

**Jubilee line – Doors open on a train in service
between Finchley Rd and West Hampstead
stations**

1st September 2018

HSE Info Exchange Reference Number: 949522

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Commissioned by	Nick Dent	Director of Line Operations	LU
Accepted by	DRACCT (TBC)		TFL

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1.0 Executive Summary

On 1st September 2018 at 08:57 train Jubilee Line train 305 proceeded north from Finchley Road station to West Hampstead station with 11 doors open, reaching a top speed of 63 KPH. There were approximately 30 customers on the train. There were no employee or customer injuries or asset damage.

On arrival at Finchley Road station the Train Operator (T/Op) became aware that the train had issues with its doors as he had witnessed a customer pressing the saloon “door open” buttons after he had pressed the “door open” buttons in his cab. The T/Op did not know that some train doors had remained opened after he had operated the “door close” buttons prior to departure. In normal circumstances the train would not have accepted an “ATO start” command with the doors open. To address the door issues the T/Op went to operate the Emergency Saloon Door Control (ESDC) rotary switch, however he did not operate the ESDC switch, instead he operated the Train Door Interlock switch (TDIC) in error. The design of the Jubilee Line trains allows for them to be driven in ATO with the TDIC cut out; however Rule Book 7 states that the train must not be moved at a station with the TDIC cut out until a full detraining has taken place. With the T/Op unaware he had cut out the TDIC no consideration was given to detraining.

Prior to departure there are various internal and external indications on the train that would indicate to the T/Op that train doors were not closed. It is not clear whether the T/Op failed to check them or whether the check did not register with him. In either case the T/Op, having at this point become focussed on the approaching “Target Point” alarm and the importance of not causing a delay to the service pushed the “ATO Start” button and proceeded in ATO towards West Hampstead. On arrival at West Hampstead station the T/Op looked behind him and noticed that he had cut out the TDIC in error and cut it back in. At this point he did not know whether any doors had been open between stations. Immediately a passenger advised the T/Op that the train had travelled between Finchley Road and West Hampstead with doors open via the operation of a Passenger Emergency Alarm.

The FIR panel identified the root causes as:

- A: The T/Op was unaware the train systems were automatically rebooting and were not in full communication with each other.

- B: Faced with the confusion of an unfamiliar door state the T/Op did not withdraw the train from service as per Defective in Service Instruction 99.
- C: There was no audible warning to inform the T/Op he had operated the TDIC.
- D: The nature of Automatic Train Operation work is repetitive.
- E: Visibility of the Door Closed Visual Indicators and in-cab monitors were affected by sunlight.
- F: Post the train systems automatic reboot the 'train' considered all the doors were closed and did not send the T/Ops 'close' command to the doors.

The FIR makes seven 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 is commissioned into an incident where a Jubilee Line train was operated from Finchley Road to West Hampstead stations with I I doors open. There were no injuries sustained by customers and no damage to assets as a result of this event. However, the incident resulted in the affected train being withdrawn from service and a Lost Customer Hours (LCH) cumulative total of 1,438.61 was recorded against 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.

4.0 Summary of Incident

Time	08:58
Date	1 st September 2018
Organisations involved and their business units /departments	Jubilee Line Operations, London Underground.
Location	Jubilee Line - Finchley Road Station Northbound platform to West Hampstead station Northbound platform.
What Happened	Eleven doors of train remained open whilst the train travelled between stations.
Consequences	No injuries to staff or passengers No asset damage
Incident Report Number	EIRF 949522
Enforcement Authority Involvement	RAIB and ORR investigating



5.0 Location of the Incident

Jubilee Line - Finchley Road station Northbound platform to West Hampstead station Northbound platform.

6.0 Weather and Environmental Conditions

Dry and sunny - the report highlights that sunlight was a contributory factor in the incident.

7.0 Pre-Incident Details

The Train Operator was working duty 614.

06:43 The T/Op booked on as per his roster at Neasden booking on point before making his way to Neasden depot to pick up T335.

The required pre-start checks were completed satisfactorily.

07:08 T355 departed Neasden Depot.

On reaching Stratford the T/Op paid a visit to the toilet and made a hot drink prior to stepping back onto T305.

08:20 The T/Op is back in the cab and T305 departs Stratford Station.

The T/Op reported no issues with the T305 or having any issues on his mind that may have affected his concentration. He considered the day to be 'normal'.

Train downloads confirm no issues with the T305 prior to the doors issues at Finchley Road.

8.0 Incident Timeline

Time	Event
08:55:43	T305 arrived at Finchley Road and achieved correct stopping mark.
08:55:49	T/Op operated correct side door open button several times.
08:55:49 – 08:56:14	T/Op became aware that not all doors had opened after witnessing customers on platform pressing door open buttons.
08:56:14 – 08:56:55	T/Op pressed door close buttons and door open buttons multiple times in an effort to recycle the doors to no apparent effect.
08:56:55– 08:57:09	T/Op opened his cab door and placed one foot on the platform and reached over towards Rotary Switch Panel
08:57:10	Train Door Interlocks (TDIC) cut out by T/Op.
08:57:14 – 08:57:25	T/Op pressed Door Open South buttons 7 times followed by Door Close South buttons 8 times
08:57:25 – 08:57:38	Cab door is closed at 08:57:36. T/Op stated on returning to the driving seat he made a PA explaining he had had problems with the doors and would sort it out at the next station. The T/OP believed all doors were closed.
08:57:39	T/Op pressed ATO Start button
08:57:44	Train departed in ATO with 11 doors along the train remaining open reaching a top speed of 63KPH.
08:58:43	T/Op operated North Side Open buttons upon reaching West Hampstead and achieving stopping mark

