



**Railway Accident
Investigation Unit
Ireland**



INVESTIGATION REPORT

**Dangerous occurrence involving a Double SPAD at
Clontarf Road Station,**

7th December 2021

RAIU Investigation Report No: 2023-R001

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Report Description

Report publication

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Report structure

The report structure is taken from guidelines set out in “Commission Implementation Regulation (EU) 2020/572 of 24 April 2020 on the reporting structure to be followed for railway accident and incident investigation reports” having regard to “Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety”.

Reader guide

All dimensions and speeds in this report are given using the International System of Units (SI Units). Where the normal railway practice, in some railway organisations, is to use imperial dimensions; imperial dimensions are used, and the SI Unit is also given.

All abbreviations and technical terms (which appear in italics the first time they appear in the report) are explained in the glossary.

Descriptions and figures may be simplified to illustrate concepts to non-technical readers.

Preface

The RAIU is an independent investigation unit within the Department of Transport which conducts investigations into accidents and incidents on the national railway network including the Dublin Area Rapid Transit (DART) network, the LUAS light rail system, heritage and industrial railways in Ireland. Investigations are carried out in accordance with the Railway Safety Directive (EU) 2016/798 enshrined in the European Union (Railway Safety) (Reporting and Investigation of Serious Accidents, Accidents and Incidents) Regulations 2020; and, where relevant, by the application of the Railway Safety (Reporting and Investigation of Serious Accidents, Accidents and Incidents Involving Certain Railways) Act 2020.

The RAIU investigate all serious accidents. A serious accident means any train collision or derailment of trains, resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other similar accident with an obvious impact on railway or tramline safety regulation or the management of safety. During an investigation, if the RAIU make some early findings on safety issues that require immediate action, the RAIU will issue an Urgent Safety Advice Notice outlining the associated safety recommendation(s); other issues may require a Safety Advice Notice.

The RAIU may investigate and report on accidents and incidents which under slightly different conditions might have led to a serious accident.

The RAIU may also carry out trend investigations where the occurrence is part of a group of related occurrences that may or may not have warranted an investigation as individual occurrences, but the apparent trend warrants investigation.

The purpose of RAIU investigations is to make safety recommendations, based on the findings of investigations, in order to prevent accidents and incidents in the future and improve railway safety. It is not the purpose of an RAIU investigation to attribute blame or liability.

Summary

At approximately 15:59 hrs on 7th December 2021 the 15:31 hrs Iarnród Éireann (IÉ) DART passenger service from Malahide to Bray (Train E120) was stopped at Clontarf Road Station Up Platform. The signal to the rear, Signal DN295 was displaying a Red Aspect to protect Train E120.

Around the same time, the 15:40 hrs DART passenger service from Howth to Bray (Train E240) was approaching Signal DN287 at Clontarf Road Station.

The train's speedometer and *On Train Data Recorder* (OTDR) showed the train was travelling at 79 kilometres per hour (km/h); the permitted line speed for the section is 75 km/h and reduces to 30 km/h on approach to Clontarf Road Up Platform. The OTDR shows the train braking system initiated an *Automatic Train Protection* (ATP) *penalty brake* as the train was travelling at a speed (79 k/h) greater than the target speed (30 km/h). The ATP brake application, in trying to reduce the train speed, resulted in the train's *Wheel Slip Protection* (WSP) system activating to prevent the wheels from locking up and sliding on the degraded railhead caused by Storm Barra.

At 16:01 hrs Train E120 departed Clontarf Road Station with a planned stop at the Crew Ramp at Fairview Depot for a change of driver (the driver of E120 who brought the train to the Crew Ramp will be known as Driver E120a for the remainder of this report and the replacement driver will be known as Driver E120b). When Train E120 departed Clontarf Road Station the aspect of Signal DN295 situated at the south end of Clontarf Road Station Up Platform changed from green to red to protect Train E120 as it stopped at the Crew Ramp, Fairview.

At 16:03 hrs Train E240 passed Signal DN287 situated at the north end of Clontarf Road Station at danger without authority (known as a Signal Passed at Danger (SPAD)) and continue travelling through Clontarf Road Station.

The driver of Train E240, who will be referred to as Driver E240 for remainder of report, could see Train E120 ahead and phoned the Central Signalman at Centralised Traffic Control (CTC) to advise that he felt the train was sliding and was going to run into Train E120.

The Central Signalman contacted Driver E120b to enquire if the train was moving and on receipt of conformation requested Driver E120b to continue moving; had Train E120 not commenced moving, Train E240 would likely have collided with the rear of Train E120.

Train E240 passed Signal DN295 at danger without authority and came to a stop before the Crew Ramp at Fairview. Driver E240 contacted the Central Signalman to advise that his train had come to a stop.

The RAIU found that Train E240 passed Signal DN287 at danger and subsequently passed another signal, Signal DN295, at danger at Clontarf Road (Double SPAD) as a result of the following *causal, contributing* and *systemic factors*.

The following causal factors to the incident:

- CaF-01 – Driver E240 had an over-reliance on the ATP system to control the speed of the train;
- CaF-02 – LRA was present as a result of Storm Barra;
- CaF-03 – There was a sharp speed downgrade, from 75 km/h to 30 km/h, on the approach to Signal DN285R;
- CaF-04 – Driver E240 did not apply correct driving techniques, as set out in the IÉ Professional Handbook, by adequately reacting to downgrades in speed (75 km/h to 30 km/h on the approach to Signal DN285R) and the LRA conditions present on the day;
- CaF-05 – The sanding stopped during the incident which reduced the effectiveness of the train's ability to stop.

Contributing factors include:

- CoF-01 – A previous OTDR assessment of the driver did not identify Driver E240's over-reliance of the ATP system to control the speed of the train;
- CoF-02 – A previous internal investigation report into a SPAD in 2016 (which identified that there was an over-reliance by that driver on the ATP system), made two recommendations, in 2017, related the ATP systems (for drivers and District Traction Executives (DTEs)); which may have potentially avoided the incident on the 7th December 2021, remained open.

Systemic factors were identified as:

- SF-01 – The competency management system for drivers did not identify that drivers may be over-reliant on the ATP resulting in no requirement for DTEs to check for ATP penalty brake applications;
- SF-02 – The risks associated with “*driving into the bonds*” was not fully appreciated, as no urgency was applied to closing internal IÉ-IM safety recommendations made in 2017, in relation to a SPAD in 2016, and remained open at the time of the incident, which identified that there was an over-reliance, by drivers, on the ATP system.

As a result of the incident, the RAIU made six safety recommendations:

- Safety Recommendation 2023001-01 – The Head of Health & Safety Iarnród Éireann Railway Undertaking (IÉ-RU) should arrange for the development and issue of a guidance document for drivers outlining the understanding of the ATP equipment and the driving technique required. New training, monitoring and assessment material should be developed from this guidance.
- Safety Recommendation 2023001-02 – The Head of Health & Safety IÉ-RU should arrange for the development of a briefing for DTEs on analysis of driving trends by use of the OTDR.
- Safety Recommendation 2023001-03 – IÉ-RU Chief Mechanical Engineer Department (CME) should upgrade the OTDRs on the 8500 Electrical Multiple Unit (EMU) fleet to the most up-to-date version, to ensure that digital signals are recorded for ATP penalty brake applications.
- Safety Recommendation 2023001-04 – IÉ-RU CME should consider retrofitting all EMU fleets with a Remote Diagnostic System, whereby a rule can be introduced so that DTEs are immediately notified of ATP penalty brake applications.
- Safety Recommendation 2023001-05 – Iarnród Éireann Infrastructure Manager (IÉ-IM) Chief Civil Engineer (CCE) should consider, based on a risk-based approach, the introduction of *Traction Gel Applicators* (TGAs) at more locations.
- Safety Recommendation 2023001-06 – IÉ-IM Signalling, Electrical and Telecommunications (SET) should undertake a review of I-SIG-2145, Calculation of Signal Spacing Distance, to consider if the risk approaches identified in the standard are effective in relation to the calculation of the spacing of signal distances, in particular, in relation to sharp speed decreases on the approach to signals and consideration should be given to incorrect driving techniques (i.e. driving into the bonds). A review of the use of derogations should also be undertaken.

In addition, the RAIU made six safety recommendations as a result of additional observations, as follows:

- Safety Recommendation 2023001-07 – IÉ-IM SET should put systems in place to ensure that the train simulator staff are provided with updated signal layout schematics as and when required e.g. altered signal positions.
- Safety Recommendation 2023001-08 – IÉ-RU CME should update its commissioning documents, to ensure that maintenance tasks commence after installation.
- Safety Recommendation 2023001-09 – IÉ-RU CME should review the 8500 EMU sanding improvement plan (2016) against current standards with a view to updating and implementing the sanding improvements to current standards.
- Safety Recommendation 2023001-10 – IÉ-RU Ops should update the OTDR Download Assessment Form for DART drivers with only tasks pertinent to DART drivers; allowing DTEs to carry out comprehensive assessments of the DART drivers' driving techniques.
- Safety Recommendation 2023001-11 – IÉ-RU Ops should update its competency assessment processes to ensure that the assessments carried out, are the most beneficial, in terms of identifying driver discrepancies.
- Safety Recommendation 2023001-12 – IÉ-RU Ops should brief all drivers on the importance of making an open call in an emergency situation rather than calling the Signalmen direct.

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RAIU Investigation

RAIU decision to investigate

- 1 In accordance with the Railway Safety Act 2005 and European Union (Railway Safety) (Reporting and investigation of Serious Accidents, Accidents and Incidents) Regulations 2020, the RAIU investigate all *serious accidents*; the RAIU may also investigate and report on *accidents* and *incidents* which under slightly different conditions might have led to a serious accident.
- 2 The RAIU on-call investigator received a notification that two consecutive signals had been passed at danger on the approach to Clontarf Road on the 7th December 2021. The RAIU conducted a Preliminary Examination and the RAIU's Chief Investigator (CI) made the decision to conduct a full investigation into the incident, given its impact on railway safety (*Article 20 (2) (c)*), as under slightly different circumstances the failure may have led to serious accident with the potential for fatality or serious injuries due to one passenger train almost colliding with another.
- 3 In terms of categorisation, the EU Agency for Railways categorisation for this occurrence is an: Incident – Train Operations & Management.
- 4 The RAIU's CI allocated RAIU Senior Investigators, trained in accident investigation, to conduct this investigation, as appropriate. In this instance, no external parties were required to assist with the investigation.

Scope & limits of investigation

- 5 The RAIU have established the scope and limits of the investigation as follows:
 - Establish the sequence of events leading up to the incident;
 - Identify any other precursors which led to the incident;
 - Establish, where applicable, causal, contributing and systemic factors;
 - Examine the performance of the train involved in the incident;
 - Examine the effect of the relocation of signals at Clontarf Road as a result of the Dublin City Centre Resignalling (DCCR) Project;
 - Examine the relevant operation, standards and manuals and review against the actions taken by the driver on the day of the incident.

Communications & evidence collection

- 6 During the investigation, the RAIU collate evidence through the submission of Requests for Information (RFIs) and interviewing. Related to this investigation, the RAIU collated and logged the following evidence:
 - Closed Circuit Television (CCTV) of the incident from Clontarf Road Station;
 - Voice communications between the drivers and the Central Signalman;
 - Witness statements from parties involved in the investigation into the incident;
 - Formal interviews of the parties involved;
 - Maintenance specifications for the train from IÉ-RU and the Original Equipment Manufacturer (OEM);
 - Maintenance interventions to EMU set 8627, 8527, 8528, 8628;
 - Post incident inspection of EMU set 8627, 8527, 8528, 8628;
 - OTDR of incident train and train in advance of incident train.
- 7 All relevant parties co-operated fully with the RAIU investigation; with no difficulties arising.

Other stakeholder inputs

- 8 No judicial authorities or emergency service were involved in this incident.

Other information relevant to the investigation process

- 9 The late publication of the internal IÉ-IM investigation report, “Report of Investigation: Train E240 passed signals DN287 and DN295 at Danger without authority, 7th of December 2021” on the 26th January 2023 delayed the publication of the RAIU report.

Summary of the failure & background information

Synopsis of the incident

- 10 At approximately 15:59 hrs on 7th December 2021, Train E120, the 15:31 hrs DART passenger service from Malahide to Bray was stopped at Clontarf Road Station Up Platform. The signal to the rear of Clontarf Road Up Platform, Signal DN287, was displaying a red aspect to protect the train.
- 11 Train E240, the 15:40 hrs DART passenger service from Howth to Bray, was approaching Signal DN287 on the northern side of the Up Platform at Clontarf Road Station. Train E240's speedometer and OTDR showed that Train E240 was travelling at 79 km/h; the permitted line speed for the section is 75 km/h and reduces to 30 km/h on approach to Signal DN285R. The train braking system initiated an ATP penalty brake as the train was travelling at a speed greater (79 km/h¹) than the target speed (30 km/h). The ATP penalty brake application, in trying to reduce the speed, resulted in the train's WSP system activating to prevent the wheels from locking up and sliding on the degraded railhead caused by Storm Barra.
- 12 At 16:01 hrs Train E120 departed Clontarf Road Station with a planned stop at the Crew Ramp at Fairview Depot for a change of driver. As the Crewe Ramp is in the overlap for Signal DN295 both Signals DN295 and DN287 were displaying red aspects to protect Train E120.
- 13 At 16:03 hrs Train E240 passed Signal DN287 at danger without authority and continued through Clontarf Road Station.
- 14 Driver E240 could see Train E120 ahead and phoned the Central Signalman to advise that he felt the train was sliding and was going to run into the rear of Train E120.
- 15 The Central Signalman immediately contacted Driver E120b to enquire if the train was moving and on receipt of conformation requested Driver E120b to continue moving.
- 16 Train E240 passed Signal DN295 at danger without authority and came to a stop before the Crew Ramp at Fairview.
- 17 Driver E240 contacted the Central Signalman to advise that Train E240 had come to a stop just before the Crew Ramp at Fairview Depot.

