

**Investigation Report 2011-R003**



**Tram derailment at The Point Stop, Luas Red Line**

**13<sup>th</sup> May 2010**

**Document History**

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### **Purpose of the Railway Accident Investigation Unit**

The Railway Accident Investigation Unit (RAIU) is a functionally independent investigation unit within the Railway Safety Commission (RSC). The purpose of an investigation by the RAIU is to improve railway safety by establishing, in so far as possible, the cause or causes of an accident or incident with a view to making recommendations for the avoidance of accidents in the future, or otherwise for the improvement of railway safety. It is not the purpose of an investigation to attribute blame or liability.

The RAIU's investigations are carried out in accordance with the Railway Safety Act 2005 and European railway safety directive 2004/49/EC.

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## Summary

On Thursday the 13<sup>th</sup> May 2010 LUAS Tram 3006 was travelling on the shuttle service between Dublin Heuston Railway Station and the Point Stop on the Luas Red line. At 22:10 Tram 3006 proceeded into The Point Stop with the intention of stabling at the Inbound Platform.

However Tram 3006 travelled forward a distance of sixty-four metres towards the Event Platform, and not the Inbound Platform as was intended. The Tram Driver stopped Tram 3006 and after communicating with the Controller in the Central Control Room, subsequently changed driving cab ends and drove Tram 3006 outbound, derailing the third bogie on a set of spring points.

The immediate cause of this accident was:

- Tram 3006 had not travelled clear of the spring points before carrying out a reverse manoeuvre.

Contributory factors were:

- The Controller was not fully aware of the exact position of the tram;
- Communications between the Tram Driver and Controller were not clearly understood;
- The Tram Driver momentarily forgot that Tram 3006 would derail over the spring points due to its current position.

An underlying factor was:

- There is no mandatory procedure other than in an emergency call for a Controller and a Tram Driver to clarify and check any misunderstandings in radio transmissions.

As a result of the RAIU investigation the following safety recommendation has been made:

- Veolia should introduce a communication protocol between normal and emergency for given situations where a clear understanding between a tram driver and Central Control Room are required.

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## **1 Factual information**

### **1.1 Parties involved**

#### **1.1.1 Organisation involved**

Veolia Transport Ireland operates the Luas light rail tram system in Dublin on behalf of the Railway Procurement Agency, which is the government agency with responsibility for the LUAS system. Veolia Transport acts as the *Railway Undertaking* and the *Infrastructure Manager*.

#### **1.1.2 Roles involved**

A tram driver is responsible for the safe operation of the tram. The Tram Driver of Tram 3006 at the time of the accident was certified as having completed relevant training to drive a tram, and was qualified on 7<sup>th</sup> May 2010 and was working his first evening shift unaccompanied.

The Controller is responsible for monitoring the trams and maintaining communication with the drivers in to ensure the smooth running of the Luas Red Line. The Controller had five years experience in *Central Control Room (CCR)*, having previously been a tram driver, the controller was familiar with both the track layout and procedures at the Point Stop. He had just commenced duty at the time of the accident.

## 1.2 The accident

On Thursday the 13<sup>th</sup> May 2010 Tram 3006 was operating a shuttle service between the Heuston and The Point Stops on the Red Line, see Figure 1 for location map.

