



Railway Accident
Investigation Unit
Ireland



INVESTIGATION REPORT

**Collision between a car and a train at
Level Crossing XM190, Mayo, 9th September 2023**

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Report Description

Report publication

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Report structure

The report structure is written as close as possible to the structure set out in the “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 in order to illustrate concepts to non-technical readers.

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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 may 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 RAIU investigation shall analyse the established facts and findings (i.e. performance of operators, rolling stock and/or technical installations) which caused the occurrence. The analyses shall then lead to the identification of the safety critical factors that caused or otherwise contributed to the occurrence, including facts identified as precursors. An accident or incident may be caused by *causal*, *contributing* and *systemic factors* which are equally important and should be consider during the RAIU investigation. From this, the RAIU may make safety recommendations 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 15:15 hours (hrs) on Saturday the 9th September 2023, the Iarnród Éireann (IE) 12:45 hrs Heuston to Westport passenger service (Train A804) was approaching Prendergast's Level Crossing (LC), asset number XM190 (to be referred to as LC XM190), located between Ballyhaunis and Claremorris (County Mayo), at a speed of 70 miles per hour (mph) (110 kilometres per hour (km/h)). The train driver (Driver A804) sounded the horn at the *whistle board* associated with LC XM190 on their approach.

LC XM190 is an *Occupational Public (OP) user worked unattended level crossing (UWLC)* meaning it is guarded by metal gates across a public road; whereby a member of the public, the “user”, will have to open and shut the gates to cross the railway and continue on the road.

At the same time as Train A804 was approaching LC XM190 a car was also approaching LC XM190 from the *up side* (right hand side from the perspective of Driver A804). The car was travelling on a rural local road L65516 which links national road, N60, with another local road, L5551, and onto the N17. The speed limit for the local road is 80 km/h. The driver of the car (Car Driver) had taken a wrong turn at Claremorris and their satellite navigation system had diverted them onto these local roads which routed them over LC XM190 to continue on their journey.

On the approach to LC XM190 there are three “Level Crossing with No Flashing Red Signal (with Barriers or Gates)” advance warning signs (Sign W121) located at 100 metres (m), 200 m and 300 m in advance of LC XM190. In addition, there is a “Warning Railway Crossing Ahead Stop before you Cross the Railway” sign, a mandatory Stop Sign (Sign RUS 027), and a “Warning Trains” sign mounted on poles at LC XM190.

The gates at LC XM190 were left open to road traffic by a previous unknown user of LC XM190.

When Driver A804 saw the car approaching LC XM190 they sounded the train horn again. Driver A804 could see that the car was travelling “a bit fast” and made a full service brake application and continued to sound the horn. On realising the car was not going to stop, Driver A804 made an emergency brake application.

As Train A804 slowed, Driver A804 saw that the car was also slowing while arriving onto LC XM190, with the car coming to a “standstill” on the railway line.

There was insufficient time to bring Train A804 to a stop before reaching LC XM190 and Train A804 collided with the car (at the time of the collision the *coupler* was in the extended position as a result of issues with retracting couplers on the Intercity Railcar (ICR Fleet)).

The car sustained substantial damage on impact and was propelled approximately 31 metres (m) into an adjacent field landing on the passenger side.

The front of Train A804 came to a stop 310 m past the centre of LC XM190.

Driver A804 contacted the Mayo Line Signalman requesting emergency service and followed all other post-accident procedures correctly.

The two occupants of the car sustained injuries (the passenger sustained life-changing injuries) and were treated at the scene before being airlifted to hospital for treatment.

The RAIU have identified the following causal factors (CaF) relating to the collision of Train A804 with a car at LC XM190, as follows:

- CaF-01 – The gates at LC XM190 were left open by a previous user;
- CaF-02 – The Car Driver was unfamiliar with *Occupational Public (OP) Type* level crossings and as a result the Car Driver did not:
 - React to the three advance warning signs (Sign W 121) on approach to LC XM190 by slowing the car;
 - Obey the instructions listed in the “Danger Live Railway Crossing” sign at LC XM190;
 - Stop at the Stop Sign or Stop Line to look for approaching trains as required by Road Safety Authority’s (RSA) Rules of the Road.

The following may have been a contributory factor (CoF) to the damage and injuries sustained to the car occupants and car:

- CoF-01 – The coupler was in the extended position (as a result of issues related to retracting the coupler). Had the coupler been retracted, it may have reduced the rate of rotation of the car from the initial impact and may have reduced the damage sustained by the car and the subsequent injuries to the car occupants. However, it cannot be determined, what damage the car would have sustained had the coupler been retracted (i.e. there could have been worse damage; and in addition, there could have been other unintended unwanted consequences).

The RAIU have identified the following likely systemic factor (SF) to the accident:

- SF-01 – SF-01 - Sign W 121 does not portray clear meaning that the user is approaching a UWLC, a hazard (i.e. live railway) and does not indicate the severity of not adhering to the warning (i.e. being struck by a train).

At the time of the accident, a *Decision Support System* (DSS), which provides information for users on the approach of trains, was present at LC XM190 but had not been commissioned as a result of difficulty in getting electricity to the location.

In addition, prior to and after the accident, the Department of Transport and relevant stakeholders were undergoing a pilot programme in relation to advance warning sign, Sign W 121, and additional traffic calming measures at OP Type level crossings.

A new sign is currently being trialled at two OP Type level crossings. This new sign, Sign W126, depicts a train striking a car, with a “collision” element, clearly illustrating the hazard (i.e. live railway) and the severity of the hazard if the sign is not adhered to the warning (i.e. being struck by a train). Initial feedback, from level crossing users, is in favour of the proposed new sign, Sign W126.

This RAIU investigation has resulted in the following safety recommendations:

- Safety Recommendation 2024003-01 – The Department of Transport should continue to trial the new design sign (Sign W126), in consultation with the relevant stakeholders, with a view to replacing Sign W121. The RAIU maintain that the advance warning signs on the approaches to OP Type level crossings should portray the hazard (i.e. the road user is approaching a live railway) and indicate the severity of not adhering to the warning (i.e. possible collision with a train);
- Safety Recommendation 2024003-02 – IÉ-IM should replace their "Warning Trains" sign, located at OP Type level crossings, to the new proposed advance warning sign (Sign W126), once included in the Traffic Signs Manual.

IÉ-Infrastructure Manager (IÉ-IM) and IÉ-Railway Undertaking (RU) have taken a number of actions as a result of the accident (or previous RAIU safety recommendations), which has resulted in the absence of some safety recommendations.

Contents

RAIU investigation and its context.....	1
Decision & motivation to investigate this occurrence	1
Scope & limits of investigation	1
Technical capabilities & investigation methods.....	2
Communications & evidence collection	3
Other stakeholder inputs	4
Description of the occurrence & background information	5
Description of the occurrence type	5
Background to the occurrence.....	5
Deaths, injuries & material damage.....	6
Other consequences as a result of the accident	8
Parties & roles associated with the accident.....	9
Infrastructure	12
Operations	13
Rolling Stock	14
Road vehicle involved in the accident.....	16
Level Crossing XM190	17
Post accident inspections.....	32
Event before, during and after the accident.....	33
Events before the accident.....	33
Events during the accident	36
Events after the accident.....	40
Similar occurrences	42
Occurrences at LC XM190	42
Previous occurrences at level crossings that the RAIU has investigated	43
Research related to user worked level crossing signage.....	50
General introduction to advance warning signs	50

Introduction to Sign W 121	51
Vienna Convention on Road Signs and Signals	51
Use of “picket fence” symbol in other countries	52
RSSB research into signs and signals at public road level crossings (T756)	55
RSSB research into signs at private road crossings (T983).....	59
The Private Crossings (Signs and Barriers) Regulations	61
RAIU Draft Safety Recommendation as a result of RSSB Research	62
Analysis	63
Actions of the Car Driver	63
Actions of Driver A804.....	63
Damage to Skoda Octavia.....	64
LC XM190 condition and use	65
Signage & road demarcations for UWLCs	65
Conclusions	69
Causal, contributing, and systemic factors	69
Additional observations	70
Measures taken by IÉ & other parties since the accident	71
Pilot programme at OP Type Level Crossings	71
Improvements at LC XM190.....	73
Coupler	76
Train Horn	77
CSO presence in the driving cab	77
Sounding the Train Horn	77
Safety Campaigns	78
Internal investigation	79
Safety Recommendations	80
Introduction to safety recommendations	80
Absence of safety recommendations due to measures already taken	80

Safety recommendations as a result of this accident	82
Additional Information	83
List of abbreviations	83
Glossary of terms	85
References.....	90

RAIU investigation and its context

Decision & motivation to investigate this occurrence

- 1 On 9th September 2023, the RAIU on call investigator received a notification from IÉ of a collision between a car and a train at LC XM190 between Ballyhaunis and Claremorris. The RAIU on call investigator deployed to the scene to gather the relevant evidence.
- 2 The RAIU conducted a preliminary examination and the RAIU's Chief Investigator made the decision to conduct a full investigation into the accident, given its impact on railway safety (Article 20 (2)(c) of Directive (EU) 2016/798 of the European Parliament, Article 20, Obligation to Investigate), as under slightly different circumstances the accident may have led to a serious accident with the potential for fatalities of the car occupants (who suffered injuries in the accident) or for further fatalities or serious injuries to train passengers due to risk of derailment of the train as a result of the collision.