08:58:45	T/Op cut TDIC back in after turning round and realising his error
08:58:44	PEA is operated by a passenger and the alarm sounds in the cab.
08:58:55	T/Op responds to PEA via Talkback facility
08:58:55 – 09:00:23	<p>The T/Op informed Jubilee Line Service Controller of the issue and that he was going to investigate. The T/Op stated although first car was fine he noticed several doors open along the train. He explained the situation to the CSS on the platform who started detrainment. The T/Op contacted Service Control again and confirmed the situation and additionally made a PA to customers advising them of the situation.</p> <p>On successful detrainment the train was worked into the sidings.</p>

9.0 Incident Management and Recovery

There were no issues with regards to incident management or recovery of the service post incident. Rule Book 7 does not have a procedure for this particular incident 'doors remaining open whilst the train is moving'. Section 14.2 details the steps that should be taken when doors are known to have opened on the wrong side at a platform and these include a request for traction current to be switched off.

At West Hampstead the T/Op stated he requested a check of the area from Finchley Road station northbound. The Service Controller arranged for the area to be checked by another train as it proceeded from Finchley Road to West Hampstead, with the T/Op reporting nothing identified.

Observation A: During the investigation it was suggested that Rule Book 7 currently addresses safety with regard to a conventional fixed block signalling system which may not be wholly appropriate for more modern versions of signalling systems where the following trains may be running more closely behind the incident train.

10.0 Immediate Actions Taken

- Train Operator was stood down from duty.
- Drug and Alcohol testing was undertaken of the T/Op [REDACTED].
- T305 was isolated and returned to Stratford Market Depot for investigation.
- The T/Op was interviewed by the Jubilee Line Duty Reliability Manager.
- The ORR and RAIB were notified by the London Underground Control Centre.



11.0 Causal Factors

- Immediate Cause

T305 departed Finchley Road with 11 doors open.

- Causal Factors

The FIR identified there were three causal factors; had any of these not been present the incident would not have occurred.

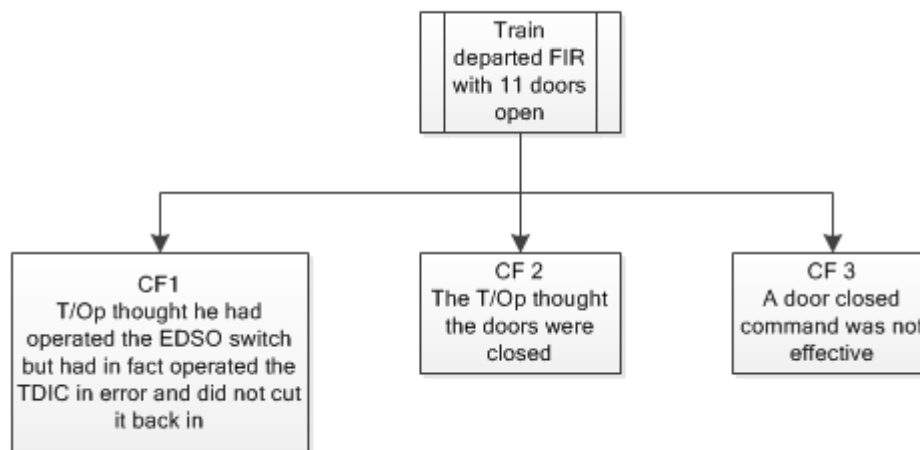


Figure 1 – The three causal factors

12.0 Root Causes

12.1 Causal Factor 1 – T/Op thought he had operated the Emergency Saloon Door Control rotary switch (ESDC) switch but had operated the TDIC in error and didn't cut it back in.

The T/Op had not encountered this particular defect before and believed that he may have been able to rectify the issue by carrying out the procedure for a missed stopping mark. This would have entailed operating the ESDC and moving it into the “emergency open” position, whilst stepping onto the platform as an additional check to ensure that the “wrong side” doors were not opened in error. Whilst this may not have been effective for the issues he faced, the T/Op did not operate the ESDC rotary switch. Instead he operated the TDIC switch in error.

The TDIC switch is sealed with a plastic tag and a cover to prevent inadvertent operation, whilst the ESDC switch is not sealed. The T/Op considers he operated the TDIC switch in error whilst he was leaning out of the train cab, with one foot on the platform and looking down the train.

