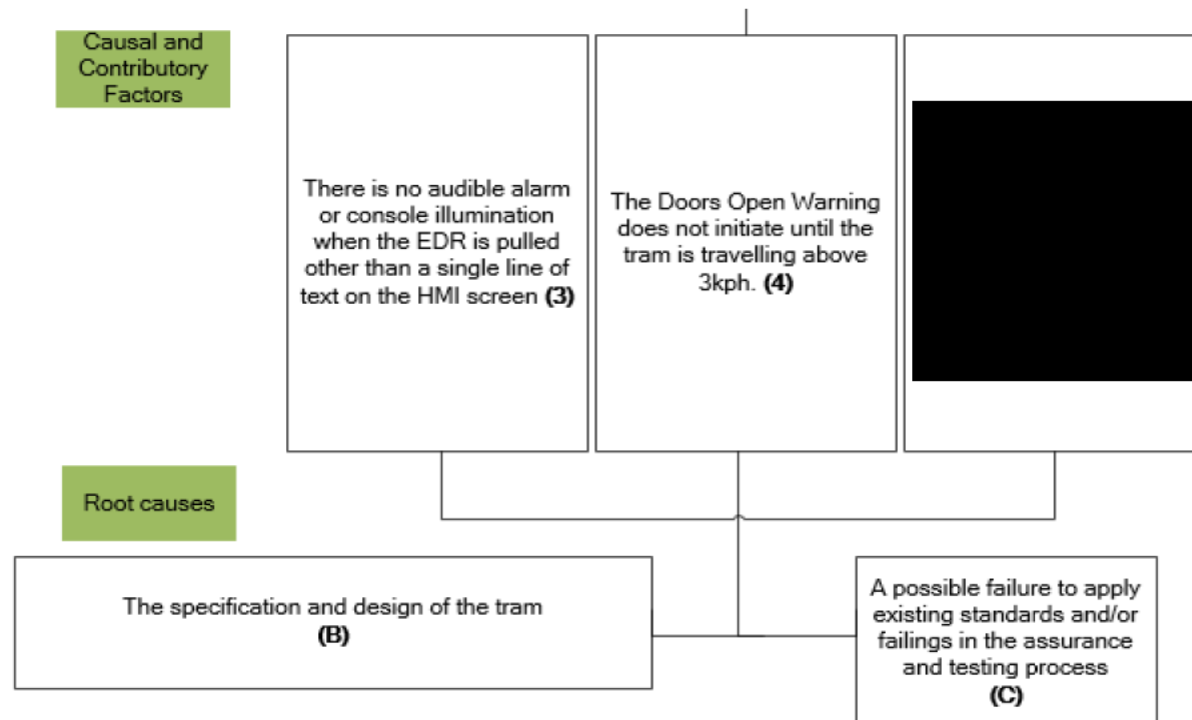


Figure 8 – Root Causes For Causal Factors 3,4 & 5

- B. The SVT was commissioned in 2012, in response to a stated intention to extend the existing Croydon Tramlink. It is not clear how the tender process was conducted, nor if there was one. Documentation that would have provided illumination on the procurement, assurance and acceptance phases of the project is not readily available. It has been suggested that there was limited oversight by LT/TFL with regards to these processes and that assurances given by the manufacturer were taken as read.

The TPG guidelines are the standard for tram design. Whilst the version provided is dated 2016, which is after the introduction of the SVT tram, with reference to the behaviour of trams in the event of an EDR being pulled, the older tram – the CR4000, is compliant with the standards, whilst the SVT is not. Specifically, the TPL guidelines require the brakes to apply and remain applied until the EDR is physically reset. A review of the RSP2 guidelines that predated the adoption of the TPG guidelines shows no variation with regards to this point. This issue is addressed in Recommendation 4.

- C. As stated above, it was not possible to obtain any documentation relating to the commissioning of the SVT. It has not been possible either to determine what, if any, processes were in place to review the performance of the tram, post acceptance, nor to determine whether any formal reporting structures were in place. During the investigation a discussion took place with a party who was present during the testing of the SVT who stated that, prior to the commissioning of the tram, questions were asked about the application of the emergency brakes after the operation of the EDR, and answers given to the effect that the SVT would behave in the same way as the CR4000 in this regard. [REDACTED]

[REDACTED] It is unclear how these concerns were addressed, other than to note that no modifications have been made to date. This issue is addressed in Recommendation 5.