Scope & limits of investigation

- 3 The RAIU established the scope and limits of the investigation as follows:
 - Establish the sequence of events leading up to, during and after the accident;
 - Identify any other precursors which led to the accident;
 - Examine the warning signs and notices for car drivers on approach to UWLC;
 - Review the existing IÉ safety measures and standards for the safe operation of UWLCs;
 - Review measures taken to date by the Department of Transport and IÉ-IM in relation to advance road signage and traffic calming measures at UWLCs;
 - Establish causal, contributing and systemic factors;
 - Identify any additional observations;
 - Make safety recommendations for the prevention of similar occurrences.

Technical capabilities & investigation methods

- 4 The RAIU's Chief Investigator allocated RAIU Senior Investigators, trained in accident investigation, to conduct this investigation, as appropriate.
- 5 During the investigation, the RAIU on call investigator deployed to the accident site when notified by IÉ and later collated evidence through the submission of Requests for Information (RFIs) to IÉ-IM and IÉ-RU Safety Departments. Related to this investigation, the RAIU collated and logged the following evidence:
 - Photographs taken on the day from the accident site at LC XM190;
 - Forward facing closed circuit television (FFCCTV) footage from Train A804;
 - On Train Data Recorder (OTDR) download from Train A804 which included details on train speed, distance travelled, brake, horn, and headlight application;
 - Training and competence records for those directly involved;
 - Maintenance interventions for Train A804 prior to the accident;
 - Interviews of the IÉ staff on board Train A804 at the time of the accident;
 - Statements from the Car Driver and their representative;
 - Level crossing inspections for LC XM190;
 - Risk ranking for LC XM190;
 - CCE-TMS-380 Technical Standard for the Management of User Worked Unattended Level Crossings, Version 2.3, issued on the 1st October 2020 (to be referred to as CCE-TMS-380);
 - CCE-TMS-382 Technical Standard for Decision Support System at User Worked Crossing, Version 1.2, issued on the 23rd July 2019 (to be referred to as CCE-TMS-382);
 - CCE-TMS-361 Technical Standard for Track Patrolling, Version 20, issued 4th June 2021 (to be referred to as CCE-TMS-361);
 - CCE-TMS-360 Track Inspection Requirements Version 3.0, issued the 3rd April 2023 (to be referred to as CCE-TMS-360);
 - IÉ Signallers General Instruction, Version 2.1, issued the 19th July 2021;

- Chapter 6, Warning Signs, Traffic Signals Manual, Department of Transport, 2019¹;
- ICAN Acoustics, 22000 ICR Warning Horn Testing and Analysis Compliance Report, Rev 1.6, 03/04/2023;
- IÉ Professional Drivers Handbook Issue 4, 30th November 2014;
- Technical Standard for Decision Support Systems at User Worked Crossings CCE-TMS-382, Version 1.2, operative since 23/07/2019;
- Department of Transport, Report into User Operated Level Crossings, Report on recommendations for the use of warning sign W 121 at user operated level crossings on the local road network, User Operated Level Crossing Pilot Programme;
- IÉ-IM (2024), Report of Investigation: Train A804 collision with car at level crossing XM190 9th of September 2023”, Report No. R0604-2024-25.

Communications & evidence collection

- 6 Communications were conducted through established processes (such as formal interviews and RFIs).
- 7 An Garda Síochána provided the RAIU with some evidence in terms of the condition of the car before and after the accident.
- 8 Relevant stakeholders were issued with the draft investigation report for comment, stakeholders' responses were considered, and the stakeholders were advised of the conclusion. In this instance the stakeholders were: IÉ-RU and IÉ-IM, the Car Driver's representative, the Commission for Railway Regulation (CRR)² and the Department of Transport.
- 9 In summary, all relevant parties fully co-operated with the RAIU investigation.

¹ It is noted that Chapter 6 was updated in February 2024 (after the accident), however, there are no changes, of note, to the level crossings section.

² The CRR is the National Safety Authority (NSA) for the Republic of Ireland and is responsible for the regulatory oversight of the application and effectiveness of railway organisations 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.

Other stakeholder inputs

- 10 The IÉ CSO made an announcement on the train public address system requesting any passengers with medical expertise to come forward. A doctor, a nurse and two rapid responders came forward to assist the injured parties.
- 11 Emergency services (ambulance, helicopter, and medical professionals) attended the accident site to attend to the two occupants of the car.
- 12 An Garda Síochána attended the scene on the day of the accident and provided Public Service Vehicle (PSV) Inspector reports in relation to the damage to the car.
- 13 The RAIU contacted Google in terms of possible warnings on Google Maps.

Description of the occurrence & background information

Description of the occurrence type

- 14 At approximately 15:15 hrs on the 9th September 2023, Train A804 was approaching LC XM190 at 70 mph (110 km/h). At the same time, a car also approaching LC XM190 from a local road. When Driver A804 saw the car approaching LC XM190 they sounded the horn and made an emergency brake application but there was insufficient time to bring the train to a stop and the train collided with the car, propelling it into an adjacent field and injuring both car occupants.
- 15 The EU Agency for Railways categorisation for this occurrence is an: Accident – Level Crossing.

Background to the occurrence

- 16 LC XM190 is located on local road L65516.
- 17 LC XM190 is an OP Type UWLC meaning it is a user worked unattended occupational level crossing on a public road; where a member of the public, the user, will have to open and shut the gates of the UWLC in order to cross the railway.

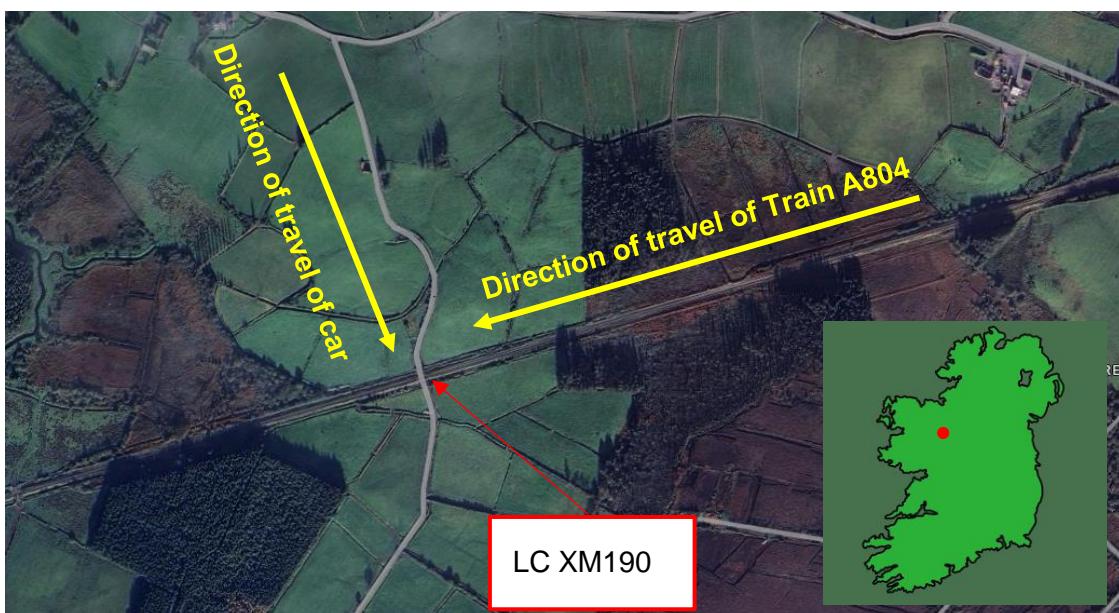


Figure 1 – Location of the accident

- 18 The accident occurred during daylight hours and the weather recorded at Met Éireann Weather Station (Claremorris), approximately 5 kilometres (km) southwest, showed a temperature of 17.6°C with no rainfall around the time of the accident. Visibility was good at the time of the accident.

Deaths, injuries & material damage

Injuries

- 19 The two occupants of the Skoda Octavia were treated at the scene before been airlifted to hospital to the treatment. The Car Driver sustained a broken ankle. The Car Passenger suffered life changing neurological injuries and requires ongoing medical interventions and therapies.
- 20 No staff or passengers were injured on Train A804.

Material damage

Damage to Train A804

- 21 The Chief Mechanical Engineer's (CME) Department examined Train A804 and recorded damage to the body work, coupler (which was in the extended position) and pneumatic braking system of the leading carriage (see Figure 2); estimating the total cost of repair to Train A804 as €263,005.

