London Underground
Health, Safety Quality and Environment

Investigation into the delayed release of customers from stalled trains following a Central line signal failure in the Liverpool Street Area [redacted] 17th February 2010

LUSEA Ref.: 20003470

[redacted]

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Executive Summary

At 1730 on 17 February 2010, a fuse failure within a signal computer caused the Central line service control centre to lose sight and control of trains and signals in the Liverpool Street Area [redacted] in both directions. [redacted] trains were stalled and the last customers were released after 84 minutes, 10 of which were treated on site by ambulance teams for the effects of heat. A number of errors in identifying and managing the stalled trains delayed the release of customers.

The report reviews the response and interaction between the NOC and the service control centre and how this influenced the actions of stations and trains staff. The use of the Connect radio system and communications protocols are also considered. The prioritisation of stalled trains is discussed and the time taken to implement alternative arrangements such a securing points and staffing of local control panels.

Immediate cause:

- There was no logical, structured approach to releasing customers from stalled trains.

Underlying causes

- Train 71 was forgotten by service control after contact at 1749
- Train 71 failed to make further contact with service control
- Position of 145 was forgotten / not recorded after initial contact at 1749
- The significance of the position of train 145 was not recognised
- NOC did not cross reference the position of trains as per [redacted]
- Decision to scotch and clip or use ELCPs was not made until 1826
- NOC concerns regarding the approach by service control were not escalated
- The Connect dispatcher and Trackernet was assumed to be inaccurate by the NOC and service control
- The Service Manager did not intervene in the initial response
- Imprecise and incomplete train information was provided to the NOC by the service control centre

Root causes

- [redacted] and rule book 2 were not fully complied with
- [redacted] NOC did not have a logical and strategic approach to identifying, recording and rescuing stalled trains as per [redacted] (including making contact with stalled trains)
- The Connect system has no functionality to delete selected calls or redundant call requests
- The competence of duty managers in ELCP use is not managed
- There was ineffective liaison between the service control centre and the Duty Operations Manager Engineering.

Recommendations are provided that address each of the root causes.

1.0 Terms of Reference

LU FIR Terms of Reference

On the 17th February 2010 a loss of signalling control and train visuals occurred in the Liverpool Street Area [redacted] **on the Central Line at approximately 17:30**

A formal investigation is requested into the protracted release of customers from stalled trains during the above incident that resulted in significant disruption to Central Line services and a number of customers requiring medical attention.

The purpose of this investigation is not to determine the cause of the failure, as this is subject to a separate technical investigation, but to investigate the operational response and cause of the delay in releasing customers from the stalled trains and to identify the measures necessary to prevent future incidents.

The investigation should:

- Confirm the sequence of events that led to the stalled trains and the delayed detrainment of customers.
- Identify immediate, underlying, root causes and contributory factors.
- Review the effectiveness of the attempts to identify and detrain the stalled trains with reference to the rule book and [redacted].
- Consider the roles and interaction of the NOC, Service Control, Trains and Stations, including the training on and use of ELCPs.
- Include the functionality and use of the Connect radio system in managing the incident and general communications between all parties concerned.
- Review previous incidents – specifically the incident at [redacted] (3 April 2008) and the effectiveness of the recommendations.
- Develop reasonably practicable recommendations to address the underlying and root causes that led to the delayed detrainment – specifically concerning actions for identifying and confirming stalled train position and reducing detrainment times.

The investigation will be led by Tony Matthews with support from:

- Mike Shirbon SQE Lead Investigator [redacted]
- and specialist advice from:
    - CMOs Signals managers
    - Operational Standards
    - Emergency Planning team

An interim / progress report shall be submitted on: 15 March 2010
The FIR shall be completed by 30 April 2010

Nigel Holness
BCV / SSR Service Director

2.0 Methodology

The causes of the incident were investigated by:

- Interviews with the staff involved
- Investigation meetings
- Discussions with engineers regarding the nature of the failure
- Listening to Connect recordings
- Reviews of the rule books, line supplements and [redacted]
- Discussion with human factors specialists
- Root cause analysis work

3.0 Background

3.0.1 The Central line is an automatic railway and train operators are only required to manually operate the train when this facility is not available. The Central line signalling system is computer operated, with local site computers serving areas of signalling along the line. The Central line service control and signalling team are based in the service control centre and can control the signalling from this location using 'mimic' screens that display an image of which trains are occupying which signal track circuit.

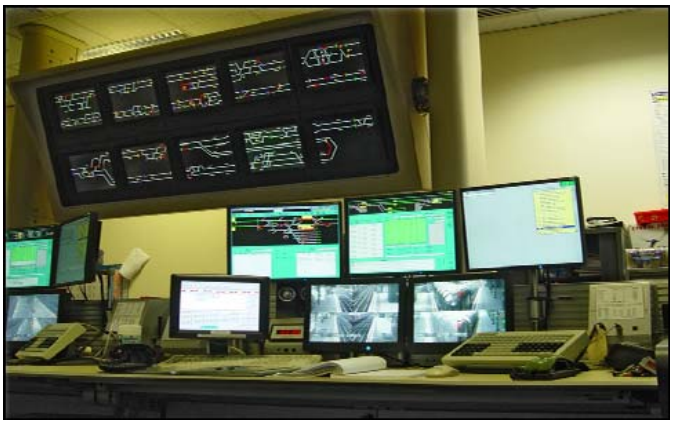


Figure 1: Service control desk showing 'overview', 'mimic' and Connect despatcher screen