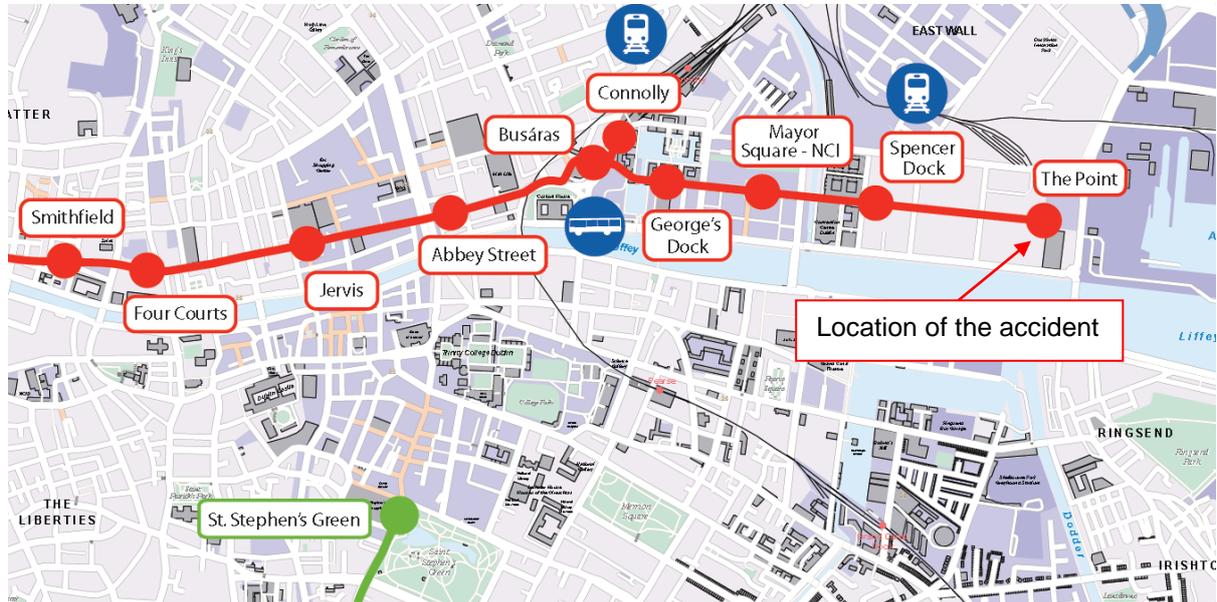


Figure 1 – Location Map

At approximately 22:10 Tram 3006 approached the Point Stop, stopping at points MO1, which is signalled by a *Points Position Indicator (PPI)* and a *Tram Signal*, see Figure 2. At this time two trams were stabled in the Outbound Platform and Event Platform, see Figure 2. (It should be noted that this was the first time that the Tram Driver had encountered this situation).

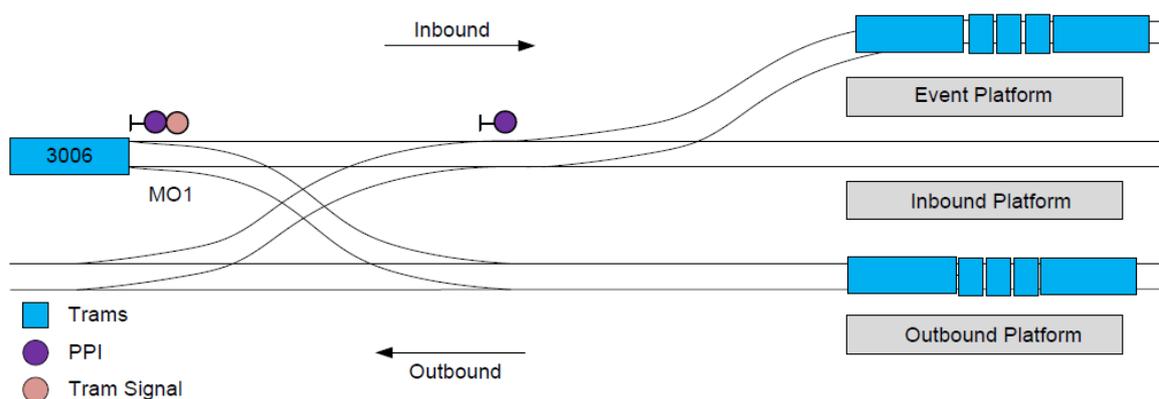


Figure 2 – Layout at The Point Stop, showing trams stabled at the Event and Outbound Platforms

The Tram Driver confirmed with CCR, by in cab radio, that he was to stable the tram on the Inbound Platform, which was situated straight ahead. The Tram Driver proceeded straight through points MO1, which were set for the Inbound Platform.

The Tram Driver continued forward over facing points SO3, and as he began to travel over MO5 points, Tram 3006 started to travel towards the Event Platform, see Figure 3.