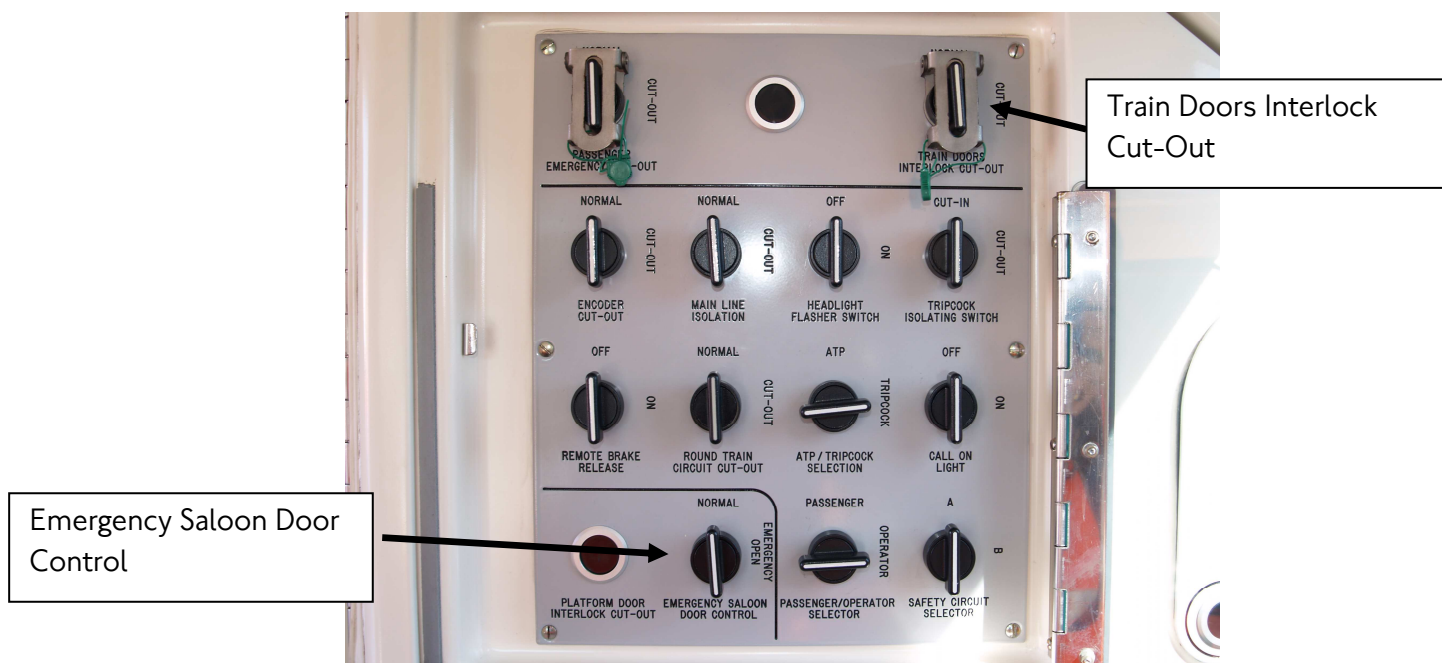
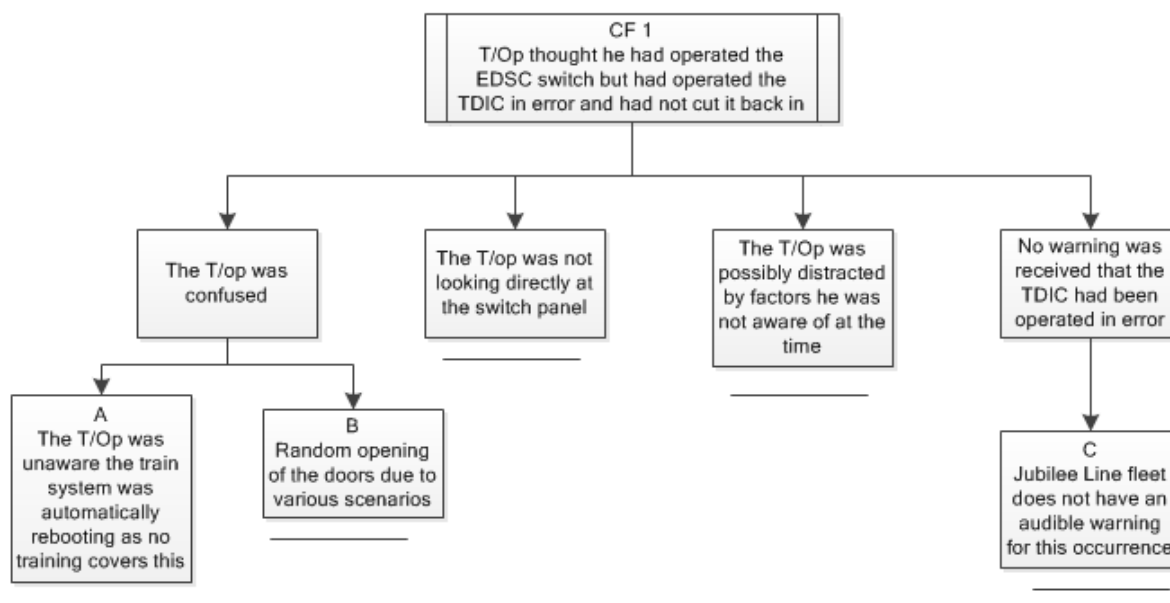


Figure 2 – A '96 stock switch panel

The T/Op was unaware that since the Jubilee Line fleet was brought into service it has always been the case that if the Train Management System (TMS) is unable to communicate with the individual door Train Management Remote Terminals (TMRT) the TMS will reboot and the door operation will default to “passenger open” mode. (This was the case in this incident; the TMS had lost communication with the remote terminals and was in the process of rebooting whilst the train was sat at Finchley Road Station).

The T/Op should have referred to the Defective in Service Instruction 99 and taken the train out of service.

Root Causes



- A. The T/Op was unaware the train systems were automatically rebooting and were not in full communication with each other.
- B. Some but not all doors opening may have contributed to the confusion faced by the T/Op. There are three conditions that applied during this incident in terms of door operation:
 - o Some of the I I doors that did open did so as a result of passengers pressing the “open” buttons whilst the train had defaulted to “passenger open” status.