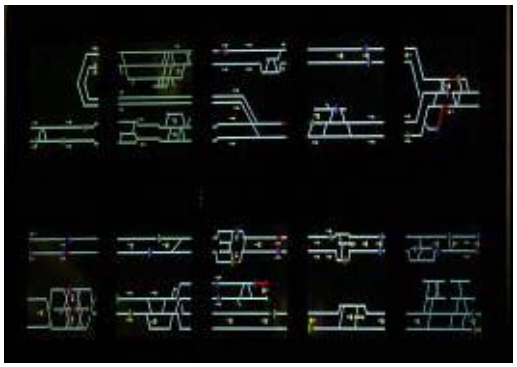


Figure 2: A close up of the signalling overview screen

3.0.2 Semi-automatic signals protect track features such as junctions and work in the same way as automatic signals, although they require an additional action by a computer or signaller to return the signal to green when the track circuit it is protecting has cleared. Emergency Local Control Panels (ELCPs) are based along the Central line and can be used to manually take control of the local signalling covered by the panel. [redacted]

Figure 3: the signalling 'mimic' screen (red sections are occupied by a train)

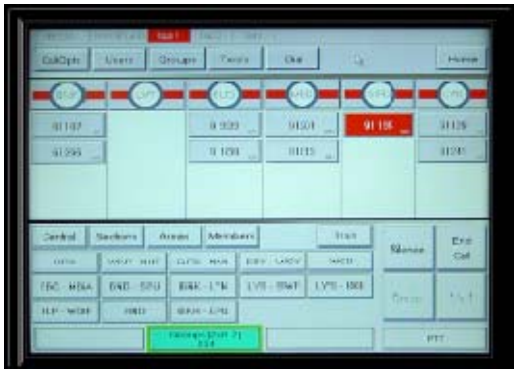


Figure 4: Connect despatcher showing trains under eachConnect 'radio cell' (circles)

4.0 The Incident

4.0.1 A full time line is provided in appendix 2

4.1 Incident Detail

Date:	17 February 2010
Time:	1730 signalling system failed 1854 last customers detrained from train 145 1917 through services resumed
Location:	Liverpool Street area [redacted] (both directions)
What Happened:	A technical fault with a local signalling computer resulted in the service control centre losing visuals display and control of signals in the affected area. Trains became stalled between stations due to semi-automatic signals not clearing and blocking back. Efforts to move trains and release customers became protracted with the last customers released 84 minutes after the failure occurred.
Consequences:	There was significant service disruption to all Central line services with knock-on implications across the network. Ambulance teams treated 10 customers on site (8 from train 145) for the effects of heat exhaustion.

4.2 Incident Summary

4.2.1 At 1730 on 17 February 2010 a defect with the signalling local site computer (LSC) [redacted] resulted in the Central line service control centre losing control of signals in the Liverpool Street area in both directions and the visual display

of trains and signals in this area. The train service was operating to timetable at the point of the failure. The signals continued to function correctly on the ground with the relevant 'fail-safe' systems ensuring that at no time were customers at risk from uncontrolled train movements. At the time of the failure, the control room staff were uncertain as to the status of the signals on the ground. Trains continued to operate as normal over automatic signals with automatic train operation (ATO) codes available. Due to the signalling LSC failing, semi-automatic signals could not be returned to green following the passing of a train; this was the cause of trains being stalled between stations and blocking back from the Liverpool Street area.

Figure 5: Location of semi-automatic signals within the affected area.

4.2.2 The service control centre immediately became aware of the failure as both the mimic and overview screens displayed the affected area as grey blocks and trains were no longer visible in the Liverpool Street area [redacted]. Attempts were made by Signal Engineers to clear the fault by resetting the relevant systems in the first few minutes, this proved unsuccessful and service control staff began a process of identifying trains in the area and any stalled trains. The service control centre used Connect radio group calls, requesting any trains in the area contact the Service Controller. The timetable was also used to predict train locations.

4.2.3 Within 10 minutes the Network Operations Centre (NOC) contacted the service control centre and due to the time, location and size of the affected area, arrangements were made for ambulance and British Transport Police (BTP) assistance as a precaution. The incident quickly affected other locations on the network and the NOC received calls regarding station closures and congestion. Due to the reported loss of power to the signal computer, there was some initial confusion whether the power loss affected the entire Liverpool Street area or just the computer.

4.2.4 Eastbound trains quickly became blocked back west of Bank (see Trackernet screenshots in appendix 1) and the service control centre received a large number of Connect radio call requests. The requests for information were in competition with the Service Controller's request that trains in the affected area call the Service Controller. Service control staff managed the number of calls by making 'group calls' to all trains informing them of the incident, what area was affected and that the call stack would be deleted. Approximately 15 minutes into the incident the call stack was deleted and a request made for trains in the affected area to make contact, both trains 145 and 71 spoke to the Service Controller and confirmed train number, direction and position using signal identification plates. A subsequent request was made for trains in the affected area to contact the control room using the mayday button to prioritise the call ahead of other calls in the stack. This request listed trains

that had already contacted the control centre and instructed them not to respond using the mayday function. This list included trains 145 and 71 in addition to others.

4.2.5 Within half an hour the Rostered Duty Officer (RDO) and Line Incident Manager (LIM) were both involved with the incident and had contacted the NOC and the service control centre. The conversations between the RDO, LIM, NOC and service control focused on identifying and moving stalled trains and differing estimates were given of how many trains were stalled. At 1758 the service control centre reported to the NOC that there were [redacted] stalled trains and there were likely to be more. At the same time the NOC reported to the RDO that there were [redacted] eastbound and [redacted] westbound trains stalled. Both the NOC and service control staff expressed a reluctance to use trackernet due to concerns the information was incorrect as it is fed by the signalling system. The Connect radio dispatcher was also perceived to be inaccurate as it does not show whether trains are within station limits, only that trains are in that station's radio cell.

4.2.6 Whilst COO staff were dealing with the trains, CMO technical staff were on site [redacted] by 1750 and made attempts to fix the fault. The suggestion of using the emergency local control panels (ELCP) to locally control the signals was suggested to the NOC and other Technical Officers attended ELCP sites in the affected area around 1830.