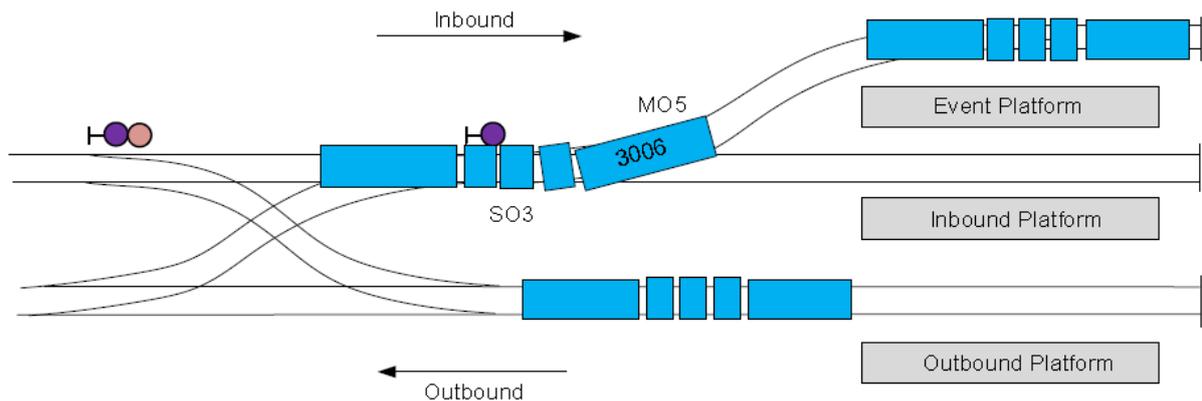


Figure 3 – Tram 3006 travelling towards the Event Platform

At this time, one of the trams remained in the Event Platform and the other tram left The Point Stop, in the outbound direction.

The Tram Driver stopped Tram 3006 having covered a distance of 64 metres (m), towards the Event Platform, and immediately reported the situation to CCR. The Controller confirmed Tram 3006 had travelled towards the Event Platform.

The Controller then advised the Tram Driver to travel no further and that he would have to change cab ends and travel in the reverse direction (travelling outbound) after checking the *spring points* (SO3 points). The Tram Driver confirmed part of the message regarding his changing cab ends but did not query the situation with the spring points.

The Controller also requested a more experienced driver, who was travelling in a following tram, to stop his tram short of The Point Stop, make contact with the Tram Driver of Tram 3006, and render what assistance he thought necessary.

As the more experienced driver boarded Tram 3006, the Tram Driver who had changed cab ends at this stage, drove Tram 3006 in the outbound direction. Tram 3006 travelled outbound 24 m when the first *wheelset* on *bogie* number 3 (no. 3) in the direction of travel, derailed, see Figure 4. The Tram Driver immediately stopped and informed CCR of the derailment.

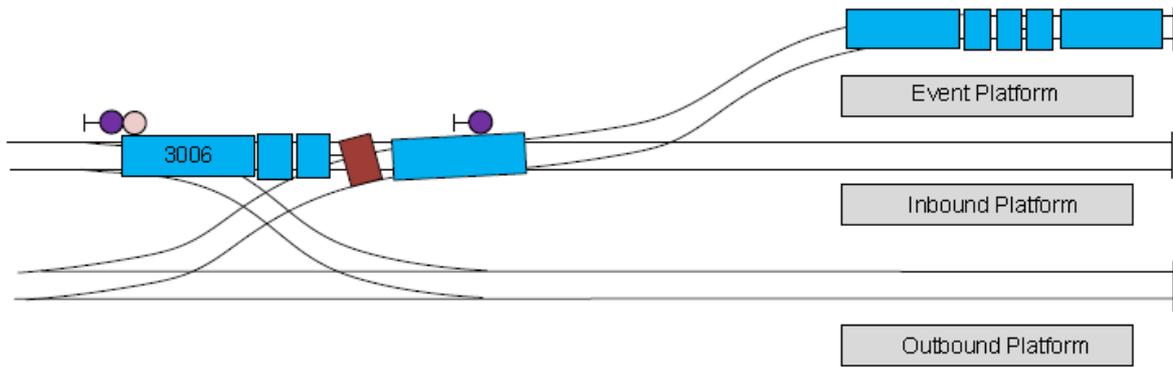


Figure 4 – Position of derailed Tram 3006

### 1.3 Track

#### 1.3.1 General description of the track

The track layout on approach to The Point Stop consists of embedded track. The layout includes a number of *scissor crossovers*, *facing points* and spring points, which are described below.

#### 1.3.2 General description of the scissor crossover

A scissor crossover leads towards the Inbound and Outbound Platforms, see Figure 2. The *facing points* (MO1 in the inbound direction and SO3 in the outbound direction) at the approach to the scissor crossover, see Figure 5. MO1 are motorised points actuated by the tram driver, who selects the required platform.