¹ Although the speed limit is 75 km/h, there is a 3 km/h allowance in terms of when the ATP will activate i.e. the train is permitted to travel at 78 km/h, but the ATP activates at 79 km/h, which is what occurred on the day of the incident.

- 18 The SPADs at Clontarf Road were a *Category A SPADs*. IÉ-IM, in calculating the *SPAD Risk Ranking* (SRR), calculate the SRR for the first SPAD i.e. Signal DN287, as the SPAD at Signal DN295 was a consequence of the first SPAD. The SRR was calculated at 17, considering it to be a *Medium Risk SPAD*.

External circumstances at the incident location

Weather

19 The weather report from Dublin Airport, 8 km to the north of Clontarf Road, for 7th December 2021 recorded 10.8 millimetres (mm) of rainfall and a temperature range between 8.6 °C and 1.8 °C and a mean wind speed of 16.7 knots.

20 Storm Barra was travelling across the country with the worst hit counties to the south and west of Ireland, see Figure 1. There was a “Status Orange – Wind” warning for Dublin (meaning the weather conditions have the capacity to impact significantly on people in the affected areas. The issue of an Orange level weather warning implies that all recipients in the affected areas should prepare themselves in an appropriate way for the anticipated conditions).

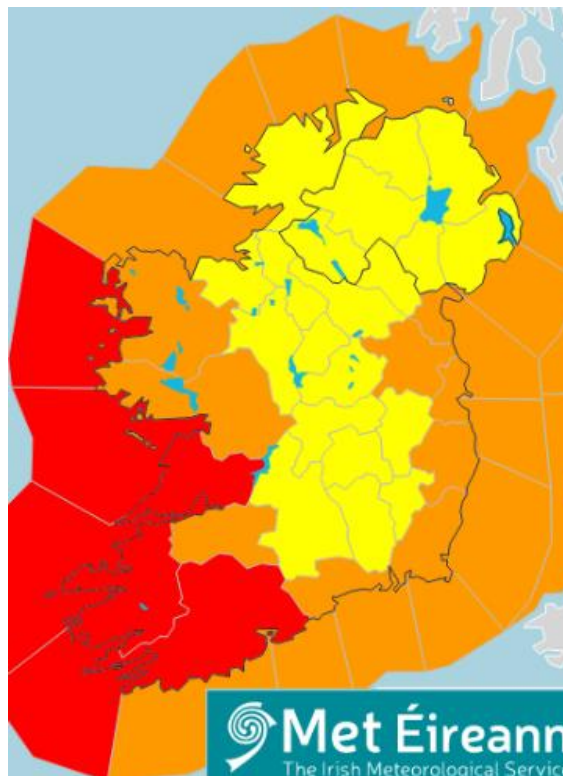


Figure 1 – Storm Barra weather warning

21 The CTC Duty Manager issued a moderate *Low Rail Adhesion* (LRA) Risk Forecast to drivers at 14:08 hrs on 7th December 2021 as per the IÉ Weather Management Protocol CTC, issued in 2013².

22 Seven drivers reported LRA hotspots for Killester Northbound and there was also a platform overrun at Clontarf Road Southbound.

23 In the Dublin area at approximately 16:00 hrs on 7th December 2021 there was a sudden and dramatic drop in temperature and air pressure. Light drizzle commenced resulting in a platform overrun at Howth Junction and multiple drivers reporting hazardous driving conditions in the north Dublin area.

24 The weather conditions were likely causal factor to the incident (CaF-02, see paragraph 188).

² It should be noted that the Weather Management Protocol CTC was operated in line with prescribed requirements on the day of the incident.

Fatalities, injuries & material damage

Fatalities & injuries

25 There were no fatalities or injuries to staff or members of the public as a result of the incident.

Material damage

26 There was no material damage.

Other consequences as a result of the incident

27 There was a total of thirty-four primary and 939 secondary delayed minutes as a result of the incident.

Parties & roles associated with the incident

Parties involved in the incident

28 IÉ-RU is the railway undertaking who owns and operates mainline and suburban railway services in Ireland and operates under a safety certificate issued by the Commission for Railway Regulation (CRR). The RU Safety Certificate is issued in conformity with European Directive 2004/49/EC and S.I. 249 of 2015; the Safety Certificate was renewed on 23rd March 2018 for a period of five years (valid at the time of incident). The IÉ-RU departments involved in this incident and relevant to this investigation are:

- IÉ-RU Operations (Ops) – Responsible for the operation of trains on the network; this includes the supervision and competency assessment of train drivers.
- IÉ-RU CME – The European Union (EU) Entity in Charge of Maintenance (ECM), responsible for the specification, purchasing, commissioning and maintenance of rolling stock, including management of the maintenance depots, associated personnel, and procedures. Support on technical matters is provided through the CME's Fleet Technical Support (FTS) staff.

29 IÉ-IM is the infrastructure manager (IM) who owns and operates the railway infrastructure in Ireland and operates under a Safety Authorisation certificate issued by the CRR. The IM Safety Authorisation is issued in conformity with Commission Regulation (EU) 1169/2010; the authorisation was renewed on the 24th March 2018 for a period of four years (valid at the time of incident). The IÉ-IM department involved in the incident and relevant to this investigation is:

- IÉ-IM CCE Department - Directs the technical, business and safety sections. The CCE Department carries out the inspections and maintenance of track and structures and is divided into three different geographical areas, with offices based at Dublin, Athlone and Limerick Junction. The CCE Department are responsible for the management of LRA, *Sandite*, and TGA.
- IÉ-IM SET Department – Responsible for the design, inspection, maintenance, and renewal of the railway's SET systems and the management of risks associated with these assets.

Parties not directly involved in the incident

- 30 The CRR is the national safety authority, which is responsible for the regulatory oversight of the Safety Management System (SMS) and enforcement of railway safety in the Republic of Ireland in accordance with the Railway Safety Act 2005 and the European Railway Safety Directive.
- 31 The CRR had insight into the DCCR Project and the repositioning of Signal DN287 at Clontarf Road.
- 32 The CRR carried out a post occurrence inspection into the incident, discussed in paragraphs 196 - 199.

Roles involved directly and indirectly in the incident

- 33 The roles involved at the time of the incident, from IÉ-RU, are as follows:
- Driver E240 – Driver E240 has been in the driving grade since July 2005 and holds a train driver's licence valid until October 2028. The driving history for Driver E240 will be further discussed in paragraphs 123 - 126);
 - Driver E120b – Driver E120b took over Train E120 at the Crew Ramp Fairview, this driver was driving ahead of Train E240 at the time of the incident. Driver E120b has been in the driving grade since November 2019, holding a train driver's licence valid until October 2029.
- 34 The roles indirectly involved at the time of the incident, from IÉ-RU, are as follows:
- Driver E120a – Driver E120a drove Train E120 from Clontarf Road Station to the Crew Ramp Fairview. Driver E120a was not driving any trains at the time of the incident. Driver E120a has been in the driving grade since September 2018 and holds a train driver's licence valid until September 2028;
 - Central Signaller – Based at Centralised Traffic Control, related to this incident, was responsible for setting of signals on the DART route.

Infrastructure

35 Clontarf Road Station is situated north of Connolly Station on the Dublin to Belfast line at the 1 ¼ Mile Post (MP) Figure 2, with two platforms, Platform 1 (northbound) and Platform 2 (southbound).

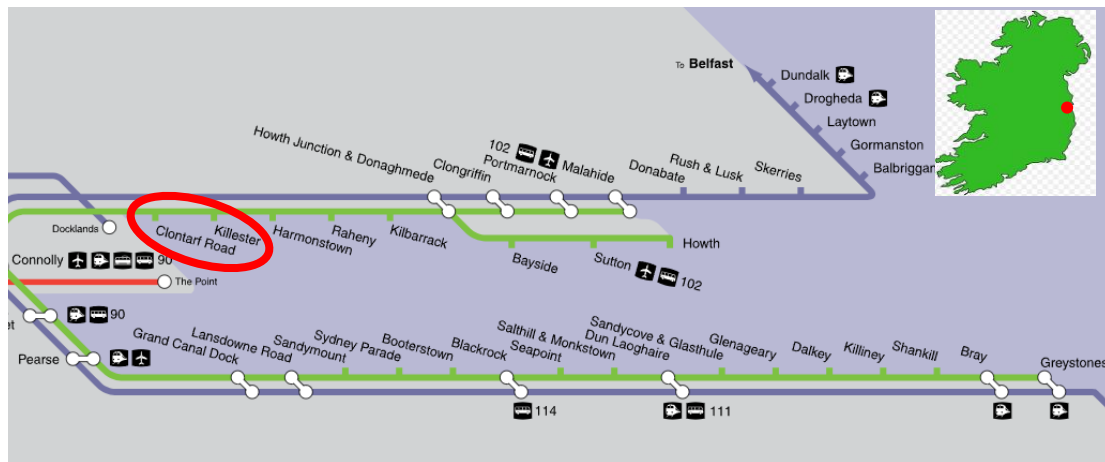


Figure 2 – Location of Clontarf Road Station

- 36 The route between Dublin (Connolly Station) 0 MP and Belfast (Central Station) 113½ MP is a double line throughout.
- 37 Overhead Line Equipment (OHLE) equipment is installed along the DART line to supply traction power at 1,500 Volts Direct Current to electric trains.

Rolling Stock

General description of Train E240

38 Train E240, the train involved in the incident, is an 8520 EMU.

39 The 8520 EMU fleet are four-car sets with the four bogies of the two middle cars providing traction and the cab cars leading and trailing comprising of four non-powered bogies, see Figure 3. The motor cars have pantographs for collection of the 1,500 V DC from the OHLE.

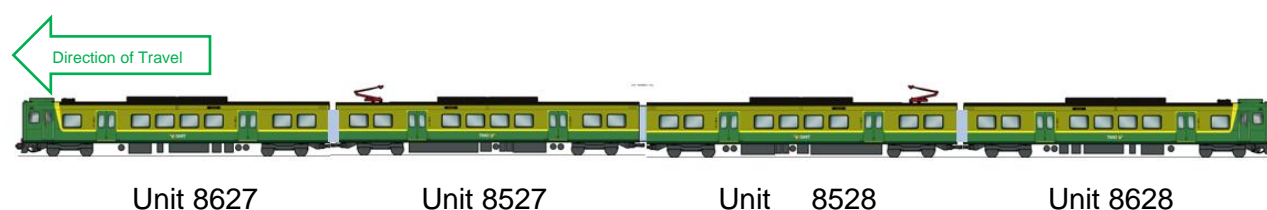


Figure 3 – Configuration of Train E240

40 A four-car 8520 EMU set is 81.71 metres (m) in length and has a tare weight of 148,070 kilogrammes (kg) and a crush laden weight of 212,484 kg.

41 The maximum permitted speed for an 8520 EMU is 100 km/h.

42 The 8520 EMU fleet is fitted with sanding equipment to improve grip when low adhesion is experienced, and the trains are also fitted with a WSP system that prevents the wheels from locking up when low adhesion is detected (these systems will be discussed later in paragraphs 92 - 103).

43 The 8520 EMU fleet are fitted with a Hasler Teloc 2530 OTDR, (two OTDR per four car set). The OTDR records many critical signals from the train including Unit number, date / time, wheel diameter, speed, power application, brake application, and ATP target speed. The Teloc 2530 records approximately seventy signals. The data can be downloaded onto a memory stick and analysed on a computer using the proprietary software.

44 When the 8520 EMU fleet were manufactured and put into service in Ireland, there was no Forward-Facing Close Circuit Television (FFCCTV) cameras fitted to the fleet. IÉ-RU CME decided to retro fit FFCCTV to both cabs of the EMU 8520 fleet and the project was completed in March 2022. EMU 8627 had the FFCCTV fitted in May 2021 and had been operational.

45 IÉ-RU retrofitted its 22000 InterCity Railcar, 29000 Diesel Multiple Unit and 201 Locomotive fleets with a Remote Diagnostic System, supplied by Nexala. Nexala is an automated communications process by which train system data are collected from the train and transmitted to receiving equipment for monitoring and analysing. The system enables IÉ staff (such as DTEs) to monitor and analyse train system data in real time remotely by computer or smart phone. The system allows alarm thresholds to be set and automatic notifications to be sent to designated staff when the thresholds have been exceeded e.g. the system has been used to monitor compliance to speed restrictions in terms of over-speeding. No Remote Diagnostic System (Nexala or other) is currently fitted to the EMU fleets.

General description of Train E120

- 46 Train E120, the train directly ahead of E240, is an 8500 EMU, similar in appearance to the 8520 EMU with a number of exceptions including not having roof mounted air conditioning equipment.
- 47 The 8500 EMU fleet are fitted with a Hasler Teloc 2200 OTDR. Although many functions are similar to the Hasler Teloc 2530 the Teloc 2200 records approximately thirty signals and does not record a digital signal that shows the ATP penalty brake, and its graphic display is not as clear as the later version Teloc 2530.