## Observation 2

The investigation was frustrated to a large degree by the lack of historical information regarding the tendering, commissioning, and testing phases of the SVT. The investigation is aware of significant management change during and after the period of introduction of the SVT. However, historical memory is vital in understanding how things came to be, and to learn lessons for the future. Regardless of changes of management, relatively straight forward requests for historical data, should

be easy to obtain, and the fact that it has not been easy to locate this evidence is a cause for concern, and forms the basis of Recommendation 6.

### 13.0 Human and Ergonomic Factors

There is no suggestion that the Tram Driver acted recklessly during this incident. His responses were measured and structured. A review of the radio recordings between the Tram Operator and the Controller demonstrates a methodical and dynamic approach to the incident as information was sought and processed. It seems certain that the procedure following notification of a “Green Loop Interrupted” status to the driver, via the HMI panel was largely followed with the decision to finally withdraw the tram, demonstrating a strong regard to safety.

Of greater significance is the design and layout of the HMI screen and the lack of alarm indications. The CR4000 has had modifications done according to the 2016 risk assessment and in reference to the 2014 RAIB report but the SVT has not. In some ways the design layout of the driving cab and associated equipment to be monitored by the driver could be argued to be inferior to that of the CR4000. Significant amounts of work have been done in recent years around the inherent risks of relying on human beings to follow rules and procedures to mitigate risk. This is particularly true in tasks that move very quickly from a low to high workload, as in the case of operational incidents such as the one under review.

LU have worked collaboratively with RSSB to understand the impacts of ATO (automation) on the health and wellbeing of train Operators, and a report, detailing the conclusions of this work was produced in 2018 with the hope that it would be shared across TFL. This report is referenced in the appendices. Whilst it is not directly comparable to the incident in question, it does provide useful information into how drivers deal with incidents that rely, to a greater or lesser extent on rules and procedures to mitigate against risk and the limitations of such an approach in contrast to a design based solution.

[REDACTED] due to the potential of the driver and/or Controller to understand the cause of the issue or follow the correct procedure by removing the human element of risk altogether with a design solution.

#### 14.0 Similar Incidents and the 2016 Risk Assessment

There do not seem to be any directly compatible incidents on record. The investigation was asked to consider what is known as the “2016 Risk Assessment” which tracked 8 recommendations made by the RAIB in their 2014 report into an incident at Lebanon Road, where a driver operated a door override safety switch in error, which enabled a CR4000 tram to travel in passenger service with the doors open. Whilst no such switches were operated by the driver during the incident under investigation, which, in any case, involved an SVT tram, there are several points made that are noteworthy:

- **Recommendation 1** seeks to reduce driver distraction during incidents by minimising where possible communications between the driver and Service Control whilst the tram is moving. This action is noted as completed (although a completion date is not given). It was observed that, during the incident under investigation, the driver initially continued to operate the tram whilst discussions with the controller took place. It is believed this is to a significant degree because the design of the SVT and the associated status indications when an EDR is pulled, coupled with the relevant procedures, do not lead the driver to initially believe anything is particularly out of the ordinary.
- **Recommendation 2** seeks, in part, to improve fault handling by drivers and controllers. This action is noted as completed (although a completion date is not given). It has been noted during the investigation into the incident detailed in this report that, although it is clear that the Controller manages instances of this nature (demonstrated in the radio recordings obtained) there is no specific procedure for the particular incident the driver or Controller faced with reference to the EDR being operated. This observation is addressed in Recommendation 3.
- **Recommendation 3** deals with methods to ensure the driver of either type of tram cannot be unaware that any doors are open on a tram. Reference is made to increasing the prominence of door open indications, audible alarms, and increased functionality on associated message displays. The status of this recommendation seems to be overdue – some 5 years later. Moreover, the focus, based on the limited notes available, seem to suggest a focus on improving alert indications when over-rides have been operated by the driver. This focus only partly addresses the recommendation.