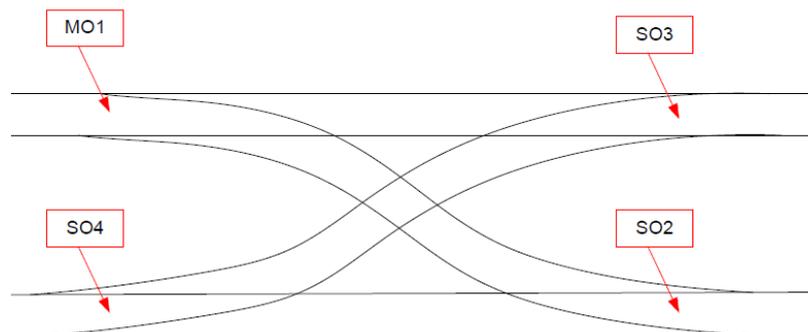


Figure 5 – Scissor Crossover

The points exiting the scissor crossover in the inbound direction are *spring points*, SO3 and SO2, which allow a tram to move through the crossover resetting to their original position once the tram has passed.

Points SO3 are spring points. Inbound trams push through the spring loaded points, see Figure 6. The spring points then 'spring back' and reset to the default outbound direction.

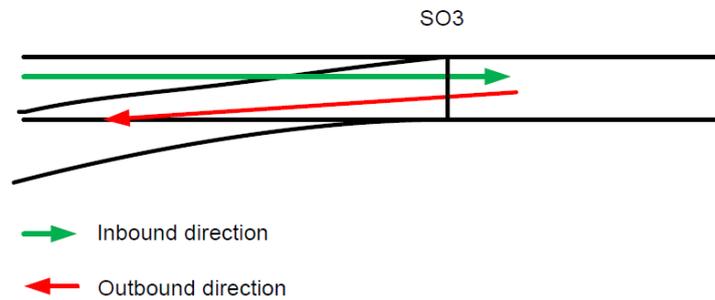


Figure 6 – SO3 spring points

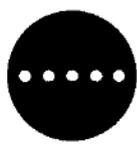
### 1.3.3 Facing Points MO5

The normal direction, where the majority of tram movements would travel, is towards the Inbound Platform. The Event Platform is usually only used when there is a function at the O2, adjacent to The Point Stop.

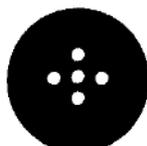
To facilitate access to the Event Platform, there is a set of *facing points*, MO5. These points are motorised and activated by the driver of the tram, from the driving cab, to allow for selection of the Event Platform, when required. The Event Platform can accommodate two trams fully clear of the spring points.

## 1.4 Signalling and communications

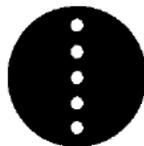
Tram movements on the Luas system are controlled by *line side signals* normally positioned to the left of the leading cab on the kerb. Antennae positioned under the tram driving cabs transmit signals to Automatic Vehicle Location System (AVLS) loops embedded in the road. The AVLS loops allow for the location of the trams to be detected and tram drivers to request a proceed or select a route at points as necessary. The AVLS operates by *electrical induction* with the antenna transmitting requests to the AVLS loops, see Figure 7 for the signal aspects displayed to tram drivers and Figure 8 for the points position indicators displayed to tram drivers.



Stop



Stop unless unsafe to do so



Proceed straight if safe to do so



Point set to the right

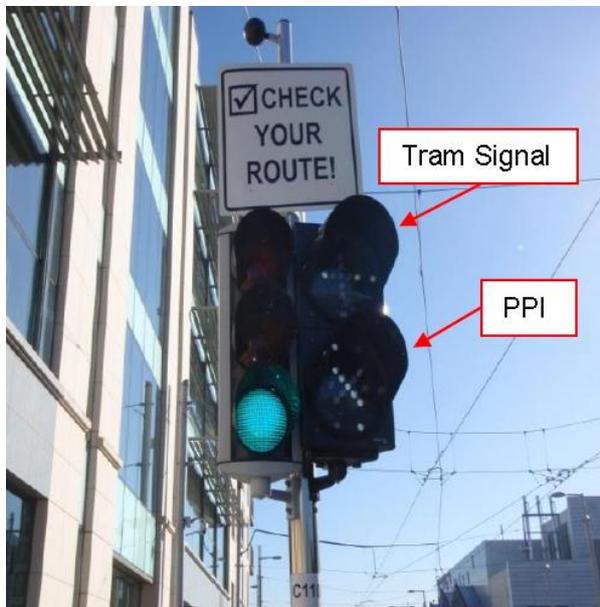


Point set to the left

Figure 7 – Tram Signal Aspects

Figure 8 – Points Position Indicators

On approach to the crossover (for points MO1) there is a tram signal with a PPI mounted below it beside a road traffic signal, see Photograph 1 and Figure 9. (The road traffic signals are not used by Luas trams and the check your route sign was added after the accident).