Signalling and communications

- 48 The route through Clontarf Road Station is comprised of a double line with four aspect colour light signalling in place. The signalling system is designed to enable trains to be signalled bi-directionally when necessary. The section is operated under track circuit block regulations, with train detection achieved by axle counters.
- 49 The route is also fitted with the Continuous Automatic Warning System (CAWS) and ATP. Train radio communication is provided throughout between drivers and the Central Signalmen, based at CTC in Connolly Station, Dublin.
- 50 Signals DN287 was relocated as part of the DCCR Project and Signal DN295 was converted from a four to a three-aspect signal (further discussed in paragraph 64).
- 51 In relation to the location of the incident, TGAs are fitted in the area between Killester and Clontarf Road Station on the Down line but not on the Up line.

Operations

- 52 Trains travelling to Dublin Connolly are travelling in the Up direction, and trains travelling from Dublin Connolly are travelling in the Down direction.
- 53 CAWS and train radio coverage with the Central Signaller is provided between Connolly and north of Dundalk 59½ MP (Border). The route is fitted with two, three and four aspect colour light signals. Trains are signalled under Track Circuit Block Regulations.
- 54 The DART network operates from Malahide to Greystones with a branch line from Howth to Howth Junction.
- 55 The DART lines and trains are fitted with ATP (further discussed in paragraphs 68 to 75).
- 56 The service was Driver Only Operated and is controlled by IÉ-RU.
- 57 The maximum permitted line speed within Clontarf Road Station is 60 miles per hour (mph) (100 km/h) for DART services as set out in working timetable effective from 26th September 2012.

Evidence

Infrastructure: Signalling

58 This part of the report outlines the main infrastructure associated with a SPAD, namely the signalling and train protection systems. In relation to signalling, the section provides an overview of the types of signals and their observance requirements; as well as providing information on the sighting required for signals. In relation to train protection, this part of the report outlines the ATP system available on the DART network.

59 The DART network is made up of a number of different types of colour light signals which the drivers must observe in order to travel through the network (see Figure 4). In terms of observance of signals, the aspects have the following meaning:

- Red light – Danger aspect, meaning the driver should bring the train to a stop;
- One yellow light – Cautionary proceed aspect, meaning the driver should be prepared to bring the train to a stop at the next signal;
- Two yellow lights – Preliminary cautionary proceed aspect, meaning that the driver should be prepared to find the next signal at caution (one yellow light);
- Green light – Clear proceed aspect, meaning the driver can proceed, as the next signal will be displaying a proceed aspect (green or yellow).





DESCRIPTION	DIAGRAM	MEANING
Danger Aspect		Stop
Proceed Aspects Caution		Be prepared to stop at the next signal
Preliminary Caution		Be prepared to find the next signal at Caution
Clear		Next signal displaying a proceed aspect

Figure 4 – Main aspects

60 Banner Repeater Signals (Figure 5) are signals provided on the approach to a main signal (Figure 4) to provide an advance warning of the aspect being displayed by the main signal. Usually provided where the reading time of the main signals is substandard.



POSITION	DIAGRAM	INDICATION	MEANING
ON		Horizontal Arm	Be prepared to find the signal to which it applies at Danger
OFF		Arm at angle of 45 degrees	Signal to which it applies is exhibiting a proceed aspect

Figure 5 – Banner Signals

- 61 The signals passed at Stop were, Signal DN287 (Figure 6) located north of Clontarf Road Station and Signal DN295 (Figure 7) located at the southern end of Clontarf Road Station.



Figure 6 – Signal DN287



Figure 7 – Signal DN295

- 62 Figure 8 shows the signal diagram, note the direction of travel of Train E240.

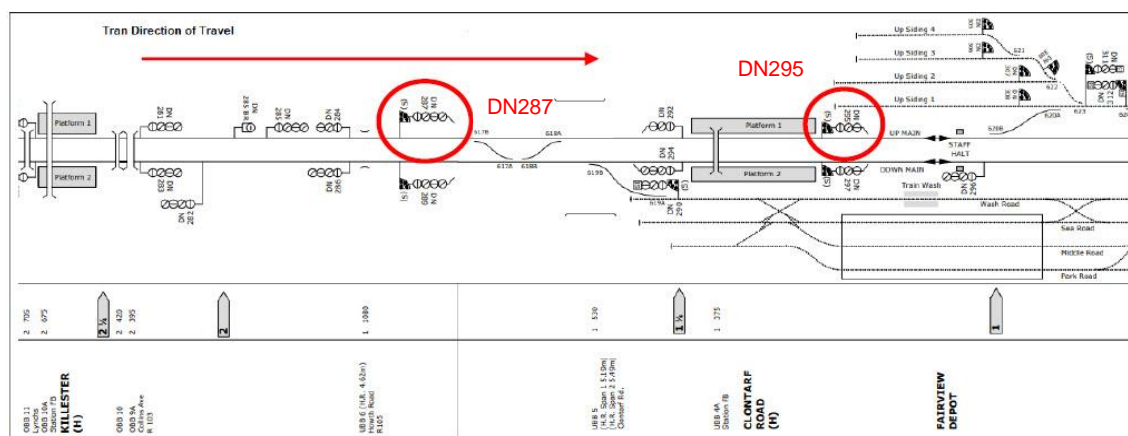


Figure 8 – Signal diagram

63 The signals passed at Stop (Signals DN287 and DN295) and the preceding signals located on the Up road between Killester and the Crew Ramp at Fairview are as follows (see Figure 9 for locations, note that the figure is for illustrative purposes only):

- Signal DN281 is the first signal after leaving Killester;
- Signal DN285R is the repeater³ for Signal DN285 and is located 488 m after Signal DN281;
- Signal DN285 is 238 m after Signal DN285R;
- Signal DN287⁴ is 420 m after Signal DN285 at the north end of Clontarf Road Station;
- Signal DN295⁵ is 629 m after Signal DN287 at the south end of Clontarf Road Station.

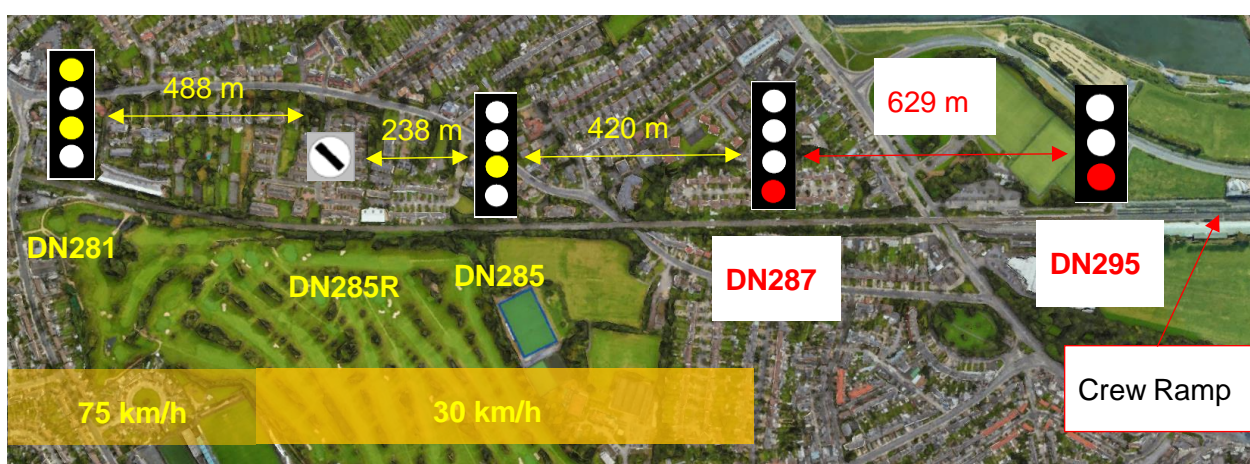


Figure 9 – Signal and speed locations

³ The repeater (Signal DN285R) is necessary to achieve the minimum viewing distance required for Signal DN285

⁴ The section between Killester and Clontarf Road was subject to change as part of the DCCR Project (Phase 2) that was commissioned in October 2020 and went into full service in December 2020. As part of the DCCR Project Signal CY13 was moved 82 m closer to Killester and renamed Signal DN287 and a new signal DN285 was added in between DN287 (previously CY13) and DN281. A Banner Repeater DN285R, was added ahead of DN285.

⁵ As part of the DCCR project, Signal DN295 was converted from a four-aspect to a three-aspect signal (to prevent ATP / CAWS from allowing trains to travel at speeds higher than the Permanent Speed Restriction (PSR) in place through the city centre when driving under a Double Yellow aspect). The PSR was in place to mitigate the risk of a SPAD due to the signal spacing being below the requirement of I-SIG 2145, Calculation of Signal Spacing Distance, Issue 1, 2006.

- 64 The DCCR layout change resulted in a reduction of 0.596 km in the position of the first cautionary aspect (Signal DN281) protecting a train stopped at Fairview Ramp and trains would now be permitted to travel at 75 km/h on a Double Yellow leaving Killester, compared to the previous 50 km/h for a single Yellow⁶ (see Figure 9).
- 65 The speed downgrade from 75 km/h to 30 km/h on approach to Signal DN285R (see Figure 9) complies with IÉ standards, I-SIG 2145, Calculation of Signal Spacing Distance, Issue 1, published in 2006).
- 66 The RAIU found, during the investigation that there were five other locations⁷ of a speed decrease of 75 km/h to 30 km/h on the DART network. It was noted by the RAIU that there was some confusion in relation to the number and locations of the speed decreases, for example, IÉ informed the RAIU in writing on the 20th July 2022 and the 6th August 2022, that the location of the incident was the only location of the network of a similar speed decrease.
- 67 It should be noted that there were no SPADs recorded against the signals in the location prior to the incident on the 7th December 2021.

⁶ IÉ have a number of train simulators at Inchicore and Thurles for the training of train drivers. Real routes can be loaded on to the simulator and trains driver over the route in various conditions. During the RAIU investigation, it was found that the changes as a result of the DCCR Project (Killester to Clontarf Road route) had not been updated on the simulators. The RAIU consider this to be an additional observation, AO-01, and have been an associated safety recommendation, 2023001-07 (paragraph 207).

⁷ (1) Down direction, Down Line towards Sutton when approaching DN213 at Red; (2) Up direction, Up Line towards Grand Canal Dock when approaching DC439 at Red; (3) Up direction, Down Line towards Grand Canal Dock when approaching DC443 at Red; (4) Up direction, Up Line towards Lansdowne when approaching DC457 at Red; (5) Up direction, Down Line towards Lansdowne when approaching DC459 at Red.

Principles of Train Protection on the DART (ATP)

- 68 Train protection equipment is fitted to DART vehicles and tracks to reduce the risks of SPADs and over-speeding and includes enhanced overrun protection systems and in-cab appliances.
- 69 The ATP system fitted to the DART fleets operates on the principle of speed signals. The target speed is transmitted from the trackside to the train by means of coded information carried on the track circuits and picked up by antennae connected in series, located at the front of the train. The locations of the speed changes are sometimes referred to as “bonds”.
- 70 The information is analysed, tested, and validated.
- 71 Two tachometric generators, connected to two separate axles on the train, send a pulse string to the ATP system which the later converts into the train’s instantaneous speed and is presented to the driver on a display showing both the actual train speed and the target speed, see Figure 10.



Figure 10 – Driver's in-cab display of the ATP

- 72 The system compares the actual speed with the maximum permitted speed indicated by the code pick up and if the real speed of the train is greater than the maximum permitted speed, (either because of an increase in actual speed or a downward change in permitted speed) the system alerts the driver.

- 73 If the driver fails to respond to the alert by controlling the speed of the train, the system activates the *full-service brake* to slow the train down. If the full-service braking is not reducing the train speed sufficiently, the emergency brake is automatically activated to reduce the train's actual speed to the target speed before the train reaches the signal at danger or the commencement point of the lower permitted speed.
- 74 The application of the emergency brake is *latching* (meaning, once commanded, it cannot be "un-commanded" until the train is at a standstill).
- 75 ATP is only provided on the DART network and trains.

Infrastructure: Track

General management of LRA conditions

- 76 The CCE's Department have a list of known "Hotspots for LRA" based upon reports received and during the previous LRA season. The known LRA hotspots north of Connolly Station were identified as Down platforms at Malahide; Portmarnock; Bayside; Killester; Harmonstown; Claremont; and the Up platform at Raheny. Prior to the 7th December 2021, there had been reports of LRA on the Up line between Killester and Clontarf Road Station, however, the location was not considered a hotspot like the Down line.
- 77 The programme in place for the treatment of the rail consists of treatment of the railhead by the Multi-Purpose Vehicle (MPV) by means of water jetting and application of *Sandite*. The MPV is programmed to operate during October, November and December and is pathed to operate six nights a week Sunday to Friday inclusive.
- 78 In addition, there is the application of traction gel by TGAs located at known areas prone to LRA. TGAs are commissioned into operation at the end of September each year and are de-commissioned out of operation in January.

Management of LRA conditions prior to incident

- 79 The MPV operated to its programmed path on the evening of the 6th December 2021 into the morning of the 7th December 2021.
- 80 There are two TGAs installed in the vicinity of Killester Station; one at 2 miles and 880 yards in the Up direction and a second at 2 miles and 300 yards in the Down direction. The TGAs were operational on the 7th December 2021.