As has been noted elsewhere in this report, the HMI screen of the SVT tram should illuminate door status on the home screen when there is an abnormal door indication. It does not do this. Whilst additional information would be contained on interrogation of the relevant sub screen, it is unclear why this anomaly was not picked up during the review process into this recommendation, nor is it clear why the prime focus seems to be on improvements made only with regard to improved awareness after safety switches have been operated.

The CR4000 was retrofitted with an audible alarm whenever the tram moves with a saloon door open. Whilst this modification was made prior to 2012 and the introduction of the SVT, it is unclear why its clear benefits were not incorporated into the SVT tram either prior or post its introduction.

- **Recommendation 4** seeks to address the risk of drivers inadvertently operating safety related switches. The report suggests some modifications were undertaken to both fleets. However, the available report suggests that final actions pertaining to this investigation remain outstanding as of at least August 2015.
- **Recommendation 5** seeks to address the issue of producing suitable guidance pertaining to the ergonomic principles of cab design with reference to the appropriate tramway, railway and European standards. The ORR is the action holder for this recommendation and therefore falls outside the scope of the investigation.
- **Recommendation 6** seeks to address improvements in the design of passenger controls (emergency alarms, intercoms etc.) through shape, colour, symbols and/or signage. Some actions are completed. Changes to signage remain outstanding according to the Risk Assessment as of at least August 2015. Confirmation was received during the investigation stating that this action is complete. However, it should be noted that the two fleets continue to utilise different accesses, colours and signage. It is not clear why attempts to harmonise to a common standard using the CR4000 modifications as the template were not done.
- **Recommendation 7** seeks to minimise the potential for miscommunications on London Tramlink by enhancing the quality of the radio system. This recommendation seems to be complete. It was noted that the initial communication received by the Controller from the driver of the tram is of very poor quality and did lead to an initial misunderstanding as to the location of the tram.

The investigation found that further work has now progressed to upgrade the communications system using digital technology.

- **Recommendation 8** seeks to improve the flow of safety and fault related information between the operator (TOL), the infra-structure manager (LT), and the maintainer (Bombardier). In late 2014 maintenance of the fleet was transferred from Bombardier to LT who now fulfil this function. During the current investigation frequent use was made of TOL's FRIL Fault Reporting Incident Log (FRIL) and requests for data-dives were timely and thorough. The initial review of incidents seems to be based on these incident logs as well as the "48 Hour report". It is not possible for this investigation to determine whether the current systems suit all parties' needs. However, it is noted that a change to TFL's SAP reporting systems to make better use of available data appears to still be outstanding. These issues are addressed in Recommendation 7.

### **Observation 3 – The 2016 Risk Assessment**

There were several points of note during a review of the 2016 Risk Assessment:

- By and large actions on the part of TOL were completed, or awaiting further action by LT
- By and large actions on the part of LT were outstanding or overdue
- As a tracking tool there were shortcomings in terms of the robustness of milestones and individual accountability. The updates seem to largely cut and pasted from a March 2015 letter from HM Inspector of railways to the Chief Inspector of Rail Accidents

Two accountable persons (one for LT and one for TOL) seem to be responsible for all of the outstanding actions contained in the risk assessment. In the case of the LT individual, they left as LT's Head of Engineering in July 2015. The individual for TOL resigned from their role of Managing Director of TOL in August 2017. Following their departure, the investigation found no evidence that outstanding actions had been re-assigned to their replacements. In light of the lack of updates on these outstanding actions since 2015 it seems logical to conclude that there were shortcomings in the handover processes following the departure of these two figures. Whether there remain shortcomings that adversely affect the progression this and other relevant work streams forms the basis of Recommendation 7.

## 15.0 Conclusions

The FIR reviewed available direct evidence. This included tram CCTV, data logs, radio recordings, operational manuals, procedural manuals, historic incident logs and reports of previous incidents. In addition, the report benefitted from the considerable assistance of Subject Matter Experts from both LT and TOL. In addition, discussions took place with various Tram Drivers, Instructors and Controllers.

It was identified that there were five causal factors (Section 11) which contributed to the incident:

- Causal Factor 1: The handles are easily accessible
- Causal Factor 2: The operation of the EDR enables doors to be manually opened when the tram is stationary
- Causal Factor 3: There is no audible alarm or console illumination when the EDR is pulled other than a single line of text on the HMI screen
- Causal Factor 4: The Doors Open Warning does not initiate until the tram is [REDACTED].