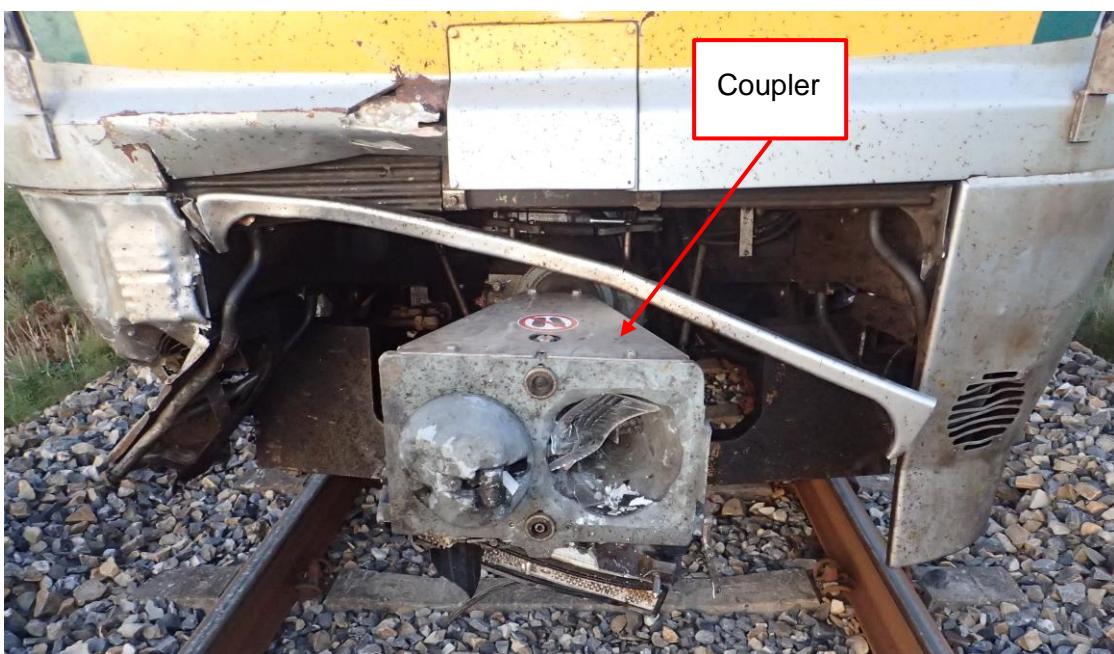


Figure 2 – Damage to Train A804

Damage to LC XM190

22 There was some damage to cattlegrids and fencing.



Figure 3 – Damage to level crossing infrastructure

Damage to Skoda Octavia

23 The Skoda Octavia was examined by An Garda Síochána Public Service Vehicle (PSV) Inspector (An Garda Síochána Inspectors who undertake vehicle examinations) who noted “massive” damage to the passenger’s side front of the car, crushing inwards the passenger’s side of the car including the chassis leg, dash, bulkhead, the bonnet and the roof (see Figure 4). The engine was broken out to of the car. Both passenger side doors and the quarter panel and both wheel rims and tyres and the suspension arm were damaged. Both driver’s side doors the wing and quarter panel were damaged. The driver’s side front wheel rim was damaged. The brake pipe was damaged at the master cylinder. Both passenger side dampers/shocks were damaged.

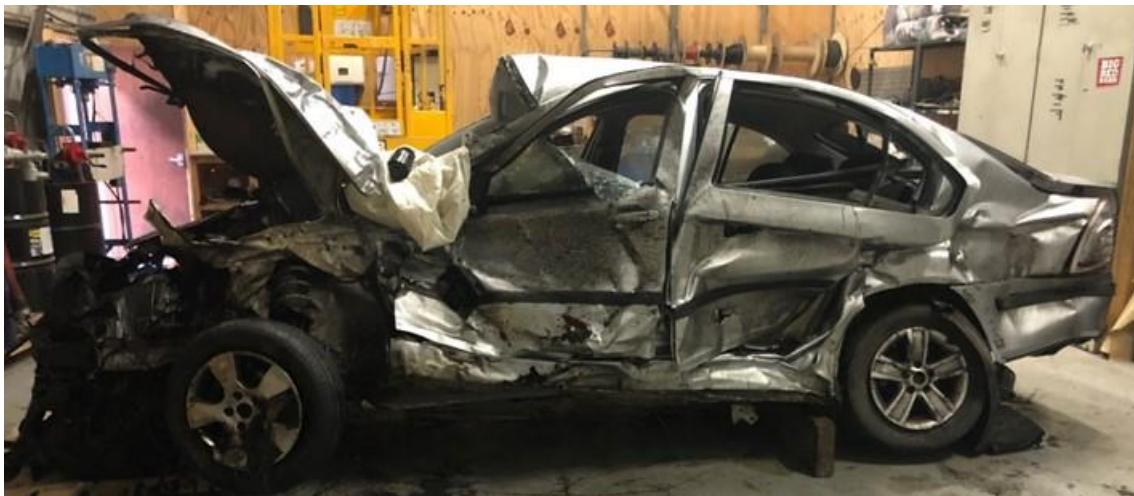


Figure 4 – Damage to the car

Other consequences as a result of the accident

- 24 The line reopened for normal traffic at 20:47 hrs; approximately 5 hours and 32 minutes after the accident. Four passenger trains were delayed as a result of the accident resulting in a total of 372 delay minutes experienced.
- 25 Bus and taxi hire for the onward journeys of passengers delayed as a result of the accident resulted in a cost of €8,073.
- 26 The total financial costs to IÉ, as a result of the accident (damage to rolling stock (paragraph 21)) and onward transport (paragraph 25), was approximately €271,078.

Parties & roles associated with the accident

Parties involved in the accident

27 IÉ-IM is the infrastructure manager 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 European Directive 2016/798, S.I. No 476 of 2000 and Commission Regulation (EU 2018/762) the authorisation was renewed on the 24th March 2022 for a period of five years. The IÉ-IM department involved in the accident and relevant to this investigation is:

- IÉ-IM Chief Civil Engineer's (CCE) Department - Directs the Technical Support, Business Support and Safety Sections within the Civil Engineering Department of IÉ-IM. The CCE Department carry out the inspection and maintenance of track and structures, including level crossings.

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 CRR. The RU Safety Certificate is issued in conformity with European Directive 2016/798 and S.I. 249 of 2015; the Safety Certificate was renewed on the 23rd March 2023 for a period of five years. The IÉ-RU department involved in the accident and relevant to this investigation is:

- IÉ-RU CME – 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;
- IÉ-RU Operations – responsible for the operation of trains on the network; this includes the supervision of train drivers and CSO staff.

Roles involved in the accident

IÉ-RU staff

29 The IÉ-RU members of staff involved in the accident are:

- Driver A804 – Driver A804 was passed competent as a train driver in October 2000 and held a valid Train Driving Licence at the time of the accident. Driver A804 completed his last assessment on 15th June 2023 and was in date for all the relevant train driver competencies. Driver A804 was rested and fit for duty on the day of the accident;
- CSO – Member of IÉ staff who travels onboard trains to assist passengers and was competent at the time to perform relevant duties after receiving all necessary briefings including protocols for entering driving cabs. The CSO was rested and fit for duty on the day of the accident.

Third parties

30 There were two occupants of the car, the:

- Car Driver – At the time of the accident, the Car Driver was twenty years old and held a full Irish driving licence, with no endorsements. The Car Driver resides in County Galway and has confirmed that they were unfamiliar UWLCs (in particular OP Type level crossings) and they had never approached one until the day of the accident;
- Car Passenger – Travelling with the Car Driver.

Parties not directly involved in the accident

Commission for Railway Regulation

- 31 The CRR is the national safety authority, responsible for the regulatory oversight of the Railway's Safety Management System and enforcement of railway safety in Ireland in accordance with the Railway Safety Act 2005 and the European Railway Safety Directive.
- 32 CRR have issued "Guidelines for the Design of Railway Infrastructure and Rolling Stock", Section 5 Level Crossings, CRR-G-006-C (2022).

Road Safety Authority

- 33 The RSA is a state agency formed by the Irish Government to promote road safety within Ireland. The agency has devolved control of much of the work of the Department of Transport and aims to reduce the number of deaths and serious injuries on Irish roads by 50% over the next ten years (2021-2030).
- 34 The RSA is responsible for the drafting, re-drafting and issuing of the Rules of the Road. The Rules of the Road form the basis of road safety in Ireland and all drivers are required to demonstrate their knowledge of the Rules of the Road before being issued with a driving licence.

Department of Transport

- 35 The Mission Statement of the Department of Transport is: "To deliver an accessible, efficient, safe and sustainable transport system that supports communities, households and businesses."
- 36 The Department of Transport have produced and when necessary, revise, the Traffic Signs Manual, to be discussed in paragraphs 61 to 63.