LRA conditions on the day of the incident

- 81 There was a platform overrun of Train E218 at Clontarf Road in the Up direction at 10:50 hrs on the morning of the 7th December. The driver of Train E218 reported that LRA was the cause of his platform overrun. OTDR demonstrated LRA at the same location as Train E240 (the train involved in the incident) although the driver of Train E218 stated that the LRA was closer to Clontarf Road.
- 82 On the 7th December 2021, there were four LRA reports, prior to the incident, at the following times and locations:
- 11:45 hrs – Killester to Harmonstown;
 - 13:10 hrs – Sydney Parade;
 - 13:40 hrs – Killester to Clontarf;
 - 14:25 hrs – Clontarf to Killester.
- 83 After the incident, at approximately 16:15 hrs, a train overshot the platform at Howth Junction by at least two coaches.
- 84 On the day of the incident, the Signalmen made numerous *General Calls* to the drivers in relation to LRA in the DART area.
- 85 Driver E240 applied maximum power while leaving Killester and did not experience wheel slip.
- 86 The relief driver for Driver E240 stated that the rail conditions were “very poor” post-incident.

Post-incident inspection of the track for rail contamination

- 87 The CCE Department scrubbed the railhead when peak-time passenger rail services were over; the locations scrubbed were the Up Road between the 1 MP 550 yards to the 1 MP 233 yards; the process included applying orange cleanse to the rail followed by scrubbing the head of the rail with handheld rail scrubbers.
- 88 No contamination of the track was found prior to Clontarf Road Bridge (UBB5) 1MP 503 yards on the Up Road, see Figure 11.

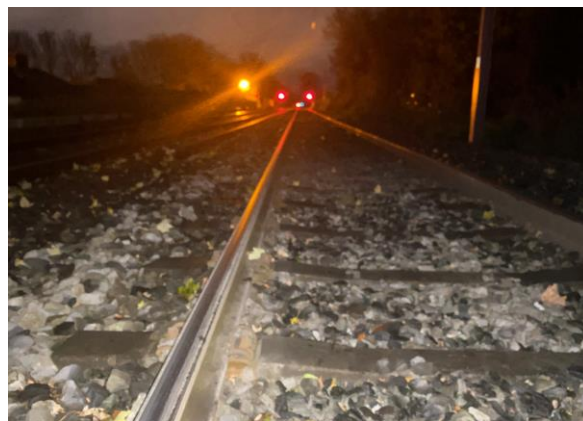


Figure 11 – Dry railhead prior to Clontarf Road Bridge

- 89 Track contamination was found on the Up Road past Clontarf Road Bridge and through Clontarf Road Station, see Figure 12.



Figure 12 – Contaminated railhead on the Up Road

90 The following figure, Figure 13, indicates where the LRA conditions (blue line) were identified, post-incident.



Figure 13 – LRA conditions identified post-incident

91 The swabs taken were sent, by IÉ-IM, to be analysed by the Centre for Microscopy and Analysis, Trinity College, Dublin. The results of this analysis concluded that no organic residues were detected on the cloths. All of the sample residues were found to consist of silica and iron oxide.

Rolling Stock

Mechanical & Electrical Train Maintenance

General information

- 92 IÉ-RU CME maintain the DART fleet at its Fairview Depot. The 8520 EMU fleet accumulate approximately 180,000 km per year. The running scheduled maintenance cycle is divided into an “A” Exam every 30,000 km and six “C” Exams (C1-C6) every 30,000 km (with each of the six “C” Exams varying in content). The “A” exam is scheduled 15,000 km after a “C” exam given a cycle of “A”, “C”, “A” with the fleet receiving maintenance intervention every 15,000km. Heavy Maintenance overhaul is carried out every six years.
- 93 Train E240 (consisting of Units 8627, 8527, 8528, 8628) underwent a planned schedule maintenance Mechanical and Electrical “C2” exam on the 28th October 2021, in accordance with Vehicle Maintenance Examination document reference number:
- E-852-C2-1 Mechanical (Issue 11, issued on 8th May 2020);
 - E-852-C2-2 Electrical (Issue 6, issued on 26th March 2021).
- 94 Tasks to be completed and relevant to the incident from E-852-C2-1 Mechanical include:
- Filling the Sandbox (AS85J0001) (which was noted as being carried out and an equal amount of sand was topped up in each sandbox indicating that a consistent amount of sand was supplied to each sanding nozzle);
 - Checking Brake Pads (BB85J0001) task completed and within specification;
 - Undertaking a Functional Brake Test (BZ85J0001) (with the measured brake pressure readings higher than specification levels);
 - Undertaking a visual assessment of the wheels (UW**J0001) (with the wheels being noted to be within specification).
- 95 The remainder of the exam sheet was completed with the exception of one non safety critical item Flange Lubricator – Top Up (UW85J003) this item was not possible to complete due to the fact that no depot compressed air supply was available. A job card (440605394) was created to ensure the work was completed on its next exam.
- 96 Tasks to be completed and relevant to the incident from E-852-C2-2 Electrical include:
- Master Controller – Examine (EQ85J0001) marked as completed;
 - Wheelslide Control Unit Test (EY85J0001) marked as completed.
- 97 Six non-safety critical tasks were not completed and deferred with job cards created.

Post incident inspection of Train E240

- 98 Train E240, DART Units 8627 and 8628 were returned to Fairview Maintenance Depot for an inspection by IÉ-RU CME staff post-incident.
- 99 The sand boxes were topped up with sand and all boxes were 75% full before filling indicating that the sand injectors were all working to approximately the same rate while in service.
- 100 The wheel running surface was examined for *wheel flats* and none were found, indicating that the WSP system operated correctly and prevented the wheels from locking up and skidding.
- 101 Although it was not possible to calculate the brake retardation rate of Train E240 between Killester and the Crew Ramp Fairview due to WSP activation; a post-incident functional brake test showed that the brakes were working to specification.
- 102 The OTDR⁸ showed that the sanding operated when required but sanding did stop on Unit 8528 for a period of fifty-six seconds during the incident. The reason for this cannot be fully determined, however it could be attributed to the trailing car been lighter than the motor car; or it is possible that differing train speed information was being supplied to the respective control units at the same moment in time (e.g. sliding wheels vs rotating wheels), thus producing differing sanding commands for the two parts of the train. Sanding is only used when the system decides it is necessary to aid wheel slip and as such if the system feels that the WSP system is coping, sanding will not be activated. Additionally, the algorithm within the control units places an emphasis on conservation of the compressed air supply for the brake system and, if it deems necessary, sacrificing sanding in order to maintain braking.
- 103 In addition to the functional brake test, Service Engineers from Knorr-Bremse OEM for the brake system came to Fairview DART Depot to evaluate the performance of the brake, WSP (an inspection of the wheel running surface showed no signs of damage that would have been caused by the wheel locking up and confirms that the WSP operated correctly) and sanding system and concluded all systems functioned as required under the reported weather conditions.

⁸ The OTDR analysis in terms of driving is discussed further in the report in terms of the driving of the train, such as the ATP penalty brake applications, WSP and target speeds (paragraphs 126 - 130).

Rolling Stock Additional Observations: OTDR, FFCTV & Sanding

OTDR

104 The OTDR download from Unit 8628 incorrectly showed the Vehicle ID to be Unit 8627, see Figure 14.

07.12.2021	
Wheel diameter: 814	Vehicle typ: 8520 EMU
Serial Number: 03062192	Vehicle ID: 8627

Figure 14 – Train E240 OTDR download extract

105 The wheel diameter was shown as 814 mm (see Figure 14); a physical check of the vehicle wheel diameter gave a reading of 840 mm⁹¹⁰. A smaller wheel diameter inputted on the OTDR would result in speedometer in the driving cab showing a lower speed than the actual speed of the train. For Unit 8628 a speedometer reading of 79 km/h would in fact be travelling at 81.5 km/h. In addition, a wheel size above that which the ATP correction factor is set would mean that the ATP will permit a train to travel at a speed higher than the signals allow.

106 A review of the maintenance schedule (“C2” exams) for the 8520 EMU fleet did identify that there were no vehicle maintenance instructions for an OTDR functional check.

107 The RAIU consider these findings to be an additional observation, AO-02 (paragraph 191). Measures have been taken by IÉ-RU CME for the prevention of a re-occurrence (paragraph 201), therefore a safety recommendation is not warranted (paragraph 203).

⁹ The correct input of the wheel diameter would not have prevented in the incident on the 7th December 2021.

¹⁰ DART Unit 8627 / 8628 received a bogie change out on 17/08/2021 as part of its Heavy Maintenance schedule. At the time of the incident the 8500 Post / Wheel Change validation procedure, E-085-*-1, Issue 2, published on the 29th August 2018, did not contain a section for updating the wheel diameters on the OTDR and ATP.

FFCCTV

108 When staff attempted to download the FFCCTV footage post-incident it was discovered that the recorder had malfunctioned, and no footage was available.

109 A maintenance regime for the 8500 EMU FFCCTV was not put in place until the complete 8520 EMU fleet had been fitted with the FFCCTV. A review of the maintenance schedule for the 8520 EMU fleet did identify that there were no vehicle maintenance instructions for an FFCCTV functional check.

110 The RAIU consider these findings to be an additional observation, AO-03 (paragraph 191), which warrants safety recommendation 2023001-08 (paragraph 208).

Sanding

111 At the time of the incident sanding on the 8520 EMU fleet would stop at 10 km/h as the sanding improvement project agreed in 2016, was not carried out on the fleet¹¹; the programme included:

- A test button will be added to the vehicle so that sanding can be tested at standstill.
- A manual sanding activation button will be added to the driver's cab. This will permit the driver to activate the sanding on the unit when in traction. The sander will then apply sand for a period of 5 seconds after which sanding will be inhibited for 10 seconds.
- The functionality of the sanding on the 8500 fleet will be modified so that when emergency brake is selected, and wheel slide is detected the vehicle can apply sand down to a speed of 5 kph.

112 Despite receiving a Certificate B for interim operation with the specification complete, tested and material in stock other modification were given priority and the project was never completed. The RAIU consider these findings to be an additional observation, AO-04, which warrants safety recommendation 2023001-09 (paragraph 209).

¹¹ Although it should be noted that the implementation of the sanding improvement project would not have prevented the SPAD at Signals DN287 and DN295 with Knorr-Bremse (OEM) confirming the brake system functioned correctly with all systems operating as required under the reported weather conditions.

Driver Training, Assessment & Competency Management

Standards & Procedures

- 113 Ops-SMS-3.1, Competence Management Drivers (to be known as Ops-SMS-3.1 for the remainder of this report) is part of the IÉ Operations Department Safety Management System and sets out the requirements for the competence management of drivers. The standard is designed to ensure persons who drive trains consistently achieve the standards of competence and fitness required for their work. The standard also determines how and by whom competence and fitness is to be assessed along with the frequency and records that need to be kept of the assessments.
- 114 The Competence Management System for drivers is structured in four stages:
- Stage 1 – “Initial assessment of competence”, which involves the initial assessment of competence after a driver has completed training and is deemed a qualified train driver;
 - Stage 2 – “Post Qualifying Assessments (PQA) of competence”, which follows on from the initial assessment and ensures the compliance with the standards delivered during training and assesses the level of additional confidence and experience the newly qualified driver has gained;
 - Stage 3 – “Continuous assessment and monitoring of driver performance”, which involves the continuous assessment to ensure drivers remain competent at all times and ensures drivers are regularly briefed and assessed on all issues applicable to the duties of a train driver.
 - Stage 4 – “Performance monitoring of competence and fitness” which involves performance monitoring and is integrated into the assessment process for drivers’ competence and contains requirements from personal fitness, wearing of uniform use of equipment and documentation to operational issues including speed checks and train dispatch among other items.
- 115 As part of the continuous assessment in Stage 3, two OTDR downloads are required to be taken and analysed for the driver being assessed. The OTDR assessments are carried out at random and have a due date of end of Year 1 and end of Year 2.
- 116 The OTDR Download Assessment Form, published on the 13th March 2017 is a generic form for all driving assessments and is not customised for the different modes of motive power units and does not specifically monitor ATP penalty brake interventions. In addition, the assessment form contains many tasks that are not relevant to DART drivers and omits many task that could be monitored for DART drivers including reliance on ATP to control the speed of the train.

117 The OTDR Download Assessment Form contains forty-nine check items with twenty-three items marked as not applicable (N/A) for DART drivers. The RAIU consider this to be an additional observation, AO-05 (paragraph 191) which warrants a safety recommendation, 2023001-10 (paragraph 210).

118 Ops-SMS-3.1, paragraph 10.3, “Unobtrusive Assessments and Monitoring” states: “It may occur that OTDRs are not fitted, or District Traction Executives are not yet trained on the equipment. In such cases the OTDR assessment and monitoring must be replaced by an unobtrusive assessment”^{12 13}.

119 An Unobtrusive Assessment of a driver’s performance is normally carried out by the District Traction Executive (DTE) in the rear cab and mostly related to platform interface tasks¹⁴. The assessment is not as comprehensive as a review using OTDR assessment as many driver techniques would not be identified, in the Unobtrusive Assessment, including ATP penalty brake activation in comparison to an OTDR assessment¹⁵.

¹² Monitoring and assessments of District Traction Executive’s is carried out through IÉ’s Operations Safety Management System, Ops-SMS-6.1, “Selection, Training, Monitoring and Assessment of District Traction Executives”, Version 1, operative since the 20th April 2020 (to be referred to as Ops-SMS-6.1 for the remainder of this report).

¹³ Paragraph 9.2.4, of Ops-SMS-6.1 “Use of OTDR retrieval and analysis and use of radar equipment competency”: states that District Traction Executives must achieve competency of the use, retrieval, and analysis of OTDR retrieval, and radar equipment; and, in order to ensure competency District Traction Executives must be assessed every two years and receive refresher training if required to maintain competency.