4.2.7 Eastbound train 145 approaching [redacted] was identified as a potential problem by the NOC at 1807 due to the need to secure the points between the train and [redacted] station. Train 145 was not specifically discussed with service control and at 1813 the NOC were still requesting details of train numbers and locations from service control. An attempt to berth train 145 in [redacted] platform was delayed as the position of the points could not be confirmed, and a decision to scotch and clip the points made at 1826. The operator of train 145 was able to shout down the tunnel to the [redacted] Station Supervisor and was told that the decision to scotch and clip had been cancelled. The train operator called the Controller at 1845 and requested an update and stressed the urgency of berthing at [redacted] in a subsequent call at 1847 due to passenger emergency alarms being activated. Train 145 arrived in the platform at 1854 and detrained an estimated 950 customers; eight were treated on site by ambulance staff for the effects of heat: none were taken to hospital.

4.2.8 The Duty Director was informed at 1817 that 2 of the 3 stalled trains would shortly berth in platforms and train 120 [redacted] was the only concern. Both the service control centre and the NOC expressed concern at approximately 1840 that there may still be trains unaccounted for. The concern was for trains 42 and 7, although records indicate that both had been detrained by this point. Train 7 later 'appeared' on the signalling display at [redacted] station having earlier detrained at [redacted] Train 71 gained the platform [redacted] at 1845 having been unable to make contact with the Service Controller since their initial conversation at 1749 (see section 5.3). Power was restored to the signal computer at 1855 and services resumed 1917.

5.0 Discussion

5.1 Identification of Stalled Trains

5.1.1 [redacted] 'stalled train verification process' details the actions that the NOC should take to independently verify the positions of stalled trains in comparison with information from the service control centre. [redacted] 'Service control response to incidents involving stalled trains' details the actions that the service control teams should take to manage stalled trains. The Central line service control staff did not apply a structured approach to identifying and rescuing affected trains. Eastbound trains to the west of [redacted] were dealt with first, possibly as the signalling and associated displays in this area were functioning correctly, allowing full control. The absence of precise information from the service control centre meant the NOC felt unable to fully implement [redacted] as they did not receive train position information to verify. The quality of the information regarding the position of stalled trains had an adverse impact on the effectiveness of the plan to release customers and the collaboration with the NOC. The initial response to the incident by the service control centre lacked strategic direction and once in motion, the response was not re-evaluated. In human factors terms there is evidence of 'anchoring heuristic[1]' and 'group think[2]' within the service control room where the commitment to the initial response is not challenged or altered.

5.1.2 The primary means of identifying stalled trains by service control was a request for trains to call the Service Controller and was supported by the use of CCTV, the timetable and station staff to confirm train numbers and positions. The onus was on train operators to make contact with service control. Trackernet was not fully used as it was assumed the information would be incorrect (as it is fed by the signalling system) and the affected area had 'frozen' on the screen. The Connect dispatcher will show trains within each station cell by their train number, although will not show whether the train is in the platform or not (see fig. 4). It is possible that Connect and Trackernet were sub-consciously dismissed as neither contained all the information required to manage the incident, although collectively they would have been of use. [redacted] requires that trackernet and the Connect dispatcher are used to verify train information, in not using these resources an opportunity was missed to determine the sequence and position of trains. In consequence of the quality of train position information, there was no overall strategy for how affected trains would be dealt with.

5.1.3 Formal incident management (FIM) was not introduced as per rule book 2 and the line emergency plan (figure 6) aside from a DSM [redacted] who assumed the role of silver control. Not implementing FIM was a causal factor in the lack of a co-ordinated approach with station and contributed to the delayed release

[1] Anchoring heuristic: 'to bias our belief revisions in favour of the initially chosen hypothesis' Wickens, C and Hollands, J. (2000) Engineering Psychology and Human Performance. New Jersey. Prentice Hal

[2] Group think: 'a collective try to minimise conflict and reach consensus without critically evaluating' Irving, J. (1982). Groupthink: Psychological studies of policy decisions and fiascos. 2nd ed. Boston: Houghton

of customers. After initial communication between service control and trains 145 and 71, where their locations are established, it is apparent in later radio conversations that the position of trains 145 and 71 were either forgotten or not accurately recorded.

Figure 6: Implementation of the incident management structure
(note the step implementing rule book 2 was missed in this incident)

5.1.4 It was noted that the NOC frequently deal with incidents that involve stalled trains and successfully implement [redacted] daily. The intention of [redacted] is that both the NOC and the service control centre independently and simultaneously seek information regarding the position of stalled trains. The two lists are then cross-referenced and any differences investigated further. The NOC manager had interpreted the wording of [redacted] to mean that the NOC should independently check the information once it is provided by the service control centre. In this instance, the information from the service control centre was vague and the NOC felt unable to implement [redacted] The NOC began to seek their own train position information using CCTV, trackernet and BTP officers on the platforms, albeit under the impression that [redacted] could not be implemented. The intention of [redacted] has since been clarified within the NOC.

5.1.5 There was a perception within the NOC that the service control centre had more accurate sources of information available, which caused doubt as to whether the NOC had the correct understanding of train positions. Central line service control is regarded as being technologically advanced within LU and it is thought this inference led to the perception that service control had better sources of information available when in fact they had the same as the NOC. Conformity is a known human factor in decision making, where persons readily agree with those perceived to be in a position of knowledge or power without verifying the quality or source of that information.

5.1.6 The NOC had concerns with the information provided by service control but did not escalate these concerns to the LIM or RDO until much later in the incident around 1840. The NOC perceived that service control had better information sources at their disposal, which introduced an element of doubt as to whether their understanding of the incident was more accurate than service control, particularly where differences were identified. This doubt may have been sufficient to reduce the NOC's confidence in escalating their concerns, in case their opinion was base on old information and they were perceived to be wrong.