Infrastructure

Track

- 37 The accident occurred on a bi-directional single line section of track between Ballyhaunis 124 ¼ Mile Post (MP) and Claremorris 135 MP, which is plain line with flat bottom *continuously welded rail* (CWR) mounted on concrete sleepers in ballast.
- 38 The line between Athlone (78 ¼ MP) and Westport (161 ¼ MP) takes its MP datum from Broadstone (0 MP) the former Dublin terminus of the Great Western Railway.

Signalling & communications

- 39 The line is operated under the rules and regulation for trains signalled by Track Circuit Block (TCB) and is controlled by the Mayo Line Signalman located in the Athlone Control Centre. The signals along the line comprise of two and three aspect colour light signals.
- 40 The means of communication between train drivers and the controlling signalman is by train radio.

Operations

General description

- 41 Trains travelling towards Dublin, are travelling in the *up direction*. Trains travelling towards Westport are travelling in the *down direction*.
- 42 The maximum permissible line speed for the section of line where LC XM190 is located is 70 mph (110 km/h) as set out in the Working Timetable. There were no permanent or temporary speed restrictions in place at the time of the accident.
- 43 Train A804 was the 12:45 hrs Heuston to Westport passenger service carrying 190 passengers and two staff (Driver A804 and CSO) at the time of the accident.

Sounding of the train horn

- 44 Section 3.0, Instructions to Drivers, of the IÉ Rule Book, states that drivers must sound the horn as a warning when passing a whistle board (whistle boards are located on the approaches to UWLCs³).

Driving cab access

- 45 The IÉ Rule Book, Section 5.2, Travelling in Driving Cabs, states that “no-one is allowed to travel in any driving cab apart from the driver in charge, except: anyone carrying out duties which specifically require them to accompany the driver in accordance with the Rules; a driver during road learning duties; a shunter during shunting operations; or a person required to travel by Engineer’s Train to or from a worksite in a possession”.

³ It is noted that in some cases where the UWLC has been closed, the whistle boards may remain for operations reasons (e.g. on curves for the safety of Track Patrollers or if the level crossing, although closed, is used for access by permanent way staff). Irrespective of the reason for the whistle board at certain locations, drivers must sound their horn at all whistle board locations.

Rolling Stock

General description of Train A804

- 46 Train A804 was formed by two coupled 22000 Class Diesel Multiple Units (DMUs) ICR sets (collectively referred to as ICRs in this report); each car in a set is joined together by mechanically, pneumatically and electrically by a semi-permanent coupler (further discussed in 51 to 53).
- 47 Train 804 was formed by a three car set (22250, 22450, 22250 trailing) and a four car set (22343 leading, 22443, 22543, 22243), see Figure 5. This formation is 165 m long and weighs 352 tonnes (352,000 kilogrammes (kg)).



Figure 5 – Configuration of Train A804

- 48 ICR trains have a maximum permissible speed of 100 mph (160 km/h).
- 49 The last routine maintenance interventions for the ICRs recorded no outstanding tasks.

Train horn

- 50 At the time of the accident, the audible warning device on the ICR fleet consists of a dual sounded 370 Hertz (Hz) and 311 Hz horns, high and low tone horns, fitted on either side of the front underframe of the driving cab⁴.

⁴ The 22000 DMU ICR fleet was due to undergo a proposed change to the horn at the time of the accident, which is further discussed in paragraphs 261 to 262.

Coupler

51 The ICR Fleet was originally designed to operate with the cab end automatic coupler retracted, see Figure 6. Note: ICRs are the only IÉ vehicle fitted with a retractable coupler. All other IÉ fleets have a coupler fixed in the normal (extended) position. The ICR Fleet was modified in 2015 removing the front hatch and installing new trim, which exposed the coupler, see Figure 7.

52 In January through March 2023 there was an issue with the couplers on the ICRs; when the coupler was being retracted it was damaging coils within the coupler. On the 6th January 2023, the Head of Health & Safety IÉ-RU issued a Shed Notice (700/29 RU23) for the 22000 Class DMU (ICR), which stated "At present some 22000 Class DMU (ICR) trains will not retract the coupler. If this happened the train may continue in service as normal. Once this has been resolved a further notice will be issued". This decision to leave the couplers in the extended position was to limit the damage from the coils when retracting and any potential associated service affecting failures⁵.

53 As a result of this Shed Notice, the autocoupler on Train A804 was in the extended position.



Figure 6 – Coupler retracted



Figure 7 – Modification to hatch

⁵ It is noted that the CME Heavy Maintenance Manager engaged with the manufacturer of the coupler in terms of reliability of the coupler running in the permanently extended position, whereby the manufacturer stated that "there are additional forces presented by the increased length of the coupler (acting as a lever arm) when the head is in the extended position", however the manufacturer noted there would be "minimal risk to reliability" in the "short term" with increased monthly checks (to assess the vertical alignment of the couplers for any signs of degradation); this was signed off by the manufacturer in March 2023. There was no time scale on the couplers being left in the extended position, however, IÉ-RU staff travelled to the manufacturer to assist with a resolution.

Road vehicle involved in the accident

- 54 The road vehicle involved in the accident was a 2009 silver Skoda Octavia (see Figure 8 for a car similar to that involved in the accident). The weight of the car is approximately 2015 kg.



Figure 8 – Stock image of Skoda Octavia similar to the car involved in the accident

- 55 The car passed its yearly National Car Test (NCT) with no outstanding defects listed; the next NCT was due on 22nd January 2024.

Level Crossing XM190

Location and road access to LC XM190

- 56 LC XM190 is located at 131 miles 1139 yards between Ballyhaunis Station (124 ¼ MP) and Claremorris Station (135 MP).
- 57 LC XM190 is located on local road L65516, which links national secondary road N60 with the L5551 and onto N17.
- 58 The road speed limit is 80 km/h⁶, the speed limit for local roads.

Designation

- 59 LC XM190 (see Figure 9), also known as Prendergast's Level Crossing, is classified as an OP Type UWLC⁷, meaning it is a user worked unattended occupational level crossing on a public road.



Figure 9 – LC XM190

⁶ It should be noted, the Road Traffic Act 2024 proposes reductions in speed limits on national, regional and local roads; under this legislation, the 80 km/h speed limit would be substituted with 60 km/h; however, at the time of publication of this report, the speed limit remains at 80 km/h.

⁷ As of July 2024, there are forty-two OP Type level crossings on the IÉ network. Note, there is an estimated cost of €2,000,000 to €6,000,000 associated with closing these type of level crossings, as bridges are required.

60 UWLCs require the user to open and close the gates present at the level crossing. Under the Railway Safety Act 2005 persons who fail to close railway level crossing gates after use are liable to a fine of €1,000.

Road Traffic Signs

Requirements for Level Crossing Warning Signs at OP Type level crossings

- 61 In accordance with Chapter 6, Warning Signs, of the Traffic Signs Manual (published August 2019) a “gated crossing with iron gates operated by the user” requires Signs W 121 and a supplementary plate P 001 showing the distance to the junction and two RUS 027: Stop Signs on the gate and post, see Figure 10.



W 121 – Level Crossing with no flashing red signals (with barriers or gates)⁸ P 001 – Supplementary Plate: Distance RUS 027 – Stop Sign

Figure 10 – Required road signage on approach to and at gated crossings

62 Level Crossing Countdown

Markers, Signs W 122.1 to W 122.3 (see Figure 11), may be provided as an alternative to Supplementary Plates (P 001). In particular, Level Crossing Countdown Markers should be provided on the approaches to railway level crossings on national roads outside urban areas.



Figure 11 – W122, Level Crossing Countdown Markers

- 63 The above signs are erected by the relevant local authority.

⁸ Note although stating that these signs are used at barriers or gate, they are not used at barrier level crossings such as all automatic full barrier level crossings. The use of this sign at barrier crossings in other countries is outlined in paragraphs 184 to 187.

Warning signs on the approaches and at LC XM190

- 64 The required Signs W 121 and W 122 were erected at three locations on each of the approaches to LC XM190 in accordance with the Traffic Signs Manual (paragraphs 61 and 62), see Figure 12 for an example of the advance warning signs on the approach to LC XM190.



Figure 12 – W 121 and W 122 Signs (Upside LC XM190)

- 65 The Stop Sign (RUS 027) is present at the Stop Line⁹ (also required by the Traffic Signs Manual), see Figure 13.
- 66 This signage at LC XM190 has been complaint with the Traffic Signs Manual since 2015.



Figure 13 – LC XM190

⁹ The Stop Line is the “Decision Point”, a point 2 m from the nearest rail, where it is safe to stop clear of the railway track on an O, OP, OC, P and F Type level crossing at which the level crossing user decides to either wait or continue across the railway track.