Photograph 1 – Tram signal & PPI at crossover



Photograph 2 – Tram signal at facing points

At 45 m beyond this tram signal and PPI, there is another PPI located at facing points MO5 for the Event Platform, see Photograph 2 and Figure 9. This provides information to tram drivers in relation to the direction that the points are set i.e. Inbound Platform or Event Platform. The tram driver can then change the direction of the points, as necessary.

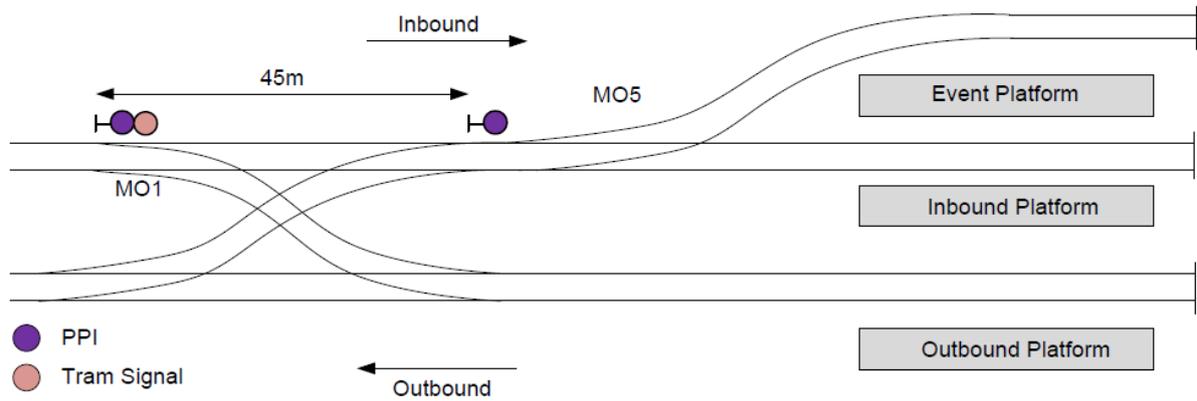


Figure 9 – Layout of tram signals and PPIs in relation to MO1 and MO5

### 1.5 Rolling stock

Tram 3006, is an Alstom Citadis 401, which entered service in 2004. It is 40.9 m long and has a mass of approximately 49,000 kilograms. It consists of five sections with bogies positioned under all but the middle section, which is suspended and the tram has articulated couplings between the sections. There is a driving cab at each end to allow driving in either direction.

The tram wheel profiles were checked after the accident and were found to be within the correct tolerance. The condition of the tram was not found to have contributed to the accident.

## 1.6 Operations and Communications

### 1.6.1 General operations description

The tram is worked by a tram driver, who observes both the road and tramway traffic in front controlling the speed of the tram to maintain a safe distance between them. This is known as *line of sight* driving. Independent tram signals are used to give indications to the tram driver to control movements.

### 1.6.2 General communications description

Communications between CCR and tram drivers is over a secure analogue radio system. This system allows both one-to-one communication with CCR and also facilitates the CCR to transmit messages to all drivers in a given area.

### 1.6.3 Communication protocols for drivers and CCR

Veolia's 'Tramway Safety Instruction Manual' (the manual), issued October 2007, instructs both drivers and CCR in the communication protocols for both normal and emergency communication.

Although the manual refers to both normal and emergency calls, there is no definition for either. In the case of 'normal calls' the Section 6.4 of the manual states, Use of Radio System, states the following (where CSO is a Customer Service Officer):

**"Normal call:**

- Ask the authorization to speak to CCR
- State **This is service XX** or **CSO XX to Control**
- Wait until CCR give you the **Go ahead** to communicate
- Give your staff number, service number (when relevant) and the nature of your call
- Ensure correct understanding by CCR
- Repeat message if necessary"

In the case of 'emergency calls' the manual states (where OCS is Overhead Contact System):

**"The message must include the following:**

- **State clearly that <This is an emergency call>**
- The tram number or service number when relevant
- The location of the emergency
- The nature of the emergency
- Whether an Emergency De-energisation of the OCS is required
- Whether any emergency services are required
- Whether any other lines are blocked"

The manual continues:

"The CCR must repeat all the details given by the user, to demonstrate that the call has been understood, and the caller must confirm his understanding".