- Some doors did not open when the door open buttons were pressed by passengers because the buttons were faulty. *
- Some doors opened on their own without passenger intervention because the buttons were faulty. *

(*) As passenger mode had been withdrawn some years ago the door buttons were not subject to planned maintenance causing the above two conditions.

The defect scenario encountered by the T/Op during this incident is not covered in the Jubilee Line Defect Handling Guide and as per Defective in Service Instruction 99 the train should have been taken out of service.

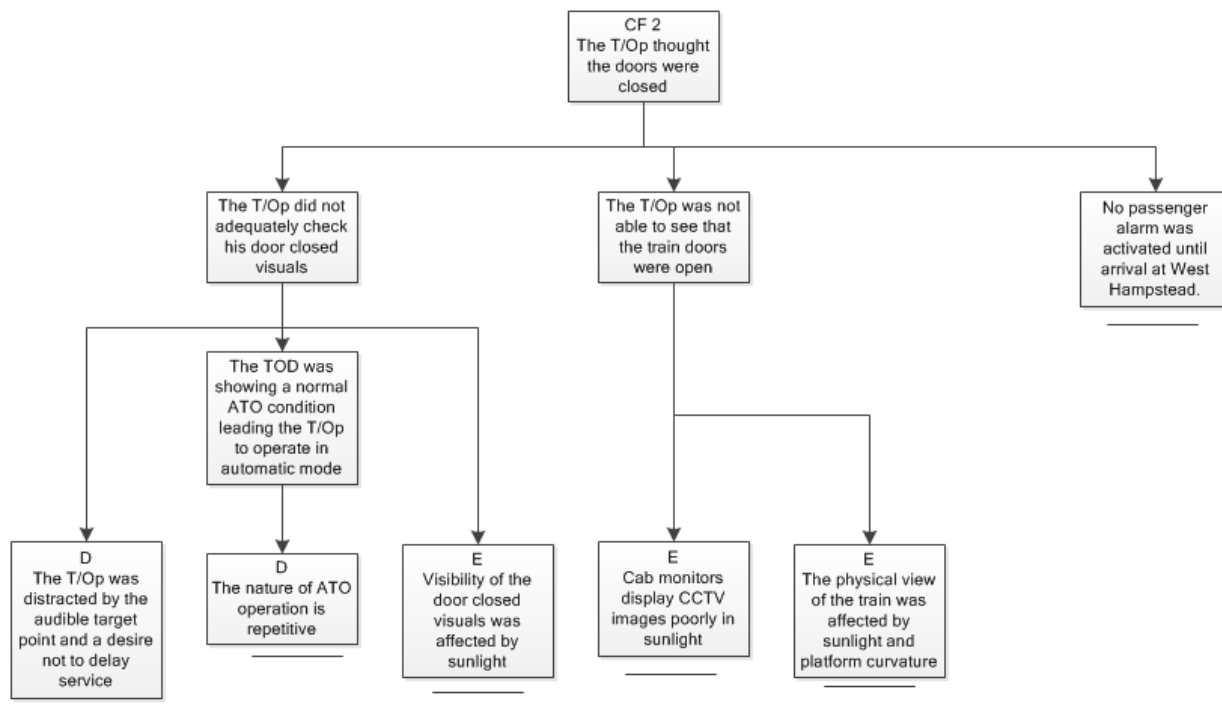
- C. LU Cat 1 Standard for Rolling Stock - S1180 requires an audible warning to sound if motoring is demanded when the TDIC is cut out. After delivery the Jubilee Line fleet was updated to include ATO, the rolling stock standards indicate that if the TDIC is operated that the ATO function should be disabled, however it does not specifically stipulate it and therefore an FIR action has been issued to ensure this is made clear in the latest rolling stock standards S1180 and S2180. The 96TS was procured against the 'Jubilee Line technical specification contract 201' dated 1993, this referenced the prevailing rolling stock door standard at the time - RSE/STD/036 which required that the audible alarm would have been activated if motoring was demanded, however this was not fitted or operational. The Investigation identified that audible and visual warnings should be given to the T/Op when the TDIC is cut out, and if operating in ATO mode, that the ATO be disabled. This will ensure consistency across the LU fleets and protect against a similar accidental operation. Appendix 18.5 contains information of relevance to this finding.

Observation B: The Jubilee Line Defect Handling Guide currently in the cabs is the 2012 version. The current version on the intranet is dated 2015 version. The 2015 version does not include the section on dealing with loss of door closed visuals. All other stocks contain this section in their defect guides.

12.2 Causal factor 2 – The T/Op thought the train doors were closed.

The T/Op departed Finchley Road Station unaware that I I doors were open.

Root Causes



- D. The T/OP stated that ATO workload is very much a routine “Stop/Start/Stop” mode of operation. At the time of the incident the train was in an abnormal condition (TDIC operated) but the Train Operator Display (TOD) was showing a normal condition for ATO operation. The T/Op stated that whilst at Finchley Road platform he was distracted by the approaching ATO Target Point. It cannot be certain whether the Train Management System (TMS) screen would have shown an indication that the TDIC had been cut out as it has not proved possible to recreate the conditions of the fault. It is likely that the routine condition displayed on the TOD and the mundanity of the task, coupled with the audible warning that the ATO Target Point had been and the concern the T/Op had for not delaying the service reached led the T/Op to overlook the fact that he did not have his Door Closed Visual indications.