Additional IE Level Crossing Warning Signs at OP Type level crossings

Requirements set out in CCE-TMS-380

- 67 CCE-TMS-380 sets out the requirements for IE-IM signage and road markings at O/OP Type level crossings which includes (for each approach to the level crossing): one "Warning Trains" (Diamond Type) (see yellow diamond sign in Figure 14); two "Danger Live Railway Crossing" signs (one English language (see yellow and red sign in Figure 14), one Irish language), one "Keep These Gates Shut".
- 68 There is an additional Stop Sign mounted on the metal gates (see Figure 13).
- 69 CCE-TMS-380 requires Stop Lines to be painted on the road to indicate, to the level crossing user, the safe distance that a vehicle user can stop without the vehicle encroaching onto the path of trains, this is sometimes referred to as the "decision point" i.e. the point where the motorist decides to cross if it is safe to do so. The Stop Line is a 300 millimetres (mm) continuous white line which is painted from the left edge to a point, two-thirds across the roadway and continues as a broken white line to the edge of the roadway (this has been designed in agreement with the Department of Transport). The line should be located approximately two metres from the running edge on each side of the level crossing road approaches.
- 70 Additional Stop Signs are mounted on the gates in accordance with CCE-TMS-380 (see Figure 13).

Signage at LC XM190

- 71 The Stop Line has been present at LC XM190 since March 2012 and the signage was last updated in April 2019, to meet the requirements of CCE-TMS-380 (see Figure 13).
- 72 Although no longer a requirement in CCE-SMS-380, additional, "Stop before you Cross the railway" signs, remain in place on the approaches to LC XM190 as an additional advance warning sign, see Figure 15.



Figure 14 – Warning & Danger Signs



Figure 15 – Old signage

Other infrastructure at LC XM190

General infrastructure at LC XM190

- 73 The surface of the intersection of the road with the track is a sealed surface, providing a level surface over the track. Cattlegrids are installed on each side of the roadway, where it crosses the track. There are concrete post and wire fencing running between the gates and the boundary hedges.

Decision Support System

74 Since 2020, IÉ-IM have been installing DSSs at four types of UWLCs, on single lines only where the maximum permissible line speed is 100 mph (160 km/h)¹⁰.

75 The system utilises a two-aspect colour light warning to crossing users, Figure 19. Orange to indicate that a train has not been detected and red to indicate that an approaching train has been detected i.e. When no train is being detected, the Orange light will be displayed to the user. When a train is detected, the Red light will be displayed to the user.

76 The system also provides for the Audible Warning Device to signify a train is approaching the level crossing, and this is maintained until the warning light is switched back to orange.

77 The default sound levels are set at 80 dB day and 70 dB night but may be varied as necessary to suit local circumstances. The audible warning unit produces two alternating tones with frequencies of nominally 800 Hz and 1000 Hz.

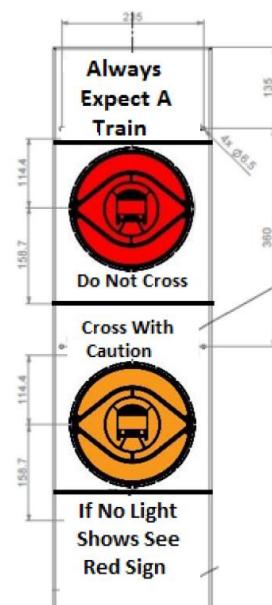


Figure 16 – DSS Lights

¹⁰ To date sixty-two DSSs have been installed on the IÉ network, at OP/O Type level crossings, F Type and P Type.

78 The technical management standard related to DSSs, CCE-TMS-382, notes that the DSS:

- Does not remove the obligation on the user to open and close the gates;
- Does not in any way aim to control train movements;
- Provides an aid to the crossing user in terms of utilising the crossing safely;
- Provides a means of facilitating further, the level crossing user in their determination of whether or not it is safe to cross the railway;
- Provides improved information on the approach of trains to assist users with their determination of when it is not safe to cross.

79 On the day of the accident, LC XM190 did have the DSS infrastructure installed, however, it was not commissioned¹¹ and was covered by orange tarpaulin in (see Figure 17).

80 Prior to the accident, IÉ-IM, in conjunction with ESB Networks attempted to agree, with a local landowner, a proposed electricity supply route through their adjacent land to the DSS, however, the landowner would not agree on the proposals presented¹².



Figure 17 – DSS covered in tarpaulin

¹¹ The DSS was commissioned at LC XM190 on the 11th November 2024 (paragraph 252).

¹² It should be noted that a different landowner has now agreed a new proposed route.

Operation of O & OP Type level crossings

Documentation for the use of O &OP Type Level Crossings

81 The use of O¹³/OP Type Level Crossings is specified in four publications, all of which are available on their respective websites:

- The RSA's 'Rules of the Road', last revised in 2022¹⁴;
- IÉ-IM's 'The SAFE use of Unattended Railway Level Crossings', last updated in June 2024 (to be referred to as IÉ-IM Booklet for the remainder of this report);
- Safety at Level Crossings, an RSA document with contributions from the CRR, published by the RSA in June 2016.

Operation of unattended level crossings according to the RSA's Rules of the Road

82 The RSA's Rules of the Road states that "These unattended level crossings are found on minor roads. The railway is normally guarded by iron gates which must be kept shut – there is no other protection. The user has the responsibility to open and shut the gates after use. It's the law. These crossings can be dangerous to use and drivers should use all available help to cross safely. It is preferable for drivers to use a bridge or an attended or automated level crossing where one is available".

83 In terms of what drivers "should" do, in terms of preparing to cross, drivers should: stop clear of the gates; switch off phone and music systems; open windows on driver and passenger sides; read instructions¹⁵ at the crossing; get a helper to operate the gates if possible.

84 In terms of driving across safely, the drivers should "First walk across and open both gates; Drive forward and STOP two metres clear of the railway line; apply your handbrake; look right and left and listen; drive across quickly when the railway is clear; and stop well clear of the tracks on the opposite side".

¹³ There are sixty-five O Type level crossings on the network, nineteen of these have approach roads under the control of the local authority (in terms of approach signage).

¹⁴ Knowledge of the RSA's Rules of the Road is required by all drivers and is tested as part of the driving test for the issuance of a full driving licence; as such, the Car Driver should be aware of the requirements set out in terms of level crossings.

¹⁵ "Danger Live Railway Crossing" Sign to be discussed in paragraph 90.

85 What drivers must do, drivers must “shut gates at unattended level crossings; you must shut and fasten the gates as soon as you and any person, animal or vehicle under your care has passed through; even if the gates are open when you arrive, you must shut and fasten them after you to protect others; failure to shut and fasten the gates is an offence”.

Minimum viewing distances for approaching trains

86 In terms of drivers looking for approaching trains, where practicable, in order to provide level crossing users with a satisfactory warning time to safely cross the railway line, minimum views of an approaching train are required to be achieved. CCE-TMS-380 sets the minimum viewing distance¹⁶ in accordance with the speed of the line and, whether it is single or double line¹⁷.

Audible warnings of approaching trains

87 In order to provide an audible warning to drivers while stopped at level crossings, whistle boards are located on the approaches to OP level crossings and must be erected at a distance 5% to 10% greater than the minimum viewing distance for the particular class of line.

¹⁶ It should be noted that while the calculated viewing distances for vehicles are based on visibility for the level crossing user 3.66 ± 0.15 m horizontally and 1.22 ± 0.075 m vertically, the vehicles using the level crossing may be afforded a much better view of the level crossing, for example tractors or other high riding vehicles. Therefore, while maintaining viewing distances based on these measurements are undertaken, it should be acknowledged that the actual viewing distance available to the vehicle user may be greater than this.

¹⁷ In order to maintain minimum viewing distances, *Patrol Gangers* are required to note when vegetation is required to be cut back, under CCE-TMS-361. Where vegetation boards (V boards) are provided to mark viewing distances, these can be used for verifying the acceptability of the viewing distance rather than actually undertaking the measurement of the views (i.e. views of the V boards must be achieved at the required sighting).

Operation of LC XM190

Usage of LC XM190

- 88 At the time of the accident, *Level Crossing Risk Model* (LCRM) recorded the average daily utilisation of LC XM190, as 47.7 cars or vans, 0.42 buses, 1 lorries or heavy goods vehicle trucks, 1.42 tractors/ farm machinery, 1 cycles or motorcycles and 0.5 pedestrians. These figures are the average daily utilisation (the sum of both directions) and were recorded during a seven day / twenty-four hour traffic survey in 2023.
- 89 There are nine recorded level crossing users for LC XM190, these are level crossing users known to IÉ, who have been issued with IÉ-IM's "The SAFE use of Unattended Railway Level Crossings" (paragraph 81).

Instructions at LC XM190

- 90 The "Danger Live Railway Crossing" Sign positioned at level crossings also provides instructions on how to operate the level crossing (paragraph 84, see Figure 18), requiring users to stop clear if the level crossing, open both gates, stop behind the Stop Line, look both ways every time you cross and listen for trains (open window and turn music off) and shut the gates after use.