In relation to points, Section 6.13 of the manual, Points and Crossings areas, states:

"Stopping or reversing on point is forbidden unless in an emergency and authorized by CCR, under no circumstances reverse over spring points."

## **1.7 Fatalities, injuries and material damage**

### **1.7.1 Fatalities and injuries**

There were no fatalities or injuries as a result of this accident.

### **1.7.2 Infrastructure damage**

There was no damage to the infrastructure as a result of this accident.

### **1.7.3 Rolling stock damage**

There was no damage to the tram as a result of this accident.

## **1.8 History of accidents and incidents**

There was a previous derailment of a tram at the Connolly Stop on the 16<sup>th</sup> July 2010, see details of this occurrence in RAIU report 2010-002.

## 2 Analysis

### 2.1 Tram movement

As the Tram Driver approached The Point Stop, trams were stabled at both the Outbound Platform and the Event Platform. From the RAIU investigation, it was found that this was the first time he had dealt with this scenario. The Tram Driver confirmed with CCR that the Inbound Platform (the default platform for trams travelling inbound) was his destination platform.

It cannot be established if the Tram Driver selected MO1 points to travel in the inbound direction, or if the points had been previously been set by the previous tram, however, the Tram Driver proceeded through MO1 points (which form part of the scissor crossover).

As mentioned previously, MO5 points at the junction of the Event and Inbound Platforms, are motorised. Therefore these points have to be selected by the tram driver to access the Inbound Platform or Event Platform. The tram driver should stop on the loop associated with MO5 points in order to set them correctly, therefore, allowing the tram to proceed to the selected platform.

In this case, the Tram Driver, did not select MO5 points for the Inbound Platform, where he had intended to travel, and therefore travelled for a distance of 64m towards the Event Platform, for which MO5 points had been set. The driver stopped Tram 3006 and informed CCR.

Tram 3006 had not finished travelling over MO5 points in the position he had stopped. As mentioned previously, inbound trams push through the spring loaded points, which then 'spring back' and reset to the default outbound direction. As Tram 3006 had not completely cleared SO1 points, when Tram 3006 began to travel in the outbound direction, the first three sections of Tram 3006 travelled back along the inbound track and the last two sections began to travel on the outbound track, leading to the bogie on the fourth section derailing as it was dragged by the first three sections towards the inbound track.

Tram 3006 should have been driven forward a short distance, clearing the spring points, before starting the reverse manoeuvre.

## 2.2 Communications

When the Tram Driver contacted CCR he was advised by the controller to change cab ends and reverse the tram, the Controller also asked the Tram Driver to check the adjacent spring points. The instructions from the CCR controller can be summarised as follows:

- Stop;
- Do not approach the Event Platform any further;
- Change cab ends in order to make a reverse manoeuvre;
- Check the spring points in the area before the manoeuvre.

These instructions were correct, however, the Tram Driver who was anxious to remedy the situation changed cab ends without checking Tram 3006's position in respect of the spring points and reversed Tram 3006.

Reviewing the transcript of the communications between the Tram Driver and the Controller, it is evident that the 'normal call' procedures were following correctly, however, had the 'emergency call' procedures been followed, the Tram Driver and Controller would have had a better understanding of the situation. A significant difference in the protocols is the repetition of the communication by both parties in order to ensure a full understanding to both the driver and CCR. The normal transmission only requires this repetition if necessary.

### 3 Conclusions

The Tram Driver of Tram 3006 was on his first unaccompanied evening shift and encountered a situation he had not experienced before, where both the Event and Outbound Platforms were occupied. He did not set the motorised MO5 points for the Inbound Platform, and therefore travelled towards the Event Platform, for which the points had been set to the Event Platform by the previous tram.

As Tram 3006 had not travelled far enough through the spring points, therefore when the outbound manoeuvre was made the tram derailed.

The Tram Driver did not adequately assess the situation. The Controller had warned the Tram Driver of the spring points, but although aware afterwards of the spring points and the chance of derailling, it did not occur to him at that moment in time and he carried out his reverse move.