Although the design of the stock allows the train to be driven in ATO mode with the TDIC cut out the advice given on the TMS screen states that the train should be driven in manual mode. It is not clear if this message only appears if the train is in non-ATO mode.

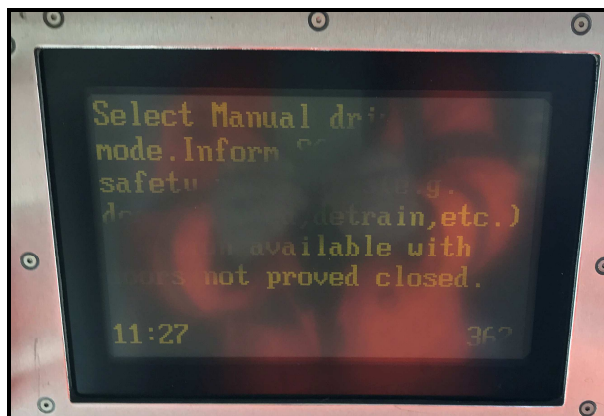


Figure 3 – TDIC Cut Out information displayed on TMS screen

During the FIR investigation several conversations took place with Instructor Operators, Line Trainers and current Metropolitan Line Train Operators who previously operated Jubilee Line stock. There was a common belief that the mundanity of ATO operation and that ATO being a very safe form of train operation has caused a level of complacency to creep in.

Information provided by Jubilee Fleet suggests demands for motoring in ATO whilst train doors are open occurs between 0.8% and 1.3% of all station stops each day (derived from a sample of log data for 5 trains over a 20 day period). Whilst not inherently dangerous as under normal circumstances the train would do nothing in ATO mode when this occurred, it does lend weight to the view that complacency is a concern.

It was also noted that stock and defect handling used to form a greater part of the T/Op Continuous Development Program (CDP) and that some of the softer elements of current CDP were not perceived by the Train Operators consulted as part of the investigation to provide that much benefit to them. It has also been highlighted that trains are not always available to utilise in the coaching of defects and that table-top is used instead. A review of the CDP content for the incident T/Op over the last two years confirms a variety of door related defects including loss of Door Closed Visual indications were covered with no recorded issues and the T/Op confirmed that a train had been available when he attended CDP.

- E. On the day of the incident the cab was in bright sunlight and the sunlight was impacting on the ability of the T/Op to adequately view the driving console and TOD. This is a common occurrence and T/Op's mitigate against the sunlight and glare by attempting to shield the CCTV and TOD displays, as the T/Op states he was doing that day. It is likely that the sunlight also impacted on the visibility afforded by the OPO cameras on the platform, although these images are not recorded. There was significant glare apparent on the platform images at Finchley Rd at the time of the incident as evidenced in the downloaded CCTV footage. Photographs were taken of the Door Closed Visual Indicators on the Driving Console and Rear Bulk Heads during an FIR site visit under similar conditions and the FIR considered it was very difficult to distinguish between active and inactive states of the indicators, particularly if the inactive state had not been witnessed prior to the active state.

It was noted that the Door Closed Visual Indicators were brighter on the Jubilee Line fleet until a change effected around 2003 in response to complaints from T/Ops that they were distracting in tunnel sections. It was also noted that there are variations in the intensity of the illumination of the DCVIs on the current fleet. Three trains were utilised during the FIR site visit and some indicators were illuminated considerably brighter than others and one had a sticker over the lens. However, it must be reiterated that in all cases the illumination was severely affected by sunlight.

The FIR also noted that the visibility of the Outside Door Indicating Lights (ODILs), which identify open saloon doors by means of an orange light, were also affected by both sunlight and the recessed design. When viewing the ODILs from the CCTV monitors in the driving cab it was impossible to distinguish between the ODILs being illuminated and not. Further, by physically leaning out of the train it was only possible to see the first ODIL in the front saloon due to the recessed nature of the lights. In this incident the doors of the first saloon remained closed at the departure point at Finchley Road until detrainment commenced at West Hampstead, therefore the T/Op would have not had an indication that any doors were open from the ODILs.





Figure 4 – Image of DCIVs with saloon doors open on a sunny day



Figure 5– Image of DCIVs with saloon doors closed on a sunny day



Figure 6 - Physical view of ODILs from driving side cab door

Observation C: At the time of the incident there were approximately 30 passengers dispersed in six of the seven carriages. Train CCTV shows three passengers filming the train moving with doors open and one customer appearing to attempt to physically pull one of the doors closed whilst the train is moving. However, a PEA is operated by a passenger only when the train arrives at West Hampstead station.

The FIR considered why a passenger had not operated the PEA earlier on. The potential reasons for this may include:

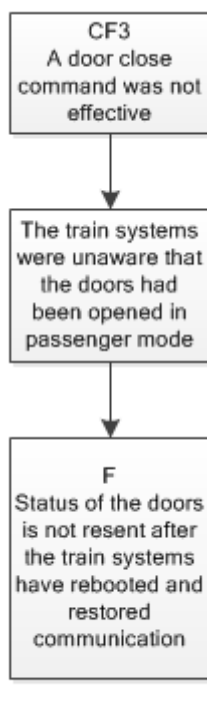
- Human nature of not wanting to delay their own journey.
- LU campaigns aimed at reducing the delays to the service when passengers are taken ill on trains: our request that PEAs are not operated between stations may have influenced the passengers.

- Passengers may have been reassured as the T/Op had made a PA stating he was aware of a door related issue which he would resolve at the next station.