Figure 18 – Danger Live Railway Crossing Sign

Minimum viewing distances for approaching trains at LC XM190

- 91 In accordance with CCE-TMS-380, the minimum viewing distance for LC XM190 is 350 m in both directions, as it is a single line with a maximum train speed limit of 70 mph (110 km/h).
- 92 The actual viewing distances for LC XM190 (up side), in place at the time of the accident, are recorded as 600 m in the up direction and 1,000 m in the down direction; in excess to the requirements set in CCE-TMS-380. See Figure 19, for a photograph taken from the viewing point on the day of the accident, of the V boards, confirming the minimum viewing distances in the direction from which Train A804 approached LC XM190¹⁸.



Figure 19 – V boards on the up side, looking in the up direction

Audible warnings of approaching trains

- 93 Whistle boards are erected at distances of 385 m from LC XM190 on both approaches.

¹⁸ V boards have been present at LC XM190 since September 2015.

Level Crossing Risk Model

- 94 The LCRM is a tool used for the calculated ranking of collective¹⁹ and individual risk²⁰ at LCs and provides a means of understanding the risk presented by each LC on the IÉ network. The LCRM provides a means for collecting, storing and recalling data on each LC and also provides a risk assessment for each LC. The LCRM calculates the risk rankings for LCs based on data input related to each LC, ranking the LCs from the highest (1) to the lowest (42 in the case of OP LCs (LC XM190 is an type OP LC)); the risk ranking is recalculated when new data is inputted.
- 95 At the time of the accident, for the Athlone Division, LC XM190 had a collective risk ranking of 1 out of 42 level crossings and an individual risk ranking of 5 out of 42 level crossings; classifying it as having a “high” level of abuse (due to the probability of gates left open) but a “tolerable” risk.

¹⁹ Collective risk is the total harm including injuries and fatalities from accidents. It includes the harm to everyone exposed to the hazards including passengers, workforce and the public. Collective risk is measured in the units of safety loss per year, referred to as fatalities and weighted injuries per year. Collective Risk is used as the basis for cost-benefit calculations as it is possible to assign a monetary value to safety loss.

²⁰ Individual risk is a measure of the likelihood that a person is fatally injured per year from their exposure to the railway. Individual Risk is measured in the units of the probability of a fatality to an individual per year. Individual Risk is used to assess the tolerability of risk, if individual risk is beyond an upper limit, the risk is considered intolerable.

Inspection of OP Type level crossings

Weekly Inspections of OP Type level crossings

- 96 Patrol Gangers are responsible for inspecting the track, related features and general infrastructure for their respective patrol length on a weekly basis and advising the Permanent Way Inspector of any issues as required under CCE-TMS-360 (Track and Structure Inspection Requirements and CCE-TMS-361 (Track Patrolling)).
- 97 The Patrol Ganger records whether the gates were left open while walking their patrol lengths, these reports are sent to the Permanent Way Inspector (PWI) who reviews; and where within the PWI's responsibility, the PWI will generate a work order in IÉ's SAP Software computer system (a tool used by IÉ to co-ordinate resources and activities in order to manage work).
- 98 Misuse and abuse of the level crossing (e.g. gates left open unintentionally or intentionally) is also recorded on the SAP Software system; this is further discussed in paragraphs 106 to 108.

Weekly Inspections of LC XM190

- 99 The section of track containing LC XM190 is inspected weekly by the Patrol Ganger, normally on a Monday.
- 100 The thirty-five Patrol Ganger Reports from 3rd January 2023 to the 22nd August 2023 (eleven days before the accident) identified gates open at LC XM190 on sixteen occasions; on finding the gates open, the Patrol Ganger closed the gates.
- 101 The Patrol Ganger did not detect any other faults at LC XM190, such as vegetation issues, during this period.

IÉ-IM Level Crossing Annual Inspection of LC XM190

- 102 CCE-TMS-380 requires a technical measurement survey to be undertaken at all O, OP, and *Open Crossing* (OC) UWLCs every year. (Section 5.1.3.1).
- 103 Records from LC XM190 Level Crossing Surveys from 2015 to 2023 record that the level crossing gates were open when IÉ-IM staff arrived at the site on eight of the nine occasions with the exception of 2021.

Maintenance of LC XM190

Vegetation management

104 There is an annual level crossing inspection process in place conducted by the Senior Track & Structural Engineer and the Regional Manager, Athlone Division. A vegetation control process is also in place for the route which comprises of level crossing surveys where the views are recorded, and the relevant notifications are created to address any non-compliances; these inspections are scheduled to take place every September.

105 Level crossing vegetation control, which comprises of weed spraying and hedge cutting the views, is scheduled to take place annually between September and March (outside the bird nesting season). Spraying took place at the level crossing on the 2nd June 2023 (three months before the accident) and the hedge cutting was completed on the 30th November 2022 of the previous year.

Misuse & Abuse of OP Type level crossings

General reporting of level crossings gate open

106 There are four primary modes for the reporting of the level crossing gates being open, this is through:

- Driver reporting – Drivers report gates open to the Controlling Signalman as required under the IÉ Professional Drivers Handbook, which states, “ensure you report crossing misuse” and “report gates open and all near misses”;
- Signalman reporting – Signalman records in the Train Register where gates have been reported open and this information is sent to the Manager CTC, as required by the Train Signalling Regulations and General Instructions to Signalmen. The Manager CTC circulates this information (and other relevant occurrences on the network) through the Daily Incident Reports (DIRs) which are emailed daily to all relevant parties in IÉ;
- Patrol Ganger reporting – as outlined in paragraphs 96 to 98;
- Level Crossing Inspections – Carried out by IÉ-IM CCE staff.

107 In terms of driver/ signalman reporting in the year previous to the accident (9th September 2022 to 9th September 2023 (the day of the accident)), there were 242 reports of gates being left open; none of these related to LC XM190.

108 The reports of gates left open are collected and reported through DIRs and through Information Asset Management System (IAMS). These are reviewed within IÉ-IM CCE and there are provisions within the LCRM where specific questions are asked in relation to gates left open (i.e. to identify bad actor usage (i.e. known level crossing where there is repeated poor behaviour by users in the operation of level crossing, normally in terms of the gates being left open)). This feeds into the LCRM calculation of the risk (collective or individual) at each level crossings which in turn informs IÉ-IM CCE management plans around level crossings (e.g. installation of a DSS).

Post accident inspections

Post-accident inspection of LC XM190

109 The post-accident inspection of LC XM190, found that the:

- Required Traffic Signs Manual signage was in place (paragraphs 64 to 66);
- The IÉ-IM signage was in place (paragraphs 67 to 70);
- The road surface condition was good (paragraph 73);
- The minimum sighting distances (350 m) were in excess of those set out in CCE-TMS-380, in that they were 600 m (up direction) and 1,000 m (down direction) on the upside (the direction the car was travelling);
- Whistle boards were provided at the correct locations.

RAIU testing of 22000 ICR horns at LC XM190

110 When located at the Stop Line at LC XM190, the activated train horn for approaching ICRs could be heard for the whistle board at LC XM190 and level crossings previous to LC XM190, where there was normal background noise.

Post-accident inspection of Skoda Octavia

111 An inspection of the car, on site, after the accident, shows that the window on the car driver's side was half lowered (see Figure 20). The damage is outlined in paragraph 23.



Figure 20 – Resting position of car with window half open

112 The PSV Inspector was satisfied that the brakes, steering and tyres had been serviceable on car prior to the collision apart from the driver's side rear tyre where the cord was exposed on the inner shoulder of the tyre (but not contributory to the accident).

Event before, during and after the accident

Events before the accident

113 At 09:00 hrs on the 9th September, Driver A804 booked on for duty at Westport Station; he was rostered to work from 09:00 hrs to 16:30 hrs. Driver A804's first duty was to operate the Westport to Dublin service as far as Athlone, arriving at Athlone at 11:25 hrs. Driver A804 then had to wait for Train A804 (12:45 hrs passenger service from Heuston to Westport).

114 At around lunchtime on the 9th September 2023, the occupants of the car, left County Galway, to travel to County Longford (a journey of approximately three hours). The intended route was to travel from Galway (on the N59²¹ and N84²²), through County Mayo (on the N60²³ and N61²⁴) and onwards to County Longford (on the N63).

115 Train A804²⁵ departed Athlone at 14:09 hrs, the CSO entered the driving cab shortly after departing Athlone (stating that he was feeling unwell) and remained in the driving cab up to the time of the collision²⁶.

²¹ Sligo Town (County Sligo) to Galway City (Galway).

²² Galway City (County Galway) to Castlebar (County Mayo).

²³ Castlebar (County Mayo) to Roscommon town (County Roscommon).