Neither the Tram Driver nor the Controller were obligated to repeat the message in full to ensure a full understanding of the situation. Had either party realised that Tram 3006 had not cleared the spring points, Tram 3006 would have been driven forward a short distance, clearing the spring points, before starting the reverse manoeuvre.

The *immediate cause* of this accident was:

- Tram 3006 had not travelled clear of the spring points before carrying out a reverse manoeuvre.

*Contributory factors* were:

- The Controller was not fully aware of the exact position of the tram;
- Communications between the Tram Driver and Controller were not clearly understood;
- The Tram Driver momentarily forgot that Tram 3006 would derail over the spring points due to its current position.

An *underlying factor* was:

- There is no mandatory procedure other than in an emergency call for a Controller and a Tram Driver to clarify and check any misunderstandings in radio transmissions.

#### **4 Relevant actions already taken or in progress**

Veolia issued a traffic supervisor briefing document, 'Traffic Supervisor Briefing, Briefing No. TS 58' on the 23<sup>rd</sup> September 2010, which draws attention to the danger of derailment and the exact location of the points on the system. Photographs are also included to allow the controller to check on points locations.

The following has also been inserted into the CCR manual: "All movements across points should be completed. The Traffic Supervisor may in circumstances where there are restrictions authorize the change of direction over a point if he understands the point configuration and fully understands that there is no risk of derailment. NO change of direction may be authorised over a sprung point."

Veolia Safety Department are in the process of having all spring points clearly marked with a Red painted identification and a clearly marked area which must be passed should a reverse move over the points be necessary.

## 5 Recommendations

While the incorrect movement towards the Event Platform, was not deemed an emergency, it did require that both the Tram Driver and Controller take the necessary time to fully appreciate the situation to ensure that there was no ambiguity in relation to the position of Tram 3006 and the spring points. Therefore the RAIU make the following safety recommendation:

**Veolia should look to introduce a communication protocol between normal and emergency for given situations where a clear understanding between a tram driver and CCR are required.**

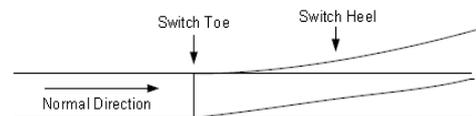
## 6 Additional information

### 6.1 Abbreviations

CCR	Central Control Room
CSO	Customer Service Officer
DCS	Depot Control System
m	Metre
PPI	Points Position Indicator
OCS	Overhead Contact System
RAIU	Railway Accident Investigation Unit
RPA	Railway Procurement Agency

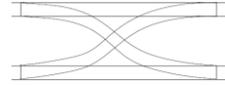
### 6.2 Glossary of terms

Bogie	A metal frame equipped with two or three wheelsets able to rotate freely in plan.
Driving Cab	A term for the driving cab, which is the driver's compartment in a tram.
CCR	Control Room at Red Cow Depot from which tram operations are managed and monitored.
Depot Control System	A system that records operational data on the LUAS, for example, the position of points.
Electrical Induction	Production of voltage across a conductor moving through a magnetic field
Facing points	A set of points installed so that traffic travels from switch toe to switch heel in the normal direction of traffic.
Inbound	Trams travelling towards the city.
Infrastructure Manager	Organisation responsible for the maintenance of the infrastructure.
Line-of-sight	A method of working trams where the driver observes the tram in front and controls the speed of their tram appropriately to maintain a safe distance between them, this also allows for the control of speed for road vehicles.
Line Side Signals	Signals that give instructions or warnings to tram drivers.
Normal	For a set of points, this is the default position, decided generally as the position which permits the passage of trams on the most used route.
Outbound	Trams travelling away from city.
Platform/ Stop	Designated place for passengers to board and alight the tram.
PPI	Indication to driver for the position of points.
Reverse	For a set of points this is the position, allowing the passage of trams on the least used route.
Railway	A company whose business is the operation of a railway.



Undertaking

Scissor crossover Two intersecting opposite crossovers allowing movements in any direction between two parallel tracks.



Spring Points Points which are held closed by a spring mechanism, except when they are trailing points and the flanges of the tram open them.

Tram Signal Signals to be obeyed by tram drivers.

Wheelset Two wheels joined by the same axle.

### 6.3 References

Veolia Transport Ireland, (October 2007), Tramway Safety Instruction Manual, Issue 2