5.1.7 The NOC independently identified stalled trains using the Connect dispatcher, CCTV and the BTP who were assisting on platforms. Trackernet was used, but similar to service control staff, it was assumed that the information would be inaccurate and was not trusted. Both service control and the NOC identified stalled trains but did not cross-reference their information, therefore this was a duplication of effort rather than an independent verification. The NOC's lack of faith in the service control centre's management of the incident prompted them to work independently and in parallel. [redacted] was not fully complied with during this incident and the NOC's concerns were not escalated to the LIM or RDO. The absence of a logical approach to identifying trains, the lack of a strategic approach to dealing with trains by service control and no independent verification of train position are causal factors in the delayed release of customers.

5.2 Communication

5.2.1 The NOC contacted the service control centre 9 minutes into the incident in order to confirm the scale of the incident and identify if there were any stalled trains. This timescale is considered reasonable for notification to the NOC as the level of information available is often proportionate to time. The LIM and RDO contacted the NOC within 30 minutes of the incident. [redacted] requires the RDO to be informed within 10 minutes of the stalled train information being verified. It appears that as detailed stalled train information was vague, subsequent steps such as verification and notification of RDO were delayed.

5.2.2 A review of the communications between service control room staff and train operators identified good use of the communication protocols in the majority of cases, with parties correctly identifying themselves, using phonetics, speaking numbers singularly and repeating back instructions. The communications between the service control centre and NOC did not detail the exact position and number of all stalled trains. All numbers and positions provided by the service control centre were approximate and the focus of attention and prioritisation of trains varies between conversations. The NOC prompted the service control on 2 or 3 occasions to clarify the positions and numbers of trains but did not actively challenge the Service Manager to provide a definitive list.

5.2.3 The tone and the content of the conversations differ between the NOC and Service Manager, and the NOC and the LIM, RDO and Duty Director. The LIM and RDO understood the incident to be satisfactorily managed and likely to be resolved within 60 minutes based on the information they were given. Overall the messages to the RDO, LIM and Duty Director are optimistic and confident of a prompt

resolution.In the conversations with the Service Manager the NOC continue to push for further details of stalled trains. For example: at 1813 the NOC called the Service Manager and the desire to get detailed information is evident in the tone used by the NOC and the Service Manager provided general information regarding 5 stalled trains. At 1817 the NOC informed the Duty Director that all stalled trains are moving with the exception of 1 and confidence is high that the incident won't exceed [redacted] minutes. Using the information recorded during the incident, at 1817 there were between [redacted] and [redacted] trains yet to be detrained that service control and the NOC were not aware of.

5.2.4 The optimism from the NOC was a result of incomplete information regarding train position and the absence of a strategic approach to dealing with stalled trains from the service control centre, creating the impression that there were fewer trains to deal with. The NOC were separately identifying stalled trains and the difference in the messages was in consequence of the different information being recorded. It would appear trains 71 and [redacted] were forgotten or overlooked, and the implication of the position of trains [redacted] and 145 (points requiring securing) either forgotten or not understood.

5.3 Trains 145 and 71

5.3.1 It was concluded that given the nature of the failure, the size of the affected area, the number of trains involved and the time of day, it is likely that this incident would take up to an hour to resolve. Trains 71 and 145 were the last 2 trains to be detrained (at 1845 and 1854 respectively) and the reasons for these protracted delays are discussed below. The investigation has prompted discussion regarding how long a train should be without contact before it is considered an emergency and when to self-detrain. With regard to this incident the panel concluded that the emphasis should be on service control to successfully lead the incident rather than developing solutions for train operators when incident management is failing.

<u>Train 71</u>

5.3.2 The operator of train 71 made contact with the Service Controller at 1749 following a group call radio message to all trains from the Service Controller that trains stalled in section should call the Service Controller. The train operator made contact using the normal Connect channel and the resulting conversation established the direction, train number and position of train 71 using a signal identification plate. This was the only contact that the operator of train 71 had with The service control centre during the incident. Train 71 was stalled at a semi-automatic signal on the westbound road approaching [redacted] with train [redacted] in the platform ahead (detrained at 1746 and moved forward). It is likely that when the ELCP was operated, the semi-automatic signals were able to be cleared allowing train [redacted] to depart [redacted] and enabling train 71 to berth in the platform at 1845. Both the NOC and The service control centre reported they were unaware that train 71 was stalled at this location, but suspected that a train was between [redacted] and [redacted] based on the Connect dispatcher.

Figure 7: Position of westbound train 71

5.3.3 After confirming his position with the Service Controller at 1749, the operator of train 71 made unsuccessful attempts to contact service control using the Connect train radio, his hand-held radio to call 103 and 903 and the local signal post telephone to speak with [redacted] station staff. Connect data confirms that no mayday calls were made by train 71. An earlier call from the Service Controller at 1757 requested that stalled trains use a mayday call to make contact with the Service Controller except those that had already made contact. Trains 71 and 145 (in addition to others) were identified as not required to make a mayday call for this reason. The operator of train 71 had concerns with using the mayday due to this earlier message, he also did not consider to be in an emergency situation despite not speaking to the service control centre between 1749 and 1845. The only alternative actions available to the operator of train 71 were to discharge traction current, self detrain or use the mayday function. It is likely that self detrainment would have protracted the incident further, possibly affecting other trains or introducing risks to customers as they walked over points. A mayday call or discharging traction current would have highlighted his presence to service control, although it remains that the position of train 71 was either not recorded or forgotten by service control.