If any of four of those causal factors had been absent, then the incident *may* not have occurred.

[REDACTED]

[REDACTED]

[REDACTED]

If causal factor 5 had not been present the incident would not have occurred.

Following on from these causal factors the FIR identified 3 root causes (Section 12 A-C). The first root cause was that a modification to the EDR panel similar to that of the CR4000 has not been adopted on the SVT and colouring and warning notices are at variance with that of the CR4000. Data Analysis comparing the number of instances of EDR pulls of the SVT and CR4000 suggests the SVT is responsible for a far higher level of activations than the size of this part of the fleet and the number of KM's operated per year would lead one to expect.

**Recommendation 1** seeks to address this issue by proposing a review into the cost effectiveness of modifying the EDR panel on the SVT including relevant warning notices so it aligns with that of the CR4000.

The second root cause was noted to be the design and specification of the tram. Analysis of the TPG shows that tram door design should be such that passengers should be able to exit a tram in an emergency when the tram is stationary. In this regard both the CR4000 and SVT are in full compliance with the standard. However, it was noted that signage giving information regarding the dangers of existing a tram at an unofficial location or advising how to exit a tram most safely in an emergency was not present. **Recommendation 2** seeks to address this by proposing a review of existing EDR signage to identify any cost-effective improvements to the information given to passengers.

It was also noted during the investigation that the current procedures for dealing with “Green Loop Interrupted” scenarios on the SVT do not specifically deal with the scenario encountered by the driver and controller. **Recommendation 3** seeks to address this by proposing a review of existing procedures and addressing any issues and communicating these to the relevant parties.

The report demonstrates several differences between the design and configuration of the SVT tram in comparison to the CR4000 tram. [REDACTED]

[REDACTED] The report presents a scenario where, in slightly different circumstances an entrapment and subsequent dragging might have occurred with potentially fatal consequences. **Recommendation 4** seeks to address this by proposing a review into the feasibility of hardware and software-based solutions into this issue.

The third root cause was that it was likely that a lack of oversight into the procurement process, coupled with a failure to apply consistent standards across both fleets, was a significant factor in how the SVT exists as it does. **Recommendation 5** seeks to address this issue through a review of the procurement, testing and completion phases of the SVT tram compared to that of the CR4000 tram, with the intention of ensuring that future procurement processes benefit from a more robust and standard compliance process.

In addition, it was observed during the investigation that relatively recent historical records regarding the tendering, procurement, testing and acceptance phases of the SVT tram were not easily

obtainable. This was a concern and **Recommendation 6** seeks to address this issue by proposing a review into how current methods of document referencing and archiving meet current and future needs.

The report was also asked to consider what is commonly known as the “2016 Risk Assessment” which relates to an RAIB report published in 2014 concerning an earlier incident of a tram travelling in passenger service with its doors open in 2013. It finds significant apparent failings in the allocation of responsible persons to actions, the transfer of those actions to other accountable persons and of the tracking process in general. These concerns are addressed in **Recommendation 7** which proposes a review of the current methods of tracking and progressing action based workstreams.

#### **Observation 4:**

The remaining element of the Terms of Reference concerned a review of Customer Risk Assessments. TOL have their own Risk Assessments dealing with customer risk. Information received recently suggests that there is also a joint Risk Management tool with ownership in the hands of LT. It is suggested that the joint risk measurement tool is within the London Trams joint risk model V3.1. The relevant section is LRTHE 0.31. The investigation concluded that the complexity of the review and the skillset required warranted a separate review with all interested parties being represented. This is addressed in **Recommendation 8**.

## **16.0 Observations**

There were four observations made during the investigation.