12.3 Causal Factor 3 - A door close command by the Train Operator was not effective

Train downloads have demonstrated that the train operator pressed the correct door close buttons on the rear bulk head.

Root Cause



- F. Jubilee Fleet have confirmed that the train systems had rebooted by this point and also that the TMRTs are not programmed to resend the status of the doors to the train systems after communication is restored. Essentially, the TMRTs stopped communicating with the TMS preventing the T/Op from opening the doors. The system reverted to passenger mode as per the design. However, as this happened whilst the TMS was rebooting the TMRTs did not send information to the TMS that I I doors had been opened. When the T/Op pressed the door close buttons, the command was not actioned because the TMS believed the doors were still closed. Had the T/Op initiated his door open command I I seconds later when

communication was restored and then pressed the door close buttons the system would have acted on his command as he would have effectively re-cycled the doors. No indication is present on the TMS to indicate it is rebooting.



13.0 Human Factors

[Redacted text block]

[Redacted text block]

[Redacted text block]

[Redacted text block]

A study looking at T/Ops losing concentration whilst operating a train is currently being undertaken by LU. This study is reviewing the risk, best practice and generating options and recommendations to reduce the possibility of T/Ops losing concentration. This work is a result of recommendations from LU’s and RAIB’s investigation into a dragging incident at Notting Hill Gate station on 31 January 2018.

LU are also working collaboratively with RSSB to understand the impacts of ATO (automation) on the health and wellbeing of T/Ops, this work will also be monitored to identify any pertinent outcomes or recommendations



14.0 Similar Incidents

The FIR is not aware of any incidents where trains have operated between stations with the doors open. However, there are a number of previous incidents where the mundanity of ATO may have been a causal factor. Recent ones include the incident in January 2018 where a customer was dragged by a train at Notting Hill Gate, an Unauthorised Wrong Directional Move on the Jubilee Line at Finchley Road Station in June 2018 and an incident at Warren Street on the Victoria Line in July 2011 where a train departed the station with all saloon doors open before being safety tripped whilst within platform limits.



15.0 Conclusions

The FIR reviewed available evidence including train, radio and CCTV downloads and interviews with the T/Op. Further interviews took place with Instructor Operators and serving and ex-Jubilee Line Train Operators in addition to the expertise gained from the people on the FIR panel and input from Skills Development.

It was identified that there were three causal factors (Section 11) which contributed to the incident. If any of the three causal factors had been absent then the incident would not have occurred.

Following on from these causal factors the FIR identified six root causes (Section 12 A-F). The initial root cause was that the T/Op was faced with a train that was behaving in a way he did not expect. The behaviour of the train and its effect on the doors, whilst always a part of the design, was never communicated to T/Ops or Skills Development and does not form part of their training, refreshing of knowledge through Continuous Development Programmes, Competence Management Systems (CMS) or support materials. Recommendation 1 seeks to address this issue through the provision of a line bulletin. Recommendation 3 also seeks to address this issue by reviewing current training methods and content and support materials available to Line Trainers and Train Operators. Recommendation 2 seeks to address this issue by speeding up modifications to the fleet which will render all passenger operated door buttons non-operational.

The second root cause was that the Train Operator had not experienced this particular situation before and no relevant examples are contained in the Jubilee Line defect Handling Guide or any other support materials. Recommendation 3 seeks to address this by reviewing existing training and support materials and ensuring they are aligned with current stock operations.

The third root cause was that no audible warning is built into the stock's design when the TDIC is operated. Recommendation 4 addresses this issue through a review of current physical protections in place against accidental operation alongside software driven indications such as audio/visual warnings.

The second causal factor was that the Train Operator was unaware that 11 doors were open on his train. Two root causes were identified by the panel.

The first root cause identified the repetitive nature of ATO operation. Recommendation 5 consists of a review of the current design standards and consideration of practical changes to the way the train informs the T/Op of the abnormal condition of TDIC operation and the modes of operation made available to the train operator during this abnormal event. Recommendation 6 aims to incorporate the findings of this FIR into existing work streams being undertaken in relation to ATO operation and health and wellbeing.

The second root cause identified the effect sunlight can have on the ability of the Train Operator to adequately see the CCTV monitors, ODILs and Door Closed Visual Indicators. Recommendation 7 aims to address this issue with a review of cost effective solutions to improve the visibility of key cab equipment in sunlight.

The third causal factor was that, following the rectification of the fault condition, the pressing of the door close buttons did not have the effect of closing the doors. This issue is addressed by the adoption of recommendations 1-5 in the report.

16.0 Observations

Observation A: During the investigation it was suggested that Rule Book 7 currently addresses safety with regard to a conventional fixed block signalling system which may not be wholly appropriate for more modern versions of signalling systems where the following trains may be running more closely behind the incident train.

Observation B: The Jubilee Line Defect Handling Guide currently in the driving cabs is the 2012 version. The current version on the intranet is the 2015 version. The 2015 version does not include the section on dealing with loss of door closed visuals. All other stocks contain this section in their defect guides.

Observation C: At the time of the incident there were approximately 30 passengers dispersed in six of the seven carriages. Train CCTV shows three passengers filming the train moving with doors open and one customer appearing to attempt to physically pull one of the doors closed whilst the train is moving. However, a PEA is only operated by a passenger when the train arrives at West Hampstead station.