Train 145

5.3.4 Train 145 was stalled at a semi automatic signal [redacted] travelling eastbound. The operator of train 145 confirmed his direction, train number and position by signal identification plate with the Service Controller at 1749 after stalled trains were requested to contact the Service Controller. The train operator of 145 contacted service control again at 1821 for an update and was advised to proceed [redacted] by the Controller who did not check the position of the points. The train operator requested confirmation the points were set in his favour and the Controller asked the train operator to confirm his location – apparently not aware of the significance of the position of train 145. Points must be secured prior to a train moving over them during a signal failure in order to prevent derailment. There is no evidence of a plan to deal with train 145 before the conversation at 1821 and it is possible that due to the logging of train positions the need to secure the points was not recognised.

Figure 8: Position of Eastbound train 145

5.3.5 The decision to scotch and clip the points between the train [redacted] was communicated to the operator at 1826, almost an hour into the incident. Rescuing trains 145 and 71 required the scotching and clipping of points or activating ELCPs, as this involves staff attending site these decisions should have been prioritised ahead of rescuing other stalled trains. The operator had to request a further update at 1845 by which time the decision to scotch and clip had been dismissed in favour of using the ELCP to bring the train into the platform using signals. The operator became aware of this change in plan by a shouted conversation with the [redacted] Station Supervisor standing on the platform near the tunnel mouth. The train operator managed to keep an estimated 900+ customers calm for 80 minutes through announcements before passenger alarms were activated. At 1850 train 145 was able to be signalled into the platform, probably due to the activation of the ELCP. The customers were detrained, 8 of which required treatment for the effects of heat; none required hospital treatment.

5.3.6 The release of customers from train 145 was delayed from the initial contact at 1749, subsequent contact at 1821, the decision to clip and scotch at 1826 and then the decision to use the ELCP at 1845. Given the information provided by service control, it is concluded that the train operator of 145 acted appropriately, chasing for progress after periods without contact and the delays arose from the absence of a plan from service control.

5.4 Role of Stations Staff in Managing Stalled Trains

5.4.1 Comments were received from both the NOC and service control staff that station staff were not as helpful with identifying stalled trains as they would wish and required direct instruction from service control. It is evident that service control staff have different priorities when dealing with stalled trains to station staff who also have to deal with congestion, other lines still operating in their station and providing alternative route information. It was also noted that a ‘signal failure’ may be perceived as service disruption rather than an ‘incident’ to station staff and therefore less of a priority than other train incidents: e.g. dealing with stalled trains [redacted] during the derailment in July 2007.

5.4.2 The investigation panel concluded that the implementation of FIM (see figure 6) would have assisted in co-ordinating and communicating the plans between service control and the station staff. For an incident of this nature it would be

appropriate to establish ‘silver control’ within the service control centre, with ‘bronze tasks leaders’ at each affected station to oversee train detrainments and movements. A duty manager [redacted] assumed the role of ‘silver control’ but this appears be a local arrangement and not co-ordinated with other incident sites across the line. At other locations station staff left platforms not realising that subsequent train movements and detrainments would take place requiring their assistance.

5.4.3 There was confusion regarding the position of train [redacted] which had been detrained on the [redacted] platform at 1745 but its status and location not recorded. At 1845 there was concerns that train 42 was still unaccounted for and efforts were made to locate the train. The station was not aware that the trackernet screen was frozen [redacted] and confusion arose as station CCTV and trackernet displayed conflicting information, delaying the confirmation of the position and status of train 42.

5.5 Emergency Local Control Panels (ELCPs)

5.5.1 The Central line has the ability to control of signalling locally through ELCPs [redacted] The train service can be operated from these panels, including setting routes to release trains stalled at signals at danger. The ELCPs were discussed as an option between the Duty Operations Manager Engineering (DOME) and the NOC at 1800 and technical staff were in reported as on route to operate ELCPs at 1830. There were issues in activating the ELCPs at some locations; with both staff competence and difficulties in activating the panels. [redacted]

5.5.2 Service control staff were initially unsure of the impact of using ELCPs as not all signals or locations can be controlled by ELCPs and they were unclear if signals between ELCP sections were functioning correctly. There are inconsistencies in the ability and experience of duty managers in operating ELCPs. All duty managers are required to maintain their competence in operating ELCPs; after an initial course duty managers should take control of a section using a panel at a time in agreement with service control to demonstrate competence. An audit by the Central line standards manager of competence in operating ELCPs in January 2010, concluded that almost all Central line duty manager trains were unable to show that they had maintained their competence in using ELCPs. The delay in activating the ELCPs is a causal factor in the delayed release of stalled trains.

5.6 Connect

5.6.1 During the incident there were frustrations with the Connect system; the main issue being that the system was swamped with calls (approximately 2500 in 2 hours) and this hindered the effectiveness of the system and the ability of control room staff to use it. The Connect system does not allow calls to be deleted from the Controller’s

screen without the call being answered by the Controller, the call stack can only be deleted in its entirety. Deleted calls are not completely removed from the system and will reappear when the train moves into the next signalling section. This increases the list of calls the Service Controller is dealing with and makes it harder to prioritise trains in the affected area if the call request list is spread across several pages.

5.6.2 Train operators are unable to cancel a call request to the Service Controller or signaller. This function was available on the legacy radio system and was frequently used by train operators when a 'group call' from service control answered the same question from a number of train operators (e.g. trains being held at stations during a signal failure). It was claimed by service control staff that a number of calls did not connect to trains, although it is not clear whether this was due to a system error, a system over load, [redacted] or train operators not being able to use the radio properly. The District line control room reported receiving several mayday calls from Central line trains. [redacted]

5.6.3 In order to prioritise calls from affected trains the Service Controller requested that stalled trains contact Service Controller using mayday calls, promoting their call request to the top of the call stack. This was effective for a number of trains and an intelligent way to make quick contact with stalled trains. There were concerns with the impact of ongoing conversations using mayday calls due to occupying an emergency functionality. The operators of both trains 145 and 71 had already made contact and were reluctant to use a mayday call unless they had a genuine emergency. There are no separate protocols for managing communications during an incident such as this, or how long a train operator should wait without contact before considering the situation an 'emergency'. Due to the number of variables within service affecting incidents, it is considered that the emphasis should be on service control to correctly identify and manage stalled trains rather than providing rules for when this is ineffective.