¹⁴ Note, that this was not affected by the COVID-19 pandemic.

¹⁵ The Chief District Traction Executive’s review of District Traction Executives in relation to OTDR retrieval and analysis entail a random request for an OTDR analysis carried out by a District Traction Executive to be reviewed and did not reveal drivers over reliance of ATP to control the speed of the train.

120 During the RAIU investigation it was noted that Unobtrusive Assessments¹⁶ were at times carried out in place of OTDR assessments when the DTEs had been trained and OTDRs were present on the train. The RAIU consider this to be an additional observation, AO-06 (paragraph 191), which warrants a safety recommendation 2023001-11 (paragraph 211).

121 The six locations of the speed decreases from 75 km/h to 30 km/h on the DART network (paragraphs 65 - 66) were not documented in the IÉ-RU Ops Route Knowledge Risk Assessment documents for the DART Network at the time of the occurrence. They were not included in the central or local training material or formally part of the route knowledge assessment process.

IÉ's Company's Expectation of a Driver

122 IÉ's Company's Expectation of a Driver, "Arriving onto Platforms or at destinations" states:

- Observe train speed;
- Anticipate down-grades in ATP;
- Sound warning device if necessary.

¹⁶ 8th December 2020, 9th November 2021 and 9th June 2022 for Driver E240; evidence provided suggests the District Traction Executive was trained to carry out the OTDR assessment and the train was fitted with an OTDR.

Training, Assessment & Competency Management for Driver E240

- 123 At the time of the incident, Driver E240 had been in the driving grade since July 2005 and held a train driver's licence valid until October 2028.
- 124 Driver E240 signed for a copy of IÉ's Company's Expectation of a Driver on 10th November 2021 which states that downgrades in ATP should be anticipated (paragraph 122).
- 125 The Assessment Tracker (Non-PQA Drivers Only) process commenced for Driver E240 on the 15th November 2019, with the Formal Driving Assessments (FDA), Safety Critical Communication (SCC), On Train Data Recorder / Unobtrusive Assessment (OTDR/UA), Safety Briefing and Update Days (SBUD) assessments all occurring within the scheduled due date timescales, with the assessor noted "Grade A" for all SCC assessments.
- 126 An OTDR Download Assessment Form carried out on 8th April 2020 for the E209 08:00 hrs Howth to Bray passenger service concluded that Driver E240 "Plan is on target with no issues" with the OTDR evidence displaying that Driver E240 "reached the required level and standard required to remain in his position as a professional train driver".



129 A review of the Assessment Tracker (Form D, Ops-SMS-3.1) for Driver E240 identified three Unobtrusive Assessments on 8th December 2020, 9th November 2021, and 9th June 2022, with no issues. Note that in an Unobtrusive Assessments it would not be possible to assess drivers relying on ATP penalty brake interventions to control the speed of the train.

130 The driving technique for Driver E240 on the day of the incident will be discussed later
in the report (paragraphs 139 - 143).

IÉ Professional Driving Handbook

General description

131 The IÉ Professional Driving Handbook, Issue 3, valid from April 2010, describes the standards of professionalism and driving techniques to be applied by all IÉ drivers in order to reach the highest standards of professionalism in terms of approach to work. Compliance to the document will enable drivers to drive safely, punctually and ensure a high level of passenger comfort. The key sections relevant to the investigation are “Defensive Driving”, “Driving under restrictive signals aspects” and “Low adhesion driving” which are outlined below.

132 It should be noted that the Professional Driving Handbook does not contain specific reference to the difference in driving techniques required to drive the various modes of vehicles, i.e. Locomotive, Diesel Multiple Unit and Electrical Multiple Unit. In addition, it does not make reference to anticipating downgrades in ATP.

Defensive Driving

133 Defensive Driving¹⁷ is an established concept designed to improve driver safety performance. It is a core component of being a professional driver and relates to a style of driving technique which actively encourages a driver to anticipate and respond appropriately to operating and environmental conditions. In simple terms, it means thinking ahead, using common sense and not taking chances with safety. You must always think ahead, be pro-active and alert to vulnerable situations that may arise.

¹⁷ Sometimes referred to as “Advanced Driving”.

Driving under restrictive signals aspects

134 Section 5.2, of the IÉ Professional Driving Handbook contains three sections that are relevant to the incident:

- Understanding the risk: Failure to react correctly to a caution aspect can result in a significant overrun passed a red signal. Depending on the speed, the train could reach a conflict point ahead of the signal;
- Typical errors when running under restrictive aspects:
 - Assuming that a signal will step up to a less restrictive aspect;
 - Not taking positive action to reduce the train speed;
 - Lack of concentration;
 - Over reliance on previous experience.
- Minimising error when running under restrictive signal aspects:
 - Always expect the next signal to be displaying a red aspect. It is important to control potential distractions. Concentrate on the job in hand – Stopping at the red signal;
 - Never “Chase signals” showing restrictive aspects, i.e. never assume that a signal showing a restrictive aspect will clear to a less restrictive aspect on approach, irrespective of what may have happened previously in your experience. Allow the train in front to clear, if possible, as this will reduce the number of occasions you will encounter a signal displaying a red aspect;
 - Ensure that you take appropriate action if a signal clears from a red aspect to a cautionary aspect as the train approaches it: remind yourself of the cautionary aspect i.e. accelerate more gently. In normal circumstances this means limiting acceleration to no more than half power.

135 During the investigation, IÉ staff advised the RAIU that when the DART system was originally put into service the policy was for DART drivers to drive into a more restrictive bond, allowing the ATP penalty brake to activate i.e. allowing the train to automatically brake to the designated speed, a term referred to as “*driving into the bond*” or “driving on the ATP”. At some stage this policy was changed to drivers anticipating downgrades in ATP i.e. defensive driving.

136 The document does not state that the train speed should be controlled by driving to the ATP commands and there is no specific mention to not drive into the speed command bonds to control the speed of the train.

Driving under LRA conditions

137 When drivers are notified of a LRA Risk Forecast by CTC (as was the case in this incident, see paragraph 21) they are to apply the principles set out in Section 5.12, of the IÉ Professional Driving Handbook, which includes requirements to:

- Carry out frequent running brake tests, which will enable drivers to feel the rail conditions and adjust braking techniques accordingly;
- Brake earlier, taking into account that under some circumstances braking distances will need to be significantly extended and, in some cases, doubled;
- Take extra care with short formations¹⁸ as these normally have a much higher occurrence rate of LRA incidents;
- Be careful on the final approach to signals or station; be prepared for low speed slides, do not run the risk of overrunning. Adopt the 10 x 20 rule, 10 mph at the CAWS downgrade and stop, where practicable 20 m from the signal;
- Do not run the risk of failing to stop at red signals or overrunning the platform, even if it means increasing the running times.

138 Information on low rail adhesion is provided to drivers by means of the seasonal LRA booklet, summarising a pre-season of the known areas of low adhesion in the previous year and daily updates of the risk forecast. It provides information on the characteristics and causes of LRA, known hotspots, sanding on the fleets, train performance and techniques on defensive driving.

¹⁸ Train E240 was a minimum consist of four cars.

Driving technique of Driver E240 on the day of the incident

139 As part of the RAIU investigation, the driving techniques of Driver E240 were reviewed, the following presents the information from the OTDR taken from the day of the incident, in terms of ATP penalty brake applications. The ATP penalty brake applications, highlighted orange, can be seen where there is a drop in the graph line on the digital display.

140 A screen shot of the OTDR data, Figure 16, for Train E240's journey from Howth to Clontarf Road shows eighteen ATP penalty brake applications (highlighted orange, Figure 16) seven of which were at stations.

141 On eleven occasions the ATP penalty brake applied (highlighted orange, Figure 16)¹⁹, this was a result of the actual train speed (red lines, Figure 16) exceeding the ATP target speed (blue lines, Figure 16).

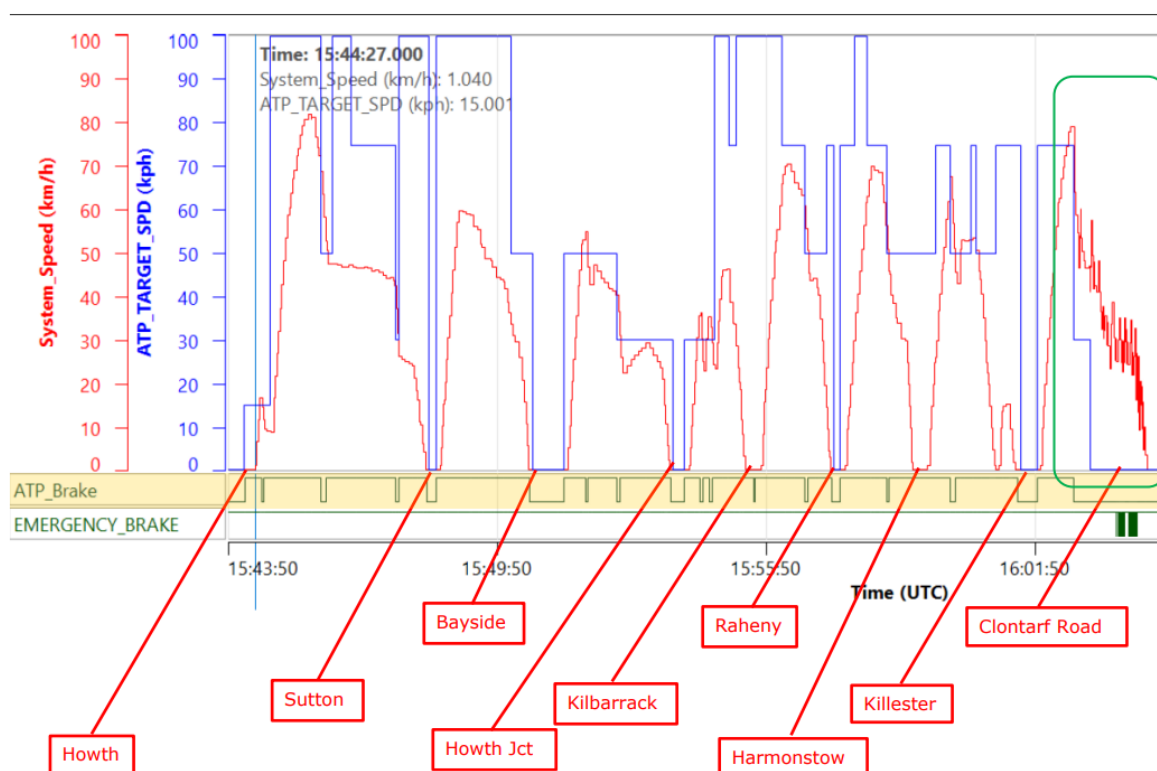


Figure 16 – Train E240 Actual Speed (Red Lines) and ATP Target Speed (Blue Lines)

¹⁹ It should be noted that this would have been harder to see on older OTDR which does not indicate the digital signal for the ATP penalty brake applications e.g. see Figure 17. As a result the RAIU consider warrants a safety recommendation, 2023001-03 (paragraph 203).

142 Note that the speed fluctuation from Killester through Clontarf Road and onto Fairview (green box, right hand side of Figure 16) is due to the WSP activity caused by an ATP penalty brake application and release due to the presence of LRA on the railhead.

143 Driver E240 applied the emergency brake (green squares, bottom right of Figure 16) at the very late stages of the incident, note that the ATP was applying the emergency brake and the driver's intervention would have had no effect.

144 By way of comparison, a screen shot of the OTDR data²⁰ for Train E120's (operated by Driver E120a) journey from Malahide to Clontarf Road, Figure 17, shows the actual speed (black line, Figure 17) staying within the bonds of the ATP target speed (red line, Figure 17) for the entire journey with no ATP penalty brake application.

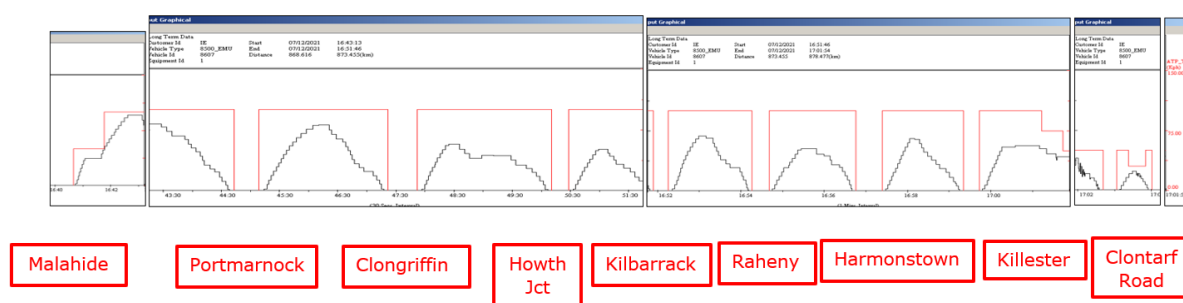


Figure 17 – Train E120 Actual Speed (Black Lines) and ATP Target Speed (Red Lines)

²⁰ As previously mentioned, the 8500 EMU fleet have an older version OTDR (Teloc 2200), and the presentation of graphs is not as good as the later version on the 8520 EMU fleet e.g. there is no digital signal for the ATP penalty brake interventions.