- |                |   |
|----------------|---|
| Observation 1: | Concerned the procedures relating to Driver/Controller actions when dealing with various “Green Loop Interrupted” scenarios (Page 20). This observation forms the basis of <b>Recommendation 3</b> .                                  |
| Observation 2  | Concerned the difficulty in sourcing historical information pertaining to the tendering, commissioning, and testing phases of the SVT tram. (Page 24). This observation forms the basis of <b>Recommendation 6</b> .                  |
| Observation 3  | Dealt with a review of the document known as the “2016” Risk Assessment and highlights deficiencies in the areas of accountability and tracking (Page 27). The conclusions of this review form the basis of <b>Recommendation 7</b> . |
| Observation 4  | Discusses the inability to progress a review of existing Customer Risk Assessments required as part of the Terms of Reference for the investigation. <b>Recommendation 8</b> addresses this issue.                                    |



Recommendation 1	
To address Root Cause A	
Purpose	To reduce the incidences of malicious activation of the EDR handle on SVT tram stock
Action	Review the cost effectiveness of modifying the EDR panel on the SVT including relevant warning notices so it aligns with that of the CR4000
Action Owner	a) To identify a potential solution – Alex Barry (Trams Fleet Manager) b) To progress a CRS solution – Esther Olorunfemi (Principal Engineer - Engineering Management)
Action Target Date	a) 31/3/22 b) 31/5/22
Validation	a) Summary report on potential solution b) Plan and Delivery of CRS Solution
Validator	Jim Medway - Senior SHE Business Partner
Validation Target Date	Within four weeks of the action being completed

Recommendation 2	
To address Root Cause B	
Purpose	To ensure passengers are aware of the dangers of exiting a tram in a non-platform location whilst providing advice on how to do so as safely as possible.
Action	Review a variety of signage models currently in use on LT, LU and NR, relating to EDR related safety signage with a view of improving current signage.
Action Owner	Esther Olorunfemi – Principal Engineer - Engineering Management
Action Target Date	31/5/22
Validation	Summary report of review and information on how any subsequent recommendation will be managed to closure
Validator	Jim Medway - Senior SHE Business Partner
Validation Target Date	Within four weeks of the action being completed



Recommendation 3	
To address Observation 1	
Purpose	To ensure tram drivers and controllers have a fuller understanding of the meaning of a “green loop interrupted” indication when the SVT is more than 36 metres from a designated platform where the doors have cycled normally when an EDR [REDACTED] [REDACTED]
Action	Review the existing procedures for dealing with Green Loop Interrupted indications on the SVT tram and disseminate appropriate guidance in appropriate forms to all relevant parties
Action Owner	[REDACTED] - TOL
Action Target Date	TOL have already completed a briefing on the issue with further analysis planned to ensure the briefing was fit for purpose. A specific procedure will be incorporated into TOL Operational Procedures Manual  15/04/22
Validation	Summary of review of briefing, any outcome recommendations.  Updated Procedures Manual
Validator	[REDACTED] – TOL/ Jim Medway – Senior SHE BP
Validation Target Date	Within four weeks of the action being completed

Recommendation 4	
To address Root Cause B	
Purpose	<p>██</p> <p>██</p>
Action	<p>A) Discuss with appropriate engineering teams the practicality of either a hardware or software modification to bring the behaviour of the SVT tram into line with that of the CR4000 ██████████. EO committed to discuss GH's hardware modification proposal with Stadler as a high priority.</p> <p>B) Implement an appropriate engineering solution</p>
Action Owner	Esther Olorunfemi – Principal Engineer - Engineering Management
Action Target Date	<p>A) 31/3/22</p> <p>B) 31/05/22</p>
Validation	Evidence of Presentation to Trams Change Panel of solution and delivery and changes delivered.
Validator	Trams Change Panel / Jim Medway – Senior SHE Business Partner
Validation Target Date	Within four weeks of the action being completed

<p style="text-align: center;"><b>Recommendation 5</b></p> <p style="text-align: center;"><b>To address Root Cause C</b></p>	
<b>Purpose</b>	To ensure that in the case of future asset procurement, the relevant team consists of appropriate people across all disciplines and that sufficient time is given to ensure the procurement and testing process is robust.
<b>Action</b>	<ol style="list-style-type: none"> <li>1. Compare the procurement and testing processes that were in place for the introduction of the CR4000 with that of the SVT.</li> <li>2. Identify the makeup of the team(s) currently involved in the latest tram procurement process, with particular regard to the input of the end user and the level of operational expertise.</li> <li>3. Consider whether enough time has been given over to the testing phase</li> </ol>
<b>Action Owner</b>	Esther Olorunfemi – Principal Engineer - Engineering Management
<b>Action Target Date</b>	31/03/22
<b>Validation</b>	Summary report to be provided
<b>Validator</b>	Trams Steering Group - Mark Davis, General Manager, London Trams
<b>Validation Target Date</b>	Within four weeks of the action being completed