5.7 Technical Failure

5.7.1 The technical cause of the signalling system failure is outside of the terms of reference for this investigation and was the subject of a separate investigation which is summarised below. [redacted] power was lost to the computer and prevented information and control being shared with the service control centre. [redacted] and the condition would not have been visible until the unit was dismantled. [redacted]

5.7.2 [redacted]

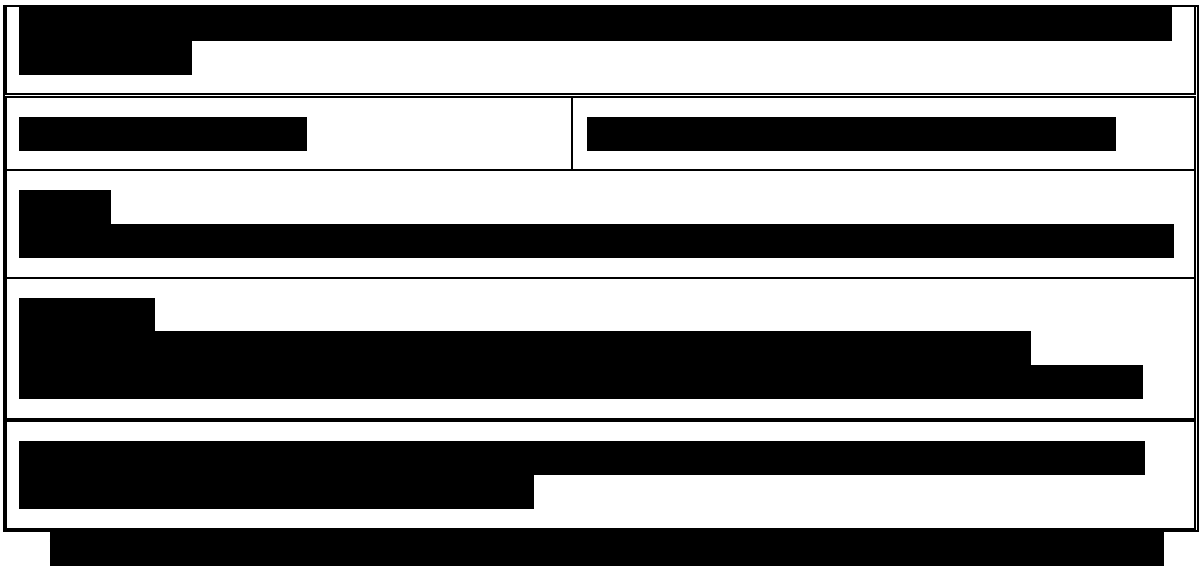
[redacted] During engineering hours immediately after the failure on the 17 February, signalling staff tested 50% of the fused connections [redacted] The remaining 50% were completed during the engineering hours of 18/19th February 2010, with no further defects found.

[redacted]

[redacted]

[redacted]	[redacted]
[redacted]	
[redacted]	
[redacted]	[redacted]
[redacted]	
[redacted]	
[redacted]	[redacted]
[redacted]	
[redacted]	

[redacted]



6.0 Conclusions

- The initial response lacked a logical and strategic approach to identifying and managing stalled trains.
- The communications between service control and the NOC did not contain sufficient detail of train position and the plan to manage those trains.
- Train positions were inaccurately recorded by service control during the incident
- Decisions regarding the movement of stalled train were delayed
- FIM was not introduced and the efforts of service control and station staff were not co-ordinated
- [redacted] and [redacted] were not implemented and service control and NOC efforts were not co-ordinated
- The information available from the Connect dispatcher and Trackerent were dismissed ad as being inaccurate
- The NOC's concerns regarding the response from service control were not escalated to the LIM / RDO

6.1 Immediate causes

- There was not a logical, structured approach to releasing customers from stalled trains.

6.2 Underlying causes

- Train 71 was forgotten by service control after contact at 1749
- Train 71 failed to make further contact with service control
- Position of 145 was forgotten / not recorded after initial contact at 1749

- The significance of the position of train 145 was not recognised
- NOC did not cross reference the position of trains as per [redacted]
- Decision to scotch and clip or use ELCPs was not made until 1826
- NOC concerns regarding the approach by service control were not escalated
- The Connect dispatcher and Trackernet was assumed to be inaccurate by the NOC and service control
- The Service Manager did not intervene in the initial response
- Imprecise and incomplete train information was provided to the NOC by the service control centre

6.3 Root causes

- [redacted] and rule book 2 were not fully complied with
- [redacted] and the NOC did not have a logical and strategic approach to identifying, recording and rescuing stalled trains as per [redacted] (including making contact with stalled trains)
- The Connect system has no functionality to delete selected calls or redundant call requests
- The competence of duty managers in ELCP use is not managed
- There was ineffective liaison between the service control centre and the Duty Operations Manager Engineering.

6.4 Observations

8.4.1 The best practice document Operational Standards number [redacted] appears to have not been well communicated or not well understood. [redacted] contains good information clearly presented and would benefit from a higher profile across LU service control rooms.

6.5 Actions Already Taken or in Progress

6.5.1 The following actions that are considered to address the causes and/or observations in this report have been undertaken:

- The Network Operations Managers have been briefed on [redacted] during NOC team days on the 24 and 31 March 2010 including the NOC's revised 'hexagon' detrainment target model .