²⁴ Athlone (County Westmeath) to Boyle (County Roscommon).

²⁵ Train A804 was operating normally, the head light was illuminated, and the horn was operational.

²⁶ The CSO was not authorised, under the IÉ Rule Book, to travel in the driving cab on the day of the accident. The RAIU consider this to be an additional observation, AO-01 (paragraph 241), however, as a result of measures taken (paragraph 274) a safety recommendation is not warranted.

116 It is estimated that around 15:00 hrs, the car approached the Seamus O'Malley Roundabout in Claremorris, and instead of taking the exit for the onward journey to Longford, via the N60 the car took the third exit onto northbound N17²⁷, see Figure 21.



Figure 21 – Rerouted journey

117 On realising their mistake, the passenger used a satellite navigation system on a mobile phone to recalculate their journey back onto the N60. Figure 21 is the route the satellite navigation (Google Maps²⁸) recalculated for the car's journey.

118 The recalculated journey was to continue approximately 2.5 km on the N17, exiting onto paved local road L5551 (see Figure 22).



Figure 22 – N17 exit onto L5551

²⁷ Tuam (County Galway) to Collooney (County Sligo).

²⁸ The RAIU contacted Google in terms of whether visual or audible alerts could be provided for Google Maps users on approaches to UWLCs. Google confirmed that this feature is available in the United States of America and Canada; however, it is not a feature that is currently being rolled out globally. Google and the RAIU have committed to maintaining contact to see whether this feature could be introduced in Ireland in the future.

119 Traveling 3.5 km on L5551 and turn onto L65516, see Figure 23.



Figure 23 – Exit for L65516

120 The car travelled approximately 1.5 km along L65516 (a boreen²⁹ type road), see Figure 24.



Figure 24 – Boreen L65516 leading onto LC XM190

121 While the car was rerouting, Train A804 departed Ballyhaunis at 15:07 hrs.

122 Between Ballyhaunis and before the whistle board for LC XM190, Train A804 approached seven whistle boards, however, Driver A804 only sounded the horn for two³⁰.

²⁹ Narrow, rough rural road with grass growing in the middle.

³⁰ In general, whistle boards are located on the approaches to level crossings (paragraph 44). If a level crossing is closed, the associated whistle boards are removed; however, in some cases the whistle boards may remain for operations reasons (footnote 3). Driver A804 incorrectly assumed that, as some of the whistle boards were at the locations of closed level crossings, he was not required to sound the horn; however, the IÉ Rule Book is clear that the horn should be sounded at all whistle board locations (paragraph 44). The RAIU consider this to be an additional observation, AO-02 (paragraph 241), however, as a result of measures taken by IÉ-IM (paragraph 265) a further safety recommendation is not warranted (paragraph 275).

Events during the accident

- 123 Driver A804 sounded the train horn for the whistle board for LC XM190.
- 124 Around the same time a silver Skoda Octavia was approaching LC XM190, passing the advance warning signs, without reacting by slowing their car. This was an unintentional error as the Car Driver was unfamiliar with UWLCs and the Car Driver did not recognise that the advance warning signage meant they were approaching a live railway.



Figure 25 – Photograph with the gates open (not taken on the day of the accident)

- 125 The gates at LC XM190 had been left open to road traffic by a previous user in contravention to the law (paragraph 60) and travelled past the open gate, see Figure 26.



Figure 26 – View of approach to railway

126 At 15:15:03 hrs, when Driver A804 saw the bonnet of the silver Skoda Octavia (see Figure 27 (images taken from FFCCTV of Train A804)) approaching LC XM190, Driver A804 sounded the horn in case the Car Driver did not see the train. The front of Train A804 was 156 m from LC XM190³¹ (the train horn was sounded continuously until 15:15:10 hrs (after the collision)).

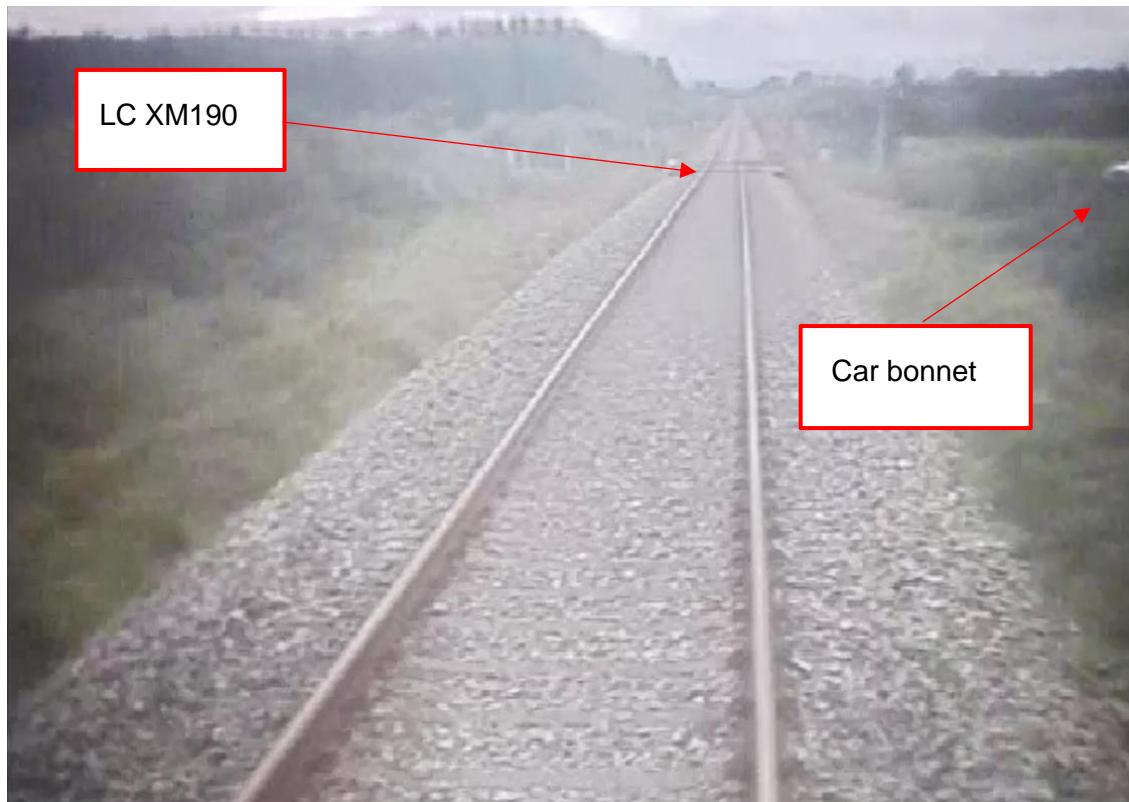


Figure 27 – Car bonnet on approach to LC XM190

127 Driver A804 saw the car continue towards LC XM190 and thought the car was travelling "a bit fast"³² (this can also be seen from the FFCCTV of Train A804) and made a full service brake application³³ at 15:15:05 hrs. Driver A804 continued to sound the horn. Train A804 was travelling 68 mph (109 km/h) and the front of Train A804 was 81 m from LC XM190.

³¹ The Car Driver does not remember the accident, only waking up in a field after the accident.

³² Although noting that there are Stop Signs at the level crossing, the speed limit for the road is 80 km/h, the Car Driver was unfamiliar with OP Type Level Crossings.

³³ A full service brake is the maximum braking for the train and is similar braking pressure to that of the emergency brake, but the brakes apply faster in an emergency brake application.

128 At 15:15:06 hrs, on realising that the car was not going to stop clear of LC XM190, Driver A804 made an emergency brake application³⁴. Train A804 was travelling 68 mph (109 km/h) and the front of Train A804 was 68 m from LC XM190.

129 As Train A804 slowed, Driver A804 saw that the car was also slowing while crossing LC XM190 (see Figure 28). Driver A804 stated “the car slowed to the point that it came to a standstill on the line directly in front of the train”.



Figure 28 – Car slowing on the LC XM190

³⁴ Train A804 was operating normally at the time of the occurrence. The braking rate achieved was $-1.24 \text{ metres squared per second} (\text{ms}^{-2})$, this exceeded the design braking rate of 1 ms^{-2} . The required braking distance at full service is 458 m; Train A804 stopped in 309 m therefore exceeding the design specifications.

130 At 15:15:08 hrs, Train A804 struck the car and was propelled approximately 31 m into an adjacent field landing on the passenger side, see Figure 29 for position of the car at moment of impact.