The FIR considered why no passenger had operated the PEA. The FIR considered potential reasons may include:

- Not wanting to delay their own journey.
- LU campaigns aimed at reducing the delays to the service when passengers are taken ill on trains, by requesting PEAs is not operated between stations, may have influenced the passengers.
- Passengers may have been reassured as the T/Op had made a PA stating he was aware of a door related issue which he would resolve at the next station.

17.0 Recommendations

Recommendation I	
To address Root Cause A	
Purpose	To provide an understanding to Jubilee Line T/Ops of how a train may perform in circumstances where an unmodified 96 stock train experiences a loss of communication between the TMRTs and the TMS.
Action	Communicate to all Jubilee Line T/Ops an understanding of how a Jubilee Line train may perform when there is a loss of communication between train management systems
Action Owner	K Rogan - Head of Jubilee Line Operations
Action Target Date	31 st October 2018
Validation	A sample of T/Ops questioned by DRMs to see they received it and understand it
Validator	Jubilee Line TOMs as instructed by the Jubilee Line Head of Operations
Validation Target Date	Within 4 weeks of the action being completed

Recommendation 2	
To address Root Cause B and F	
Purpose	Remove the possibility of this existing train condition being a factor in future TDIC incidents as quickly as possible
Action	To review / consider the a programme of works to remove the door modifications from the current upgrade works and progress at a higher task rate as a stand alone modification.
Action Owner	L Milledge – Jubilee Line Fleet Manager
Action Target Date	28/02/18
Validation	A review shall be completed of the programme to ensure it is deliverable.
Validator	D Borgese - LU Principal Door Systems Engineer, LU
Validation Target Date	Within 2 weeks of the programme being developed

Recommendation 3	
To address Root Cause A and B	
Purpose	To enhance the guidance provided to T/Ops to enable them to manage train faults.
Action	<ol style="list-style-type: none"> 1. A review shall be completed of similar incidents of this nature on the Jubilee Line to ascertain if this was an isolated incident or a more frequent occurrence. 2. On the conclusion of the review in 1. Suitable communications and / or updating of existing T/Op documentation such as the Jubilee Line Defect handling Guide shall be completed.
Action Owner	<ol style="list-style-type: none"> 1. Chris Welford – Interim Jubilee Line Fleet Engineering Manager 2. J Brown – Jubilee Line Train Operations Manager (in association with Skills Development, LU).
Action Target Date	<ol style="list-style-type: none"> 1. 31st December 2018 2. 28th February 2019
Validation	Outputs shall be reviewed to ensure they provide enhanced guidance to T/Ops in managing train faults.
Validator	K Rogan - Head of Jubilee Line Operations
Validation Target Date	Within three weeks of the final action being advised as completed.

Recommendation 4	
To address Root Cause C	
Purpose	To reduce the risk of the TDIC being operated in error by a T/Op. Applicable to all present and future train stocks across the network.
Action	Explore how physical or software changes to the current design of the rotary switch and/or procedure can reduce the risk of T/Ops being able to operate a train in contravention to the relevant sections of Rule Book 7. This should include but not be limited to, the current design of the rotary switch and any covers, types of seals used, colour coding and labelling as well as associated alarms.
Action Owner	D Borgese - LU Principal Door Systems Engineer, LU
Action Target Date	30th March 2019.
Validation	To review any output from the action to identify if the risk of operating a TDIC in error is reduced as low as is reasonably practicable.
Validator	P Cooper – Senior HSE Manager
Validation Target Date	Within two weeks of the action being advised as completed.

Recommendation 5	
To address Root Cause D	
Purpose	To ensure that Train Operators are fully aware that they are dealing with an abnormal condition having operated the TDIC's.
Action	<ol style="list-style-type: none"> 1. Review the current relevant standards (S1 I 80 / S2 I 80) and revise to ensure ATO operation is not possible following the operation of the TDIC switch 2. Review the way the Train Operator Display/TMS and associated audible alarms currently operate during the operation of the TDIC switch and issue ALARP based recommendations to minimise the risk of an operational error having undertaken a cost/benefit analysis as part of any recommendations.
Action Owner	D Borgese - Principal Door Systems Engineer.
Action Target Date	<ol style="list-style-type: none"> 1. 31st January 2019. 2. 30th March 2019
Validation	To review any output from the action to identify if the risks are reduced to a level which is as low as is reasonably practicable.
Validator	P Cooper – Senior HSE Manager
Validation Target Date	Within two weeks of the action being advised as completed.

Recommendation 6	
To address Root Cause D	
Purpose	To ensure that Train Operators maintain sufficient levels of concentration when operating ATO trains.
Action	<p>Feed the conclusions of this report into the existing work being undertaken in regards to:</p> <ul style="list-style-type: none"> • The study currently being undertaken by LU with regard to maintaining concentration. • The collaboration between LU and RSSB with regard to the impact of ATO on the health and wellbeing of train operators <p>With particular regard to the impact on High/Low frequency on alertness and decision making.</p> <p>Note - The concentration study will be completed in November 2018 and the RSSB work will not be complete until March 2019.</p>
Action Owner	R Turner - Human Factors Specialist, TfL
Action Target Date	Both studies have experienced delays, the first draft of the concentration study has just been released and the ATO impact on T/Op health and wellbeing still have to complete their interviews. As a result it is proposed to move this date to June 2019.
Validation	<p>Confirmation that:</p> <ul style="list-style-type: none"> • LU and RSSB/LU studies have been completed. • Findings and agreed actions from both studies have been shared

	appropriately with the business. Pertinent findings from the concentration work have been shared with RAIB and RSSB as appropriate.
Validator	LU HSE Manager
Validation Target Date	Within six weeks of the action being completed.