- The Central line service control centre have obtained detrainment 'visualisation boards' to record the positions of stalled trains when implementing [redacted]

- The NOC have established a series of training themes for NOC managers and Controllers. These include identifying and promoting constructive behaviours and

communications associated with specific roles within the NOC, particularly when working with service control staff. One training theme covers NOC actions when dealing with stalled trains incidents and the implementation of [redacted] These training themes are included in workshops with NOC which are due to complete in October 2010.

- [redacted] has been reviewed to determine whether it should be applicable to Service Controllers in addition to Service Managers and the NOC. It was concluded that the scope of [redacted] should remain as is, with service and NOC managers responsible for complying with [redacted] and Service Controllers following direction from Service Managers.

7.0 Recommendations

7.1 Recommendations

Item	Recommendation	Actionee	End date
Rec 1	**Review of** [redacted] Context. [redacted] details the process by which stalled trains will be independently verified by service control and the NOC. This document should be updated to reflect lessons learnt from recent incidents. Recommendation a) Review and update the content of [redacted] taking account of the findings of this and other stalled trains incident investigations to ensure any lessons learnt are captured. This should clarify that train position information used for verification purposes is obtained by the NOC simultaneously and independent of the service control centre. Other areas for review are the inclusion of; • escalation of concerns, • confirming train position with train operators, • recording train positions using a train register • implementation of FIM and • Co-ordination with station staff. b) Any changes made to [redacted] should be communicated to staff involved in the implementation of [redacted] (NOC, Service Managers, LIMs & RDOs), along with the revised NOC detrainment hexagon. Verification Activity. Review the revised [redacted], confirm it has been published on the Operational Standards webpage and communicated to those included within the scope of the document.	Mark Grey / Andy Barr Mike Shirbon / Tony Matthews	30 Dec 2010 30 Jan 2010
Rec 2	**Competence of Service Control Room Staff** Context. Incident management, with particular regard to managing stalled trains, has been raised as an issue in a number of FIRs. Service control teams take the lead in managing an operational incident of this nature and therefore the recommendation is focussed on service control and particularly service managers.	Mark Grey (programme manager)	
	Recommendation a) Develop a measure of service control staff competence in implementing FIM, knowledge of [redacted] and [redacted] including the ability to maintain a train register and use a 'visualisation board' to prioritise during a stalled trains incident. b) assess control room staff using the measure developed in	David Gibbons All SCMs	31 Dec 2010 30 Jun 2012

	2a) and identify any short term solutions required to correct any competence gaps identified.		
	c) Prepare, implement and monitor progress against personalised action plans that address any gaps identified in 2b) as a short term solution.	All SCMs	30 Jun 2012
	d) Using the findings of the analysis from 2a) and 2b) make the appropriate changes to the competence management systems and scenario based training materials for service control staff that will provide a long term and permanent improvement in competence amending as appropriate: • The content of the competence standards and guidance document for service control staff • The competence standards assessed during CDP and the appropriateness of the scenarios used to robustly test delegates • The CDP materials used for service managers to ensure that SMs can demonstrate competence in leading other service control staff through an operational incident • The suitability of the methods and scenarios used by local competence assessors when evaluating control room staff against the CMS requirements	Graham Barrow	6 months after 2b) being complete
	<u>Verification Activity</u> • Confirm measure of service control staff competence (Rec 2a) has been developed. • Confirm that all SCM have identified short term solutions to correct competence solutions (Rec 2b)) • Confirm that all SCMs have implemented personalised action plans as necessary. Dec 2011 (Rec 2c)). • Confirm completion of 2d) through copies of revised CMS and training materials.	Mike Maynard (for all)	31 Jan 2011 Jan 2011 Dec 2011 1 month after completion date
Rec 3	**Emergency Local Control Panels and Line Emergency Plans** <u>Context.</u> ELCPs (or similar) exist on the Central and another lines providing a back up signalling function. Their use during the early stages of this incident would have reduced the delay in releasing customers. <u>Recommendation</u> a) Review line emergency and contingency plans with each Line General Manager to ensure adequate arrangements exist for the use of ELCPs or similar equipment (e.g. local	Neal King in liaison with Line	31 Jan 2011

	signal control from IMRs) during an incident of this nature . b) ELCPs (or similar) are to be included in line emergency and contingency plans, with adequate arrangements regarding competence management, communications with the DOME, use of maintenance and technical staff and asset maintenance. c) Any changes must be communicated to line management teams and relevant competence management systems amended to ensure competence is recorded and monitored. <u>Verification Activity.</u> Confirm that applicable line and relevant local emergency plans have been revised and the content communicated to relevant line management teams. Where a specific competence is required, confirm that competence assessments are evaluating staff appropriately.	GMs Andy Barr	 30 Jan 2011
Rec 4	**Management of stalled trains within the line emergency plans** <u>Context.</u> Line emergency plans should detail line specific details for implementing arrangements for managing stalled train incidents, including references to [redacted] and [redacted] <u>Recommendation</u> a) Using the outcome of recommendation 3, review line emergency plans against [redacted] and [redacted] to ensure that sufficient instruction exists detailing how a stalled train incident should be managed, including use of FIM and the 'detrainment hexagon', means of identifying trains, communication with the NOC and communication links with the DOME and DOE to ensure effective use of CMO staff during an incident. b) Those responsible for implementing the plan should be briefed on the revised content. <u>Verification Activity.</u> Confirm (through evidence and sample testing) that the revised emergency plan has been communicated to Service Managers.	Neal King with relevant Line GMs Andy Barr	31 Dec 2010 30 Jan 2011
Rec 5	**Include the existing review of FIM within the programme work from this FIR** <u>Context.</u> Formal incident management was not successfully implemented during this incident which increased the delay in releasing customers. A review is currently underway within LU, assessing the implementation and effectiveness of FIM and where improvements can be made that will improve LU responses to incidents. <u>Recommendation</u>		30 Dec