Events before, during and after the incident

Events before the incident

- 145 At 14:08 hrs on 7th December 2021 the CTC Duty Manager issued a moderate LRA Risk Forecast to drivers as a result of Storm Barra.
- 146 The majority of trains were running late as a result of Storm Barra, including Trains E240 and E120.
- 147 At approximately 16:01 hrs Train E120 (Malahide to Bray) having served Clontarf Road Station Up Platform began to move forward to the Crew Ramp at Fairview to facilitate a driver change. The signals to the rear, Signals DN287 and DN295, were displaying red aspects to protect Train E120.
- 148 At 16:02 hrs Train E240 (Howth to Bray) accelerated out of Killester Station, four minutes late, without WSP activation, and passed Signal DN281 (displaying a double yellow, paragraph 145).
- 149 Seconds later, Driver E240 accelerated up to 79 km/h²¹ (speed limit was 75 km/h) as shown on the cab's digital display before allowing the train to coast for four seconds and entering the speed bond which downgrades for Signal DN285 the target speed from double yellow to yellow in this case 75 km/h to 30 km/h.

²¹ The actual speed that Train E240 at was travelling at 81.3 km/h due to the incorrect wheel diameter entered on the OTDR.

Events during the incident

- 150 At 15:59 hrs Train E120 departed Clontarf Road Station with a planned stop at the Crew Ramp at Fairview Depot for a change of driver. When Train E120 departed Clontarf Road Station and was in the overlap for Signal DN295 the aspect for Signal DN287 and DN295 changed from green to red aspect to protect Train E120.
- 151 The speed bond was 47 m before Signal DN285R which was installed to achieve the minimum viewing distance required for Signal DN285 which is two hundred and thirty-eight meters ahead (paragraph 61). The drop in permissible speed triggered an ATP penalty brake. The severity of the brake application and the degraded railhead conditions as a result of Storm Barra resulted in the WSP²² and sanding systems²³ activating and the train not stopping within the normal parameters (between 16:02 hrs and 16:04 hrs).
- 152 At 16:03 hrs Train E240 passed Signal DN287 at danger.
- 153 At 16:03 hrs, Train E120 was stopped at the Crew Ramp at Fairview (see Figure 18, the following figures are taken from Clontarf Road Station CCTV). Note Signal DN295 displaying at red aspect to protect Train E120.



Figure 18 – Train E120 stationary at the Crew Ramp, Fairview

²² Although there is no visual or audible alert, in cab, to the WSP activation, Driver E240 would have been aware it activated due to the noise of the WSP system.

²³ Although it is noted that the sanding stopped for a period of fifty-six seconds.

154 Within the minute (16:03 hrs) Train E120 began to move away from Crew Ramp, see Figure 19.



Figure 19 – Train E120 began to move away from Crew Ramp

155 At 16:03:14 hrs Driver E240 rings the Central Signalman direct rather than making an emergency call through the Global System for Mobile Communications – Railway (GSMR)^{24,25} train radio. At 16:03:22 hrs the call connects and Driver E240 advises the Central Signalman that Train E240 had passed a signal (Signal DN287) at danger and was skidding towards the train that was at the Crew Ramp in Fairview (Train E120), Figure 20.

²⁴ When an emergency call is made through GSMR other train drivers in the area (Dublin Area) can hear the call if they also have a GSMR radio fitted in their cab; all DART cabs are fitted with GSMR train radios. If Driver E240 had made the emergency call through GSMR, in this instance, it would have alerted all drivers (in particular Driver E120b at the Crew Ramp) with active GSMR train radios in the area of what was occurring (it is estimated that Driver E120b would have been alerted to the situation approximately fifty-seven seconds earlier had an open call been made).

²⁵ The RAIU consider this to be an additional observation, AO-07 and make safety recommendation 2023001-12 (paragraph 212).



Figure 20 – Train E240 approaching Train E120

- 156 The Central Signaller advised Driver E240 that he was going to hang up and contact the driver of the train (Driver E120b) at the Crew Ramp in Fairview; the Central Signaller hangs up at 16:03:56 hrs.
- 157 At 16:04:05 hrs the Central Signaller phones Driver E120b, the call connects at 16:04:11 hrs. Driver E120b confirmed that their train (Train E120) was moving, and the Central Signaller requested Driver E120b to keep moving.
- 158 Train E240 continued through Clontarf Road Station and also passed Signal DN295 (at the south end of Clontarf Road Station) at danger, travelled to within an estimated 5 m of Train E120, see Figure 21.



Figure 21 – Train E240 coming to a stop

159 Train E240 came to a stop past Signal DN295, it is estimated that a collision with the rear of Train E120, was avoided by five seconds.

Events after the incident

- 160 At 16:07 hrs Driver E240 contacted the Central Signalman to confirm Train E240 had stopped and had not collided with the rear of Train E120 before completing the post-incident procedures (including completing a SPAD form). Driver E240 was also subject to drugs and alcohol testing which returned negative results.
- 161 A relief driver was organised to replace Driver E240.
- 162 A number of post-incident checks were carried out on the railhead (paragraphs 87 - 89) and rolling stock (paragraphs 98 - 103).
- 163 All post-incident procedures were followed correctly.

Similar Occurrences

Introduction

164 SPADs are not unusual on the IÉ network, with twelve SPADs occurring in 2022 however the occurrence of a Double SPAD (i.e. a train passing two consecutive red (danger) signals) is highly unusual.

165 The RAIU did conduct an “Investigation into SPADs on IÉ Network, from January 2012 to June 2015”, which was published in April 2016, which made fourteen safety recommendations in relation to SPADs, of which five remain open/ in progress or requiring further information at the time of publication of this report.

166 In terms of similarities related to the events on the day of the incident on the 7th December 2021, IÉ-IM conducted an investigation into a SPAD at Signal DC416, Pearse Station, on the 12th August 2016.

SPAD at Signal DC416 12th August 2016

167 On Friday the 12th August 2016, the 16:45 hrs DART passenger service from Howth to Bray Station, train ID E222, passed Signal DC416, on the approach to Pearse Station at danger without authority.

168 The IÉ-IM internal investigation, published on the 14th July 2017, focussed on two key areas, the design and operation of the wayside and on-board ATP equipment and the actions of the Driver E222 (specifically in relation to the reliance on the ATP system to control the speed of the train).

169 Driver E222 had a history of over-reliance on the ATP system to control the speed of his train for speed restrictions. However, the investigation identified that not only was the driver using the ATP to control the speed of his train for speed restrictions but also in responding to signal aspects.

170 The report identified two recommendations that are relevant to the RAIU investigation:

- The IÉ-RU Safety Manager should arrange for the development and issue of a guidance document for drivers outlining the understanding of the ATP equipment and the driving technique required. New training, monitoring and assessment material should be developed from this guidance;
- The IÉ-RU Safety Manager should arrange for the development of a briefing for DTEs on analysis of driving trends by use of the OTDR.

171 The following updates, from IÉ-RU on the progress of the recommendations are as follows:

- Training is arranged for the second week in September 2022²⁶ for the recently appointed / new DTEs on how to analyse the OTDR output. A new check / guidance form is drafted to assist with the process and will be used in the training. When the training is completed, the form will undergo further review taking on board any issues found in the training. It will then become the suite of forms as part of the competence management system.
- On review of the recommendation and its intent the Chief Traction Executive made a change to the form for assessing the download data from OTDRs, Appendix A of Ops-SMS-7.0. The line to Respond to all CAWS/ATP indications and control the train speed to avoid repeated cancellations of the CAWS/ATP when following other trains, has been separated into two distinct items, one for CAWS and one for ATP. The requirement to pay particular attention to these two items has been reinforced by the Chief Traction Executive in both the quarterly meetings and the in his monitoring and review of the DTE assessment documents.

²⁶ Training was concluded in December 2022.

Analysis

External Circumstances

172 The weather conditions as a result of Storm Barra (paragraph 20) led to LRA conditions at the location of the incident, confirmed through driver reports (paragraph 81 - 83) and post-incident inspection of the railhead (paragraphs 87 - 90). The LRA conditions lead to the CTC Duty Manager issuing a moderate LRA Risk Forecast at 14:08 hrs (paragraph 21), approximately two hours before the incident.

Signalling

173 The signals between Killester and the Crew Ramp at Fairview were repositioned (in line with the required IÉ standards) as part of Phase 2 of the DCCR Project and although the reduction in speed from 75 km/h to 30 km/h is not common on the DART network (paragraphs 61 - 66); the downgrade at Signal DN285R adheres to the I-SIG 2145, Calculation of Signal Spacing Distance standard.

ATP

174 The ATP system fitted to the DART fleets operates on the principle of speed signals by comparing the actual speed (as driven by the driver) with the maximum permitted speed (on the line) and if the actual speed of the train is greater than the maximum permitted speed the system alerts the driver. If the driver fails to respond to the alert by controlling the speed of the train, the ATP system activates the full service brake and, if required the emergency brake (paragraphs 68 - 75).

175 The ATP system activated on the day of the incident, with the ATP penalty brake activating eleven times for Train E240 between Howth and Clontarf Road on the day of the incident (paragraph 141). However, due to the LRA conditions and the Driver E240's driving technique, the ATP could not slow Train E240 in a controlled manner in time to prevent the SPADs.

Driving technique

176 Defensive driving, whereby drivers anticipate and respond appropriately to operating and environmental conditions (paragraph 133), is the established driving technique for drivers. Under the requirements of the IÉ Professional Driving Handbook, when driving under restrictive aspects, drivers must react correctly to cautionary aspects (paragraph 134); and when driving under LRA conditions must be extra vigilant, such as earlier braking, extending braking distances and the adoption of the 10 x 20 rule, in particular on approach to signals and stations (paragraph 137).

177 “Driving into the bonds” is where a driver allows the ATP to apply the penalty brakes, which is not in accordance with the defensive driving technique set out in the IÉ Professional Handbook; although, it should be noted that this was the acceptable driving technique when the DART was first introduced (paragraph 135).

178 On the day of the incident, Driver E240 was “driving into the bonds” and relied on the train to apply the ATP penalty brakes (which occurred eleven times Howth and Clontarf Road due to speed differentials (paragraph 141). On approach to Signal DN285R and the speed bound downgrade from 75 km/h to 30 km/h, Driver E240 allowed Train E240 to reach a speed of 79 km/h (as shown on his display) and again relied on the ATP penalty brake to control the speed of the train (paragraphs 149 - 151). The severity of the brake application in trying to reduce the speed of the train to 30 km/h coupled with LRA resulted in the WSP and sanding systems activating to allow for a controlled stopping of the train but not before passing Signal DN287 and Signal DN295 at danger (paragraphs 152 and 158).

179 This appears to be an established technique of driving for Driver E240 as a previous OTDR assessment (8th April 2020) identified seventeen ATP penalty brake interventions as a result of the actual speed being greater than the target speed for the journey (paragraph 127). And although this was visible to the DTE, the driving technique was never discussed with Driver E240 (paragraph 128).

180 A comparison between the driving techniques applied by Driver E240 and Driver E120a shows a complete contrast in techniques. Driver E120a accelerated to approximately 75% of the permitted speed before applying the brake in anticipation of a downgrade speed bound ahead. Driver E240 on the other hand accelerated to maximum speed and allowed the ATP penalty brake to control the speed of the train.

Driving Training, Assessment & Competency Management

- 181 In general terms, the anticipation of ATP downgrades did not form part of the OTDR assessment for DART drivers (paragraph 116).
- 182 In terms of the speed downgrade from 75 km/h to 30 km/h there are a total of six locations with the same speed downgrade; however, there is no specific mention of these locations during training and assessment.
- 183 In terms of Driver E240, although Driver E240, signed IÉ's Company's Expectation of a Driver, which states that down-grades in ATP should be anticipated (paragraph 124); Driver E240's driving on the day of the incident and on at least one previous date did not reflect this mode of driving (paragraph 179). In addition, where the OTDR download previously identified that Driver E240 was not reacting appropriately to anticipate the downgrade, the DTE did not highlight this to Driver E240 (paragraph 128).
- 184 The internal investigation into a DART SPAD at Signal DC416 on approach to Pearse Station on 12th August 2016, and published in 2017, concluded that the driver involved had a history of over-reliance on the ATP system to control the speed of his train for speed restrictions and also in responding to signal aspects. The report issued two recommendations related to the development and issue of a guidance document for drivers outlining the understanding of the ATP equipment and the driving technique required; and, the development of a briefing for DTEs on analysis of driving trends by use of the OTDR. These recommendations remained open at the time of the incident on the 7th December 2021, five years after the recommendations were made (paragraphs 167 - 171). This illustrates the absence of urgency in closing out the recommendations, pointing to a lack of understanding of the consequence or potential severity of allowing ATP to control the speed of the train. The RAIU consider that had these recommendations been addressed in full, in a timely manner, it is most likely that the incident on the 7th December 2021 would not have occurred.

Rolling stock

185 Train E240, a four-car 8520 EMU had undergone the required maintenance checks, with its last planned scheduled maintenance occurring ten days before the incident with all safety critical tasks undertaken (paragraphs 92 - 97).

186 Train E240 was tested post-incident and testing of the trains brakes and WSP systems (with no wheel damage) for Train E240 showed they were working to specification (paragraphs 98 - 103). However, the sanding did stop for a period for fifty-six seconds on Unit 8528, which reduced the effectiveness of the train's ability to stop.

Conclusions

Causal, contributing, and systemic factors

187 Train E240 passed Signal DN287 at danger and subsequently passed another signal, Signal DN295, at danger at Clontarf Road as a result of the following causal, contributing and systemic factors.