Recommendation 7	
To address Root Cause E	
Purpose	To ensure Train Operators are more easily able to see the Door Closed Visual Indicators, Train Operator Display and In Cab CCTV Screen in degraded operating conditions.
Action	<p>Review incidents of visibility/glare in train cabs to understand the safety risk. Should this review identify an issue:</p> <ol style="list-style-type: none"> 1. Carry out a feasibility study with a business case for the recommended option to improve the visibility of the in-cab saloon door closed visuals, and 2. Consider methods of limiting sunlight/glare from entering the cab that may lead to a reduction in the ability of the T/Op to see visual indications, this should include but not limited to improvements to the existing sun screening methods in place.
Action Owner	Howard Taylor
Action Target Date	27 September 2019
Validation	To review any output from the action to identify if the risks are reduced to a level which is as low as is reasonably practicable and progress accordingly.
Validator	Emma Burton
Validation Target Date	Within two weeks of the action being advised as completed.

18.0 Appendices



18.1 Formal Investigation Panel Members

Name	Title	Organisation
Lee Stewart	Chair of Panel	London Underground
Phil Backhouse	Lead Investigator	London Underground
Emma Burton	Senior HSE Manager	London Underground
Andy Sansom	HSE Manager	London Underground
Sam Jemmett	Interim Victoria Line Fleet Manager	London Underground
Chris Wellford	Interim Jubilee Line Fleet Engineering Manager	London Underground
Fernando Soler	Service Control Manager	London Underground
Martin Sherry	RMT representative	London Underground
Stephen Dilley	ASLEF representative	London Underground
Dom Borgese	Principal Engineering Lead – Rail Vehicles	Transport for London
Ruth Turner	Systems & Performance Integration Manager	Transport for London

18.2 Persons Interviewed

Title	Organisation
Train Operator	LU



18.3 Consultation

Title	Organisation
Train Operators Jubilee Line various	London Underground
Instructor Operator Jubilee Line	London Underground
Jubilee Line Fleet Engineers/Managers (various)	London Underground
Principal Engineering Leader – Rail Vehicles	Transport for London Engineering
Competence Management Implementation & Verification Manager	London Underground
Senior Skills Developer Business Partner	London Underground



18.4 Documentation

Title	Reference	Revision
Train Operator interviews and memos	-	-
Incident EIRF	-	-
Finchley Rd Platform CCTV	-	-
Connect Radio recordings	-	-
Various Train Download logs and explanatory reports	-	-
Jubilee Line Fleet Incident Report	-	-
Various photograph and video recordings post incident	-	-
Email communication chain between RAIB and various parties	-	-
Fatigue Risk Assessment	-	-
Relevant Fir/RAIB reports	-	-
Train Operator Holistic and CMS reports	-	-

Rule Book 7	-	-
Defective in Service Instructions	-	-
Jubilee Line Defect Handling Guides	-	2012 & 2015 versions
Jubilee Line 96 Stock Training Book	-	2015 version
Train Operator CDP Stock Book for Jubilee Line Trainers	-	2013 Version I

18.5 Results when motoring is demanded with the door interlock cut out and the doors open for all LU Rolling Stock

Transport for London
London Underground



TFL Engineering – Rail Vehicles – Rolling Stock

Palestra

TITLE: Results when motoring is demanded with the door interlock cut out and the doors open for all LU Rolling Stock

Ref: AOS-E-RS-Int-MU-RA_12-No-772-A2

Author: Edward Skinner

Date Issued and Version:

Version	Date	Comments
1	21/09/2018	First Issue
2	27/09/2018	Simplified to tick box format, included results for doors closed and ideal performance.

MAYOR OF LONDON



Formal investigation report

Train Status With Train Door Interlock Cut Out Switch in Cut Out Position and Doors Open

Stock	ATO Start Disabled	Traction In Full Speed / Coded / Protected Manual	Traction In Restricted Manual Only	Doors Closed Visual Extinguished	Audible Alarm on each motoring demand from standstill In Manual
72	N/A	✓	X	✓	X
73	N/A	✓	X	✓	✓
92	✓	✓	X	✓	X
95	X	✓	X	✓	X
96	X	✓	X	✓	X
09	✓	✓	X	✓	X
S7/S8	✓	✓	X	✓	✓
S1180/S2180	✓	✓	X	✓	✓

Train Status With Train Door Interlock Cut Out Switch in Cut Out Position and Doors Closed

Stock	ATO Start Disabled	Traction In Full Speed / Coded / Protected Manual	Traction In Restricted Manual Only	Doors Closed Visual Extinguished	Audible Alarm on each motoring demand from standstill In Manual
72	N/A	✓	X	✓	X
73	N/A	✓	X	X	X
92	✓	✓	X	X	X
95	X	✓	X	✓	X
96	X	✓	X	X	X
09	✓	✓	X	✓	X
S7/S8	✓	✓	X	✓	✓
S1180/S2180	✓ (inferred, not explicitly stated)	✓	X	✓	✓

Ideal Train Status for Train Door Interlock Cut Out Switch in Cut Out Position and Doors Either Open or Closed

Stock	ATO Start Disabled	Traction In Full Speed / Coded / Protected Manual	Traction In Restricted Manual Only	Doors Closed Visual Extinguished	Audible Alarm on each motoring demand from standstill
S1180/S2180	✓	✓	X	✓	✓