	The existing review of FIM is to be included within the programme of work generated by the recommendations from this FIR. This should specifically address the roles associated with FIM (LIM, RDO etc.) and the how CMO teams can be effectively used as part of a larger LU response to incidents.	Andy Barr	2010
Rec 6	**Connect radio 'delete call' function** Context. Train operators are unable to cancel their call request if the call is no longer required (e.g. information from service control answers their question). This increased the number of calls on the connect dispatcher screen and hindered communications with trains during this incident. Recommendation Report to DRACCT on the options available for the cancelling or deletion of connect radio calls by train operators or service control staff. The options should be presented in terms of reasonably practicability with indicative costs.	Alistair Montgomery	30 Dec 2010

[redacted]

Appendix 2: Incident Time Line

Time	Event
1730	Service control lost signal visuals and control in the Liverpool St [redacted] area.
17:43	Service Manager reports failure and awareness of stalled trains to NOM
1745	NOC arrange for ambulances to be sent to [redacted]
1745	Trains [redacted] confirmed as in platform and detrained
1747	Technical officer on site at [redacted]
1749	Train 71 confirms train number and location (signal number) with Service control
1749	Train 145 confirms train number and location (signal number) with Service control
1755	BCV Late LIM discuss incident with NOM, confirms RDO not yet spoken to and believes [redacted] trains stalled. Question whether power failure is affecting the whole Liverpool St area.
1758	Service Manager phones NOC. No Power to local site computers SOM on way and electrician not looking easy or simple. Confirmed [redacted] trains stalled east & west between [redacted] There are likely to be more and are dealing with at the moment
1758	RDO calls NOC, NOC informs RDO that [redacted] are believed to be stalled and have concerns with accuracy of Trackernet
1800	Signal Infrastructure Manager requests that the ELCPs are put into use
18:02	Service Manager requests NOC arranges water to site. NOC confirm that water is on route and that they need to know where the trains are
18:05	NOM updates RDO confirms loss of power to signal computer and that TO and SOM are nearby. NOM states [redacted] moved, [redacted] stalled (1 approaching & 1 departed [redacted] both EB, [redacted] approaching & [redacted] departed [redacted] both EB, 1 approaching [redacted] WB and 1 approaching [redacted] WB).
1806	Arranged for water to be despatched from [redacted]
1807	Technical Officer from [redacted] asked to redirects to [redacted] to operate ELCP.
1807	Network Co-ordination Manager phones NOC for update. NOC advise how all trains are being dealt with and recognise train outside [redacted] as potential issue (Train 145)
18:13	NOM contacts Service Manager pushing for an update on train positions. SM confirms train berthing at [redacted] WB, 1 moving at [redacted] WB to allow train behind to berth. There are 2 outside [redacted] WB, 1 of which unable to contact. EB all dealt with except [redacted] outside [redacted] with possibly one in front of that. ELCP to be used shortly.
1817	Duty Director phones NOC who advise 3 stalled trains soon to become 1 and

	[redacted] approaching [redacted] on EB is the only problem.
1820	Trains [redacted] confirmed as in platform and detrained at [redacted]
1821	Train 145 told to berth in [redacted] operator requests confirmation of points position before proceeding
18:21	NOM updates RDO: 3 trains stalled soon to be 1. [redacted] is only concern with 3 trains moving into [redacted] all WB. Anticipation is all but 1 will be detrained in next 5 minutes.
1826	Train 145 advised that Station Supervisor will secure the points
1830	Train [redacted] confirmed as in platform and detrained at [redacted]
18:33	Service Manager updated NOM: cleared all trains [redacted] Last 2 trains berthing at [redacted] (numbers not known). Found another train at [redacted]
1835	Train [redacted] confirmed as in platform and detrained at
1840	LIM contacts NOC, informs NOC that SM has advised of another train found at [redacted]. Share concern that all trains may not have been found. [redacted] yet to berth at [redacted]. Believe [redacted] unaccounted for (already detrained at [redacted] 1745).
1845	Train 145 requests an update from service control
1845	Train 71 berths at [redacted]
1847	Train 145 requests update, reporting passenger alarms activated.
18:48	NOM calls Service Manager, to check that T71 that ‘just appeared’ is last train with T145 in platform. SM believes now all clear.
1848	Duty Director phones NOC for update. Informs thinks all dealt with, with T145 & T71 last trains. Can’t be sure as Trackernet is ‘useless’. Director suggests use of Connect dispatcher.
18:53	RDO calls NOM, NOM confirms that [redacted] had been found and T71 appeared and was last stalled train. Shuttle timetables in place but no through trains.
1854	Train 145 confirmed as in platform and detrained at [redacted]
1855	[redacted]
18:57	Service Manager calls NOC, believes all stalled trains cleared and may have fixed fault – getting signals back shortly.
19:01	Service Manager calls NOC, service to resume shortly
1914	Duty Director receives confirmation that trains are moving and service shortly to resumes. 8 and 4 casualties across 2 sites. [redacted] trains stalled. Longest train was 1854 with 84 min delay.
1917	Through services restored – severe delays (minor delays at 2118)
1936	Duty Director receives confirmation from NOC that all casualties are clear and none required hospital treatment. Requests time line from NOC, Central Line get statements from drivers and Connect to report on issues with radios.

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Appendix 4: Reported Train Positions During the Incident

The following is a summary of conversations regarding train position information only and is neither a full transcript or a complete list of all conversations. Train numbers provided in brackets are estimates of what number the trains are believed to be taken from trackernet re-player. The information has been summarised from recorded communications.

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Appendix 5: Root Cause Analysis