188 The following causal factors to the incident:

- CaF-01 – Driver E240 had an over-reliance on the ATP system to control the speed of the train;
- CaF-02 – LRA was present as a result of Storm Barra;
- CaF-03 – There was a sharp speed downgrade, from 75 km/h to 30 km/h, on the approach to Signal DN285R;
- CaF-04 – Driver E240 did not apply correct driving techniques, as set out in the IÉ Professional Handbook, by adequately reacting to downgrades in speed (75 km/h to 30 km/h on the approach to Signal DN285R) and the LRA conditions present on the day;
- CaF-05 – The sanding stopped during the incident which reduced the effectiveness of the train's ability to stop.

189 Contributing factors include:

- CoF-01 – A previous OTDR assessment of the driver did not identify Driver E240's over-reliance of the ATP system to control the speed of the train;
- CoF-02 – A previous internal investigation report into a SPAD in 2016 (which identified that there was an over-reliance by that driver on the ATP system), made two recommendations, in 2017, related the ATP systems (for drivers and DTEs); which may have potentially avoided the incident on the 7th December 2021, remained open.

190 Systemic factors were identified as:

- SF-01 – The competency management system for drivers did not identify that drivers may be over-reliant on the ATP resulting in no requirement for DTEs to check for ATP penalty brake applications;
- SF-02 – The risks associated with “*driving into the bonds*” was not fully appreciated, as no urgency was applied to closing internal IÉ-IM safety recommendations made in 2017, relation to a SPAD in 2016; and remained open at the time of the incident, which identified that there was an over-reliance, by drivers, on the ATP system.

Additional observations

191 Although not causal, contributing, or systemic to the incident on the 7th December 2021, the RAIU make the following additional observations:

- AO-01 – The train simulator was not updated to the new signal arrangement for the DCCR Project (footnote 6, paragraph 64).
- AO-02 – The incorrect unit number and wheel diameters were loaded on the OTDR of 8628 (paragraphs 104 - 107);
- AO-03 – The FFCCTV camera on 8627 was not operating and the maintenance regime for the checking of the FFCCTV fitted to the 8520 EMU fleet was not implemented until the complete fleet had been fitted with the FFCCTV (paragraphs 108 - 110);
- AO-04 – The 8500 EMU sanding improvement plan 2016 that would allow sanding in emergency brake to the lowest possible speed (3-5 km/h) although approved was never implemented (paragraphs 111 - 112);
- AO-05 – The OTDR Download Assessment Form is a generic document for all driving units with no specific detail for DART drivers (paragraph 116).
- AO-06 – Unobtrusive assessments are often undertaken in place of an OTDR assessment despite the presence of an OTDR on the train and the DTE having received training (paragraph 120).
- AO-07 – Driver E240 made a call to the Central Signaller rather than an emergency call through the GSMR train radio (footnote 25, paragraph 155).

Measures taken since the incident

Measures taken by IÉ since the incident

Safety Alert

192 After the incident, on the same day, IÉ-RU issued a Safety Alert (RU-Ops-SA64), as set out in Figure 22; it was not identified at this early stage that there was an issue with a reliance on the ATP system for braking of trains.


 RU Safety Department		Reference No.	RU Ops SA64
<div style="background-color: #90EE90; text-align: center; padding: 5px;">Safety Alert</div> <div style="background-color: #FF0000; color: white; text-align: center; padding: 5px;">Double SPAD</div>		Status	Live
		Issue No.	1.0
		Date of Issue	07/12/2021
		Prepared by	
		Checked by	
		Approved by	
Date:	07/12/2021	Signal:	DN287 & DN295
Time:	16:03	Location:	Clontarf Road
What happened? (Based on available details)	<ul style="list-style-type: none"> Howth to Bray (E240) passed signals DN287 & DN295 The train went into a slide approaching signal DN287 passing the signal at danger The slide continued towards Clontarf Road station Another train was stopped at the ramp at Fairview for a crew change As the train approached Clontarf Road the Driver called the Signalman reporting the train was not stopping and was sliding towards the rear of the train in front The Signalman contacted the Driver of the other train, which had just started to move, instructing them to keep moving The sliding train came to a stop beyond the point where the rear of the other had been just moments before 		
Early Points to Consider Actions to control the risk	<p><i>Professional Driving Handbook</i></p> <p>5.2 Low adhesion driving</p> <p>How much can it affect the braking of a train?</p> <p>Under certain conditions severe rail contamination can be experienced often due to leaves but sometimes other pollution of rail head. This can result in the braking capability of the train being reduced by as much as 75%.</p> <p>3. Braking trains in low adhesion:</p> <ul style="list-style-type: none"> ✓ Carry out frequent running brake tests, this will give you the feel of the rail conditions and enable you to adjust your braking technique accordingly. ✓ Be aware that short formation trains have a much higher occurrence rate of low adhesion incidents. ✓ Do not run the risk of failing to stop at a red signal or overrunning a platform, even if it means increasing the running times. ✓ In general drivers should brake earlier, taking into account that under some circumstances braking distances will need to be significantly extended and in some cases doubled. ✓ According to the braking characteristics of the train, select an appropriate braking position to achieve the desired level of retardation. ✓ In the event of wheel slide, keep the brakes on and let the Wheel Slide Protection System (WSP) operate. ✓ Don't release the brake to counter the effect of speedometer and brake gauge flicker – allow the sanders to work with the WSP. ✓ Be careful on the final approach to signals or stations; be prepared for low speed slides, do not run the risk of overrunning. Adopt the 10 x 20 rule, 10mph at the CAWS downgrade and stop, where practicable, 20 metres from the signal. ✓ With ATP fitted trains, on receipt of a zero speed command always have power/brake controller in a brake position and let the train come to a complete stop before engaging the running release. Always be on high alert when you decide to engage the running release and where practicable stop 20 metres from the signal. ✓ If there is any doubt that the train will stop safely at the intended point or there is a risk of the train over speeding on a speed restriction, apply the emergency brake. <p>The content of this alert is based on the information currently available. The Incident is under investigation</p>		

Figure 22 – Safety Alert for incident on the 7th December 2021

Investigation Report

193 IÉ-IM issued their internal report into the investigation on the 31st December 2022, entitled, “Report of Investigation: Train E240 passed signals DN287 and DN295 at Danger without authority, 7th of December 2021”. The internal report identifies safety actions and safety recommendations. The safety actions are as follows:

- A Driver Development & Support plan was put in place for the Driver E240 on the 13th January 2022 in compliance to the relevant safety standard;
- Professional discussions have been noted and recorded when carrying out Formal Driving Assessments with DART drivers;
- Formal Driving Assessments, OTDR and Unannounced Assessments have assessed driving techniques in accordance with Train Driving Competence Standards. Specific attention has been given to assess that drivers are avoiding driving into ATP bonds on the approach to a signal downgrades. If a driver is assessed driving into bonds, this is recorded and marked down as an item for review and followed up with a professional discussion with the driver to highlight the issue and the item is assessed at the drivers next assessment to ensure compliance;
- During the driver SBUD in 2022 all DART Drivers were briefed on the occurrence and viewed forward facing video footage between Killester and Clontarf Road Stations and received a verbal breakdown of how the incident occurred. Drivers were also re-briefed on making/receiving emergency calls via GSMR train radios. Drivers received information on error prevention techniques to help a driver avoid a repeat of this incident, this was both documented and recorded with drivers’ signatures;
- The six locations of ATP speed changes on the DART network from 75 km/h to 30 km/h are now included in the Route and SPAD risk briefing record for the DART District. Briefings and discussions with DART drivers on the locations and risks have commenced during Competence Assessments. Note: The IÉ-RU Audit programme for 2023 includes an audit on Train Driver Competence Management and will include the briefing of route risks;
- Railhead swab kits have been issued out to all permanent way inspectors in the Dublin DART area and are in use. Most recently used after an LRA occurrence in the Raheny area on the 28th October 2022;
- A new Vehicle Maintenance Instruction (VMI) for 6 Year Bogie Change Exam for the DART fleet was introduced in March 2022, Ref E-085-BC-4. The VMI provides prompts for and records the setting of wheel sizes on the units for ATP and Event Recorder.

194 IÉ-IM's internal report, made the following safety recommendations:

- The CME, in consultation with the Chief Engineer SET, to arrange a review of the function of the sanding system on the DART fleet and explore if additional sand application is required and feasible to improve the trains' ability to stop in LRA conditions.
- The District Manager DART to arrange for all DART train drivers to be briefed on the locations of the ATP speed command downgrades on the DART network. Additionally, the drivers should be briefed on the consequences of allowing the ATP penalty brake to apply at those locations. The briefings should be conducted through the SBUD material and during competence assessments.
- The Training Manager IÉ-RU and the Chief Traction Executive to arrange for driver training material both centrally and locally to be updated to include the locations of the ATP speed command downgrades on the DART network and on the consequences of allowing the ATP penalty brake to apply at those locations.
- The District Manager DART to arrange for training of all District Traction Executives in the DART District on the interrogation of the OTDR data to identify issues with driving particularly in instances where Drivers allow the ATP penalty brake to apply.
- The District Manager DART to provide evidence that where irregularities are identified either through OTDR or in person competence assessment that these issues are addressed and formally documented per the IÉ-RU Ops Safety Management System.
- The Chief Traction Executive to arrange for a briefing through competence assessments and SBUD material regarding the correct way to make an Emergency Call to the signalman.

OTDR Data

195 The incorrect unit number and wheel diameters were loaded on the OTDR of 8628 (AO-02, paragraph 191). IÉ-RU CME have issued a new Vehicle Maintenance Instruction, "Teloc Checks: Running maintenance exam checks to ensure time, date and wheel sizes are correct. Also checking for Teloc errors", issued on the 20th September 2022. The document includes requirements to confirm the correct wheel size and correct train IDs are displayed, etc. Therefore the RAIU consider that a safety recommendation is not warranted.

Measure taken by the CRR since the incident

196 The CRR published “CRR Post Occurrence Inspection Supervision Activity No. 257/21-POA”, entitled “Double SPAD of signals DN287 & DN295 resulting in Near Miss at Fairview Depot Staff Halt”, on the 28th October 2022. This document provided a detailed overview of the incident, the rolling stock involved, actions of the driver and general operations, and signalling at the location. The CCR made:

- Nine findings related to the rolling stock (OTDR, FFCCTV, sanding);
- Sixteen findings related to the actions of the driver and driving operations (unobtrusive assessments, OTDR assessments, trains speeding, corrective coaching plan, in-cab displays (WSP activation), defensive driving, driving style of Driver E240 (including braking techniques), horn activation, general call, drivers’ manual);
- Eleven findings in relation to signalling layout, resignalling, signalling design phase, TGAs, signalling derogations, speed restrictions, white light crossing).

197 Based on the findings, the CRR identified five *minor non compliances*, namely:

- IÉ-RU have not ensured to control of maintenance during bogie swaps. The failure to update the Teloc/ATP following a wheel change has resulted in a wrong side failure where a train was travelling faster than indicated;
- IÉ-RU rolling stock sanders appear to be configured according to superseded IM rules and have not been updated in line with IÉ-IM changes introduced some seven years ago. The change to the IM rules would have required review to ensure that the associated risks continued to be as low as reasonably practicable;
- IÉ-RU are not controlling the risks arising from drivers work activities by utilising an assessment procedure that does not conform to Ops-SMS-3.1 ~~et. 10.3~~;
- IÉ-RU provided evidence that they are monitoring how tasks are performed but the evidence did not demonstrate implementing corrective actions in relation to ATP brake applications. By not implementing corrective actions for the use of the ATP brake this may increase the likelihood that a driver would do so. The OTDR Assessment Forms used during monitoring of drivers are also generic in nature and do not account for the variations in fleet (e.g., Specific ATP related competencies for ATP equipped trains);
- IÉ-IM are non-compliant due to several findings whereby safety related information arising from the DCCR Project had not been transferred over to relevant documentation and systems.

198 In addition to the above minor non compliances, there are several *actions required* of IÉ-RU to ensure passenger safety. These are outlined below:

- IÉ-RU should review the 8500/10/20 EMU Fleet whereby a 3rd axle sander has been inhibited on fleet delivery to comply with SET restrictions. This should evidently confirm the steps taken in the inhibiting the sander and the controls used to ensure that sanding performance was maintained insofar as reasonably practicable from the Motor Control Unit/ Brake Control Unit controlled 5th axle sander. Consideration should also be given to current IM standards and the possibility that the current sanding layout could be changed to ensure the risk of exceeding stopping distances due to LRA is reduced So Far As Is Reasonably Practicable. Where other vehicles were subject to similar modifications, they should be reviewed also;
- IÉ-RU CME's Department to provide evidence of an implemented maintenance programme for the 8500/10/20 EMU OTDRs to ensure quality of accident/incident data;
- IÉ-RU CME's Department to provide the CRR with a review of all OTDRs on the 8500/10/20 EMUs outlining the number of each type and the capabilities of each type. Older OTDRs in the fleet are limited in their ability to assist with accident, training and data analysis purposes;
- IÉ-RU should review the logic relating to allowing Unobtrusive Assessments replace OTDR Assessments in driver competency cycles. And unless there is a specific, plausible, and necessary reason to maintain these Unobtrusive Assessments, they should be removed from the SMS. Should Unobtrusive Assessments remain in the SMS the controls around their quality and justifications for use should be improved;
- IÉ-RU should review the requirements for Corrective Coaching Plans in the SMS. Whilst the plans must be flexible to account for the unique nature of these plans, certain requirements (such as requiring a summary assessment only after all other parts are complete) would ensure consistency of approach and improved quality;
- The CRR should investigate the management of driver's competency for emergency scenarios. This should include: The procedures in place for each type of rolling stock, the best course of actions to take to minimise loss and injury, the frequency of the training and the scenarios presented to drivers in simulators.