Recommendation 6	
To Address Observation 3	
Purpose	To ensure records detailing rationale and decision making are maintained in such a manner as to enable easy access when required
Action	To review past and current methods of document referencing and archiving in order to determine whether current processes are adequate to ensure a robust historical memory of events is preserved.
Action Owner	Tom Singleton - Head of Service Delivery, London Trams
Action Target Date	31/03/22
Validation	Summary of review, including outcomes and improvement recommendations
Validator	Jim Medway - Senior SHE Business Partner
Validation Target Date	Within four weeks of the action being completed



## Recommendation 7

## To address Observations – 2016 Risk Assessment

Purpose	To ensure that tracking tools and reporting processes are sufficient to ensure that actions relating to safety critical workstreams are monitored to conclusion.
Action	TMC to review current methods for identifying and tracking workstreams, with particular emphasis on outstanding risk related items.
Action Owner	Jim Medway/Mark Davis
Action Target Date	31/03/22
Validation	Report on outcome of review
Validator	Tom Singleton - Head of Service Delivery, London Trams
Validation Target Date	Within four weeks of the action being completed



### Recommendation 8

To Address the Terms of Reference Requiring A Review of Existing Customer Risk Assessments

Purpose	To ensure that the current CRA's are fit for purpose, robustly reviewed and appropriately disseminated and that TOL CRA's align with LT's Risk Model.
Action	Instigate a thorough review by competent persons with input from relevant parties into the existing CRA processes and assessments
Action Owner	Esther Olorunfemi – Principal Engineer - Engineering Management
Action Target Date	31/03/22
Validation	Report on outcome of review
Validator	Level 2 Meeting/ Mark Davis - General Manager, London Trams
Validation Target Date	Within four weeks of the action being completed



**18.0 Appendices****18.1 Formal Investigation Panel Members**

Name	Title	Organisation
Mark Davis	Chair of Investigation	LT
Phil Backhouse	Lead Investigator	London Underground
Jim Medway	Senior HSE Manager	LT
Jennifer Oxley	HSE Manager	LT
Alex Barry	Head of LT Fleet	LT
Tom Singleton	Head of LT Operations	LT
Esther Olorunfemi	Head of Engineering	LT
██████████	Operations Director	TOL
██████████	Technical Support Analyst	TOL

## 18.2 Consultation

Title	Organisation
Tram Operators various	TOL
Instructor Operator	TOL
Controller	TOL
██████████ – Technical Support Analyst	TOL
Dan Morely – Service Delivery Manager	London Trams
Lewis Cole – Fleet Technician	London Trams
Esther Olorunfemi – Head of Engineering	London Trams
Ruth Turner – Human Factors Engineer	TFL

Title	Reference	Revision
The 48 Hour report	TL Trams	14/09/21
Incident Log	Tram Operations Ltd	14/09/21
Radio Recordings between Tram Driver and Controller		13/09/21
Comparison of SVT and CR4000 Emergency Door Release Systems	Ian Buck, TL Trams	Version 1 06/10/21
Various Tram Download Analysis	Stadler Tram 2562 (13/9/21) Stadler Tram 2562 (17/11/21)	Incident Date/Simulation Date
SVT Door system interaction with traction inhibit - Testing procedure.	Lewis Cole, TL Trams	13/09/21
Operational Procedures 030- Appendices (various	██████████ - TOL	V2 – October 2016
Tramway Principles & Guidance (TPG) document	LRSSB - LRG - 1.0	Issue 2 Revision 1.0 01/03/2021
Operational Manual for CR4000	Bombardier	00/99
Operational Manual for Stadler	Stadler	Version 3 - 2014
RAIB Lebanon Rd Report	RAIB	05/2014
Associated TL/TOL documentation	Various	2014-2016
Various Alertness studies	London Underground/RSSB	2019(LU) 2020 (RSSB)

## 18.4 Root Cause Analysis