199 IÉ-RU are in the process of addressing the outcomes (minor non-compliances and action required items) and the CRR is monitoring their progress.

Safety Recommendations

Introduction to safety recommendation

200 In accordance with the European Union (Railway Safety) (Reporting and Investigation of Serious Accidents, Accidents and Incidents) Regulations 2020), recommendations are addressed to the national safety authority, the Commission for Railway Regulation (CRR). The recommendation is directed to the party identified in each recommendation.

Absence of safety recommendations due to measures already taken

OTDR Data

201 As a result of the new Vehicle Maintenance Instruction related to Teloc checks (paragraph 195) the RAIU consider that a safety recommendation is not warranted in relation to AO-02 (paragraph 191).

Safety recommendations as a result of this incident

202 As a result of Driver E240's over-reliance on the ATP System, and apparent lack of understanding on the part of the DTEs' understanding of the OTDR downloads, the RAIU formalise the previous safety recommendations made by IÉ-IM, and make the following safety recommendation (CaF-01, CaF-04, CoF-01, SF-02):

Safety Recommendation 2023001-01

The Head of Health & Safety IÉ-RU should arrange for the development and issue of a guidance document for drivers outlining the understanding of the ATP equipment and the driving technique required. New training, monitoring and assessment material should be developed from this guidance.

Safety Recommendation 2023001-02

The Head of Health & Safety IÉ-RU should arrange for the development of a briefing for DTEs on analysis of driving trends by use of the OTDR.

203 To assist the DTEs in relation to the analysis of the OTDRs, the RAIU consider the following recommendation is warranted:

Safety Recommendation 2023001-03

IE-RU CME should upgrade the OTDRs on the 8500 EMU fleet to the most up-to-date version, to ensure that digital signals are recorded for ATP penalty brake applications.

204 Furthermore, to deter drivers from an over-reliance on the ATP system, the RAIU consider that the following safety recommendation is warranted (CaF-01, CaF-04):

Safety Recommendation 2023001-04

IE-RU CME should consider retrofitting all EMU fleets with a Remote Diagnostic System, whereby a rule can be introduced so that DTEs are immediately notified of ATP penalty brake applications.

205 To address issues related to the LRA railhead conditions, the RAIU make the following safety recommendation (CaF-02):

Safety Recommendation 2023001-05

IE-IM CCE should consider, based on a risk-based approach, the introduction of TGAs at more locations.

206 To address the six known locations where the speed decreases from 75 km/h to 30 km/h on the DART network (although it is noted that there was some confusion relation to the number of locations, paragraph 66). It is noted that the speed decrease required a derogation with I-SIG-2145, Calculation of Signal Spacing Distance, however, given the events surrounding the Double SPAD event, there is some doubt as to its efficacy. As a result, the RAIU consider that the following safety recommendation is warranted (CaF-03):

Safety Recommendation 2023001-06

IE-IM SET should undertake a review of I-SIG-2145, Calculation of Signal Spacing Distance, to consider if the risk approaches identified in the standard are effective in relation to the calculation of the spacing of signal distances, in particular, in relation to sharp speed decreases on the approach to signals and consideration should be given to incorrect driving techniques (i.e. driving into the bonds). A review of the use of derogations should also be undertaken.

Safety recommendations as a result of additional observations

207 The train simulator was not updated to the new signal arrangement for the DCCR Project (footnote 6, paragraph 64); As a result, the RAIU make the following safety recommendation (AO-01):

Safety Recommendation 2023001-07

IE-IM SET should put systems in place to ensure that the train simulator staff are provided with updated signal layout schematics as and when required e.g. altered signal positions.

208 The FFCCTV on EMU 8627 was not operating as a fault arose on the system and the scheduled maintenance for the FFCCTV was not implemented until the complete 8520 EMU fleet had received its installation (paragraph 108 - 110), i.e. maintenance tasks were only commenced when the fleet was complete, rather than commence with individual units. As a result the RAIU make the following safety recommendation (AO-03):

Safety Recommendation 2023001-08

IE-RU CME should update its commissioning documents, to ensure that maintenance tasks commence after installation.

209 The 8500 EMU sanding improvement plan that was approved and tested in 2015 was never rolled out across the 8599 EMU fleet (paragraphs 111 - 112). As a result, the RAIU make the following safety recommendation (CaF-05, AO-04):

Safety Recommendation 2023001-09

IE-RU CME should review the 8500 EMU sanding improvement plan (2016) against current standards with a view to updating and implementing the sanding improvements to current standards.

210 The OTDR Download Assessment Form is a generic document for all driving units with no specific detail for DART drivers (paragraph 116). As a result, the RAIU make the following safety recommendation (AO-05):

Safety Recommendation 2023001-10

IE-RU Ops should update the OTDR Download Assessment Form for DART drivers with only tasks pertinent to DART drivers; allowing DTEs to carry out comprehensive assessments of the DART drivers' driving techniques.

211 Unobtrusive assessments are often undertaken in place of an OTDR assessment despite the presence of an OTDR on the train, which is more rigorous in terms of assessing driving technique (paragraph 120). As a result, the RAIU make the following safety recommendation (AO-06):

Safety Recommendation 2023001-11

IE-RU Ops should update its competency assessment processes to ensure that the assessments carried out, are the most beneficial, in terms of identifying driver discrepancies.

212 Driver E240 made a call to the Central Signaller rather than an emergency call through the GSMR train system that would have notified the driver ahead of the urgency to clear the line approximately fifty-seven seconds earlier (paragraph footnote 25, paragraph 155). As a result, the RAIU make the following safety recommendation (AO-07):

Safety Recommendation 2023001-12

IE-RU Ops should brief all drivers on the importance of making an open call in an emergency situation rather than calling the Signaller direct.

Additional Information

List of abbreviations

ATP	Automatic Train Protection
CAWS	Continuous Automatic Warning System
CCTV	Close Circuit Television
CI	Chief Investigator
CME	Chief Mechanical Engineer
CRR	Commission for Railway Regulation
CTC	Centralised Traffic Control
CWR	Continuous Welded Rail
DART	Dublin Area Rapid Transport
DCCR	Dublin City Central Resignalling
DC	Direct Current
DMU	Diesel Multiple Unit
DOT	Department Of Transport
DTE	District Traction Executive
ECO	Electric Control Operator
ECM	Entity in Charge of Maintenance
EMU	Electrical Multiple Unit
EU	European Union
FFCCTV	Forward facing closed circuit television
GSMR	Global System for Mobile Communications – Railway
hrs	hours
IÉ	Iarnród Éireann
IÉ-IM	Iarnród Éireann Infrastructure Manager
IÉ-RU	Iarnród Éireann Railway Undertaking
km	kilometre
LRA	Low Rail Adhesion
m	metre
MP	Milepost
MPV	Multi-Purpose Vehicle
mph	miles per hour
OEM	Original Equipment Manufacturer
OHLE	Overhead Line Equipment
OTDR	On Train Data Recorder
PSR	Permanent Speed Restriction

RAIU	Railway Accident Investigation Unit
RFI	Request For Information
SBUD	Safety Briefing and Update Days
SET	Signalling, Electrical and Telecommunications
TCB	Track Circuit Block
TGA	Traction Gel Applicator
TSI	Technical Specification for Interoperability
WSP	Wheel Slip Protection

Glossary of terms

Accident	An unwanted or unintended sudden event or a specific chain of such events which have harmful consequences. For heavy rail, the EU Agency for Railways divides accidents into the following categories: collisions, derailments, level-crossing accidents, accidents to persons caused by rolling stock in motion, fires and others.
Action Required	In terms of the CRR, it's an area where potential exists for a non-compliance to occur unless remedial action is taken, or improvement is made, an isolated error that requires correction, or some other action arising from the audit.
Article 20 of Directive (EU) 2016/798, Obligation to investigation	<p>Article 20 (1) Member States shall ensure that an investigation is carried out by the investigating body referred to in Article 22 after any serious accident on the Union rail system. The objective of the investigation shall be to improve, where possible, railway safety and the prevention of accidents.</p> <p>Article 20 (2) The investigating body referred to in Article 22 may also investigate those accidents and incidents which under slightly different conditions might have led to serious accidents, including technical failures of the structural subsystems or of interoperability constituents of the Union rail system. The investigating body may decide whether or not an investigation of such an accident or incident is to be undertaken. In making its decision it shall take into account:</p> <ul style="list-style-type: none">(a) the seriousness of the accident or incident;(b) whether it forms part of a series of accidents or incidents relevant to the system as a whole;(c) its impact on railway safety; and(d) requests from infrastructure managers, railway undertakings, the national safety authority or the Member States.
Automatic Train Protection	The ATP system fitted to the DART fleets operates on the principle of speed signals by comparing the actual speed (as driven by the driver) with the maximum permitted speed (on the line) and if the actual speed of the train is greater than the maximum permitted speed the system alerts the driver. If the driver fails to respond to the alert by controlling

	the speed of the train, the ATP system activates the full service brake and, if required the emergency brake
Category A SPAD	Any SPAD when a stop signal and any associated preceding cautionary indications was displayed correctly, in sufficient time for the train to stop safely at the signal.
Causal Factor	Any action, omission, event or condition, or a combination thereof that if corrected, eliminated, or avoided would have prevented the occurrence, in all likelihood.
Continuous Welded Rail	Sections of rail that are welded together.
Contributing Factor	Any action, omission, event or condition that affects an occurrence by increasing its likelihood, accelerating the effect in time or increasing the severity of the consequences, but the elimination of which would not have prevented the occurrence.
Down Direction	In this accident, trains travelling to Rosslare are travelling in the Down direction.
Driving into the bonds	When DART drivers, drive into a more restrictive bound without intervening to reduce the speed, allowing the ATP penalty brake to activate i.e. allowing the train to automatically brake to the designated speed.
Emergency brake	Operated by driver's brake controller (moving beyond full-service) or by an electric or pneumatic push button. It applies a similar brake pressure to full-service. This brake is only used in emergency situations and cannot be released once applied, until the train has come to a stop.
Full-service brake	The service brake is operated by the driver's brake controller and contains graduated steps that allow the driver to increase braking effort of the train up to "full service". At this point the driver has requested maximum braking from the train. This increases the drivability of the train. The driver can increase/decrease the braking effort as they wish.
Incident	Any occurrence, other than an accident or serious accident, associated with the operation of trains and affecting the safety of operation. For heavy rail, the EU Agency for Railways divides incidents into the

		following categories: infrastructure; energy; control-command & signalling; rolling stock; traffic operations & management and others.
Investigation		A process conducted for the purpose of accident and incident prevention which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations
Latching		The application of the emergency brake is latching; meaning, once commanded, it cannot be “un-commanded” until the train is at a standstill.
Low Adhesion	Rail	Trains rely on adhesion between the wheels and the rail for accelerating and braking. Reduced levels of adhesion are referred to as Low Rail Adhesion (LRA) and can be caused by moisture mixing with the film produced by leaves or other contaminants, such as rust or grease on the railhead. LRA can be particularly severe in autumn, but can occur at any time of year, resulting in disruptions to passenger journeys. LRA can also cause safety risks, such as signals passed at danger and station overruns.
Medium SPAD	Risk	Scored between 16 to 19, on a scale of 0 to 28, where low risk SPADs are 0 to 15 and high risk SPADs are 20 to 28.
Milepost		Marks distances.
Minor non compliance		Identified by the CRR as an area of non-compliance with a railway organisation internal standard, an applicable external standard, or legislation that is evidence of a sporadic lapse in implementation of a system or deviation from a system.
On Train Data Record		Device that records data about the operation of train controls and performance.
Penalty brake		Full service brake in the first instance, then emergency brake, if required.
Sandite		Sandite is a substance used on railways to combat leaves on the line, which can cause train wheels to slip and become damaged with flat spots. Sandite consists of a mixture of sand, antifreeze and steel shot.
Serious Accident		Any train collision or derailment of trains, resulting in the death of at least one person or serious injuries to five or more persons or extensive

damage to rolling stock, the infrastructure or the environment, and any other similar accident with an obvious impact on railway safety regulation or the management of safety. For heavy rail, the EU Agency for Railways divides serious accidents into the following categories: collisions, derailments, level-crossing accidents, accidents to persons caused by rolling stock in motion, fires and others.

Service brake		The service brake is operated by the driver's brake controller and contains graduated steps that allow the driver to increase braking effort of the train up to "full service".
SPAD Ranking	Risk	The ranking of SPAD severity, scored between 0 and 28, with 0 being the lowest risk and 28 being the highest risk.
Technical Specification for Interoperability		The Technical Specifications for Interoperability (TSIs) define the technical and operational standards which must be met by each subsystem or part of subsystem in order to meet the essential requirements and ensure the interoperability of the railway system of the European Union.
Traction Gel Applicators		Applies traction gel to the railhead to combat the build-up of contamination on the head of the running rails. The gel is picked up by the train wheels and carried along, treating both the wheels and the railhead.
Up Direction		In this accident, trains travelling from Rosslare are travelling in the Up direction.
Wheel flat		Flat spots which occur when a rail vehicle's wheelset is dragged along the rail after the wheel/axle has stopped rotating. Flat spots are usually caused by use of the emergency brake or slip and slide conditions that cause wheels to lock up while the train is still moving.
Wheel Slip Protection		A device, where fitted, which aims to prevent skidding from leaves or any other source, and thus the problems caused by wheel burn on the railhead. It works by limiting the rate at which the wheels are allowed to accelerate or decelerate.

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