Figure 29 – Position of car at point of impact

Events after the accident

- 131 At 15:15:31 hrs the front of the train came to a stop 309 m past the centre of LC XM190.
- 132 After Train A804 came to a stop, Driver A804 made an emergency call on the train radio to the Mayo Line Signalman informing them of the accident and requesting the attendance of the emergency services.
- 133 The Mayo Line Signalman contacted the emergency services, their supervisor and Central Traffic Control.
- 134 All other relevant parties were notified of the accident.
- 135 Driver A804 then alighted from the driving cab and went to the front of Train A804 and could not see the car (but saw extensive damage to the front of Train A804).
- 136 The CSO also alighted from the driving cab and both CSO and Driver A804 then began to walk back down the line towards LC XM190, checking under the train as they walked.
- 137 As they approached LC XM190, they saw, in a field next to LC XM190, the male occupants of the car who appeared seriously injured and were seeking help.
- 138 Members of the public arrived at LC XM190 and went to help the injured parties.
- 139 Driver A804 and the CSO returned to Train A804. The CSO made an announcement on the train's public address system requesting any passengers with medical expertise to come forward. Two doctors, a nurse and two paramedic rapid response team members came forward and offered their assistance.
- 140 Driver A804 requested permission from the Mayo Line Signalman to allow these passengers exit Train A804, which was granted. The CSO then walked back to LC XM190 with these passengers.
- 141 The emergency services including the Fire Brigade, paramedics and An Garda Síochána, also arrived at the scene around this time. Shortly afterwards two Air Ambulances (Air Ambulance Athlone Air Corps 112 & Irish Coast Guard Rescue 118) also landed in fields adjacent to LC XM190.
- 142 At 16:05 hrs, an IÉ-IM Safety Investigator arrived on site and assumed the role of IÉ Incident Officer (IÉIO). Other members of IÉ-IM and IÉ-RU staff then arrived on site, in the next few hours.
- 143 At 16:20 hrs a member of the CCE Permanent Way Department took a T1 Protection (accidental obstruction of the line) of the line between Ballyhaunis and Claremorris.

- 144 At 16:40 hrs, the injured parties was removed from the scene, by air ambulance, and taken to University Hospital Galway.
- 145 At approximately 18:50 hrs (approximately three-and-a-half hours after the accident) Train 804 was driven back to LC XM190. Detraining of the 190 passengers onboard commenced shortly afterwards and was completed by approximately 20:00 hrs. Once detrained, passengers were brought, by buses to their destination stations.
- 146 At 20:45 hrs the T1 Protection of the line that had been taken between Ballyhaunis and Claremorris was handed back by the CCE Department to the Mayo Line Signalman.
- 147 At 20:47 hrs Train A804, driven by a relief driver, departed LC XM190 and travelled to Claremorris where it was then stabled.
- 148 Shortly afterwards the car involved in the occurrence was removed from the field adjacent to the level crossing by members of the Fire Brigade with the assistance of a recovery truck and taken to an An Garda Síochána storage facility.
- 149 Driver A804 was tested for drugs and alcohol, with the results returned as negative.

Similar occurrences

Occurrences at LC XM190

150 IÉ have recorded two previous Category 1 (a near miss incident in which the driver was required to make an emergency brake application) near misses at LC XM190, as follows:

- 2nd August 2019 – Driver reported: “A blue and white cattle lorry approached LC XM190 at speed. I applied the emergency brake and sounded the train horn. The lorry stopped just short of the crossing. I came to a halt, reset my brake and contacted the Signaller and reported the near miss”. The driver reported the weather conditions as fine;
- 16th June 2022 – Driver reported “that due to a tractor and slurry tanker approaching the level crossing with the gates in the open position, he had to apply the emergency brakes to the train”.

151 One Category 1 near miss occurred since the accident. At 11:18 hrs on Monday 26th February 2024, the driver (Driver S548) of the 10:05 hrs Ballina to Waterford laden timber train (Train S548) reported a near miss with a silver jeep at LC XM190. The jeep approached LC XM190 at speed and failed to stop at the regulatory Stop Sign and check for an approaching train, the jeep continued through the level crossing at speed and cleared LC XM190.

152 Driver S548 did not apply the emergency brakes to the train as he did not have time to react as Train S548 was approximately 150 m from LC XM190 at time of incident. Driver S548 did continuously sound the horn.

153 Following the near miss, Driver S548 reported the incident to the Mayo Line Signaller who in turn advised CTC and the Permanent Way Inspector (PWI).

154 The PWI went to LC XM190 and found both gates at LC XM190 in the open position and no silver jeep was found in the area. PWI reported the minimum viewing distances were compliant at LC XM190 and the safety warning signage is in place.

Previous occurrences at level crossings that the RAIU has investigated

Introduction

155 Since the establishment of the RAIU in 2007, the RAIU have investigated nine occurrences of collisions between trains and road vehicles at O/OP type level crossings:

- Kilnageer Level Crossing, XM240, Mayo, 29th April 2020;
- Cartron Level Crossing, XM220, Mayo, 17th August 2018;
- Knockaphunta Level Crossing, XM250, Co Mayo 8th June 2014;
- Corraun Level Crossing, XX024, Mayo, 12th February 2014;
- Morrough Level Crossing, XG173, Galway, 14th February 2011;
- Knockaphunta Level Crossing, XM250, Mayo, 24th October 2010;
- Stanley's No 2, XM096, Roscommon, 2nd September 2010;
- Cappadine Level Crossing, XN125, Tipperary, 31st July 2008;
- Straide Level Crossing, XX032, Mayo, 28th February 2008.

156 All the above were as a result of unintended errors. This section will review any open RAIU safety recommendations relevant to this investigation.

RAIU Safety Recommendation 2019003-03 – Level crossing signage

Introduction

157 The RAIU published “Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17th August 2018” on the 3rd September 2019. The investigation found that the existing traffic calming measures (such as the advance warning signs) may not be adequate at communicating to the users that they are approaching a railway line; and as such, made the following safety recommendation: “The Department of Transport, Tourism and Sport should review, in consultation with the relevant stakeholders, their current advance warning signage (W 121) with a view changing the signage to make it clear to road users that they are approaching a user operated level crossing. They should also consider the introduction of other traffic calming measures in efforts to encourage safe road user behaviour. Care should be taken not to inadvertently introduce new risks as a result of their proposed measures” (Safety Recommendation 2019003-03).

158 At the time of the publication of this report, the status of the safety recommendation remains open with the CRR.

159 During 2022, a series of meetings were held with representatives from the Department of Transport Regional and Locals Roads Division and Public Transport Regulation Division, the CRR, IÉ and the Department of Transport Support Office (to be referred to as the LC Working Group in this report). The purpose of these meetings was to achieve consensus and develop appropriate responses and actions regarding the RAIU safety recommendation (paragraph 157).

Pilot locations

160 Pilot trials were undertaken at four level crossings, namely:

- LC XN131, Cappanaskeady, Nenagh, County Tipperary. This level crossing is located on the Dublin to Limerick railway line where it intersects local road L6029 approximately 150 m south of regional road R445;
- LC XM122 Beagh, Castlerea, County Roscommon. This level crossing is located on the Dublin to Ballina/ Westport railway line where it intersects local road L6532 approximately 175 m east of the national road N60 at a point approximately 2.5 km south of Castlerea;
- LC XM220³⁵ Cartron, Claremorris, County Mayo. This level crossing is located on the Dublin to Ballina/ Westport railway line where it intersects local road L55381 approximately 1.2 km west of the national road N60 at Ballynew and 3.8 km north west of Claremorris, County Mayo;
- LC XM240³⁶ Kilnageer, Castlebar, County Mayo. This level crossing is located on the Dublin to Westport railway line where it intersects local road L5760 some 1.4 km south of the national road N60 at Corratanvally some 5 km east of Castlebar.

³⁵ The RAIU conducted an investigation into “Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17th August 2018”, RAIU Report No: 2019 – R003, published: 03/09/2019.

³⁶ The RAIU conducted an investigation into the “Collision between a car and a train at Kilnageer Level Crossing (XM240), Mayo, 29th April 2020”, RAIU Report No: 2021 – R001, published: 18th February 2021.

Proposed changes to Sign W 121

161 Numerous options for alterations to advance warning sign, Sign W 121, were considered and discussed by the LC Working Group. It was decided, however, to retain the existing “picket fence”, see Figure 30. The reason being that the format of existing Sign W 121 was considered as being internationally recognised through its inclusion in the Vienna Convention for Signs (of which Ireland is not a signatory). However, the application of Sign W 121 at UWLCs, in Ireland, is incorrect; Ireland is the only country to use the “picket fence” at OP Type level crossings, other countries use the “picket fence” for protected automatic half and full barriers (this is further discussed in paragraphs 177 to 187).

162 In addition, the LC Working Group noted that the existing sign was recognised and understood by over 70% of driver theory test candidates (the multiple choice question options are: “private grounds – no entry”, “farm machinery crossing ahead”, “road fencing ahead”, “level crossing ahead guards by gates or barriers”). To assist the 30 % of the driving population who had difficulty in understanding the meaning of Sign W 121, a new signage information plate, P 072, was proposed which states “Crossaire Comhréidh” (Irish for level crossing) and “TRAIN LEVEL CROSSING”, see Figure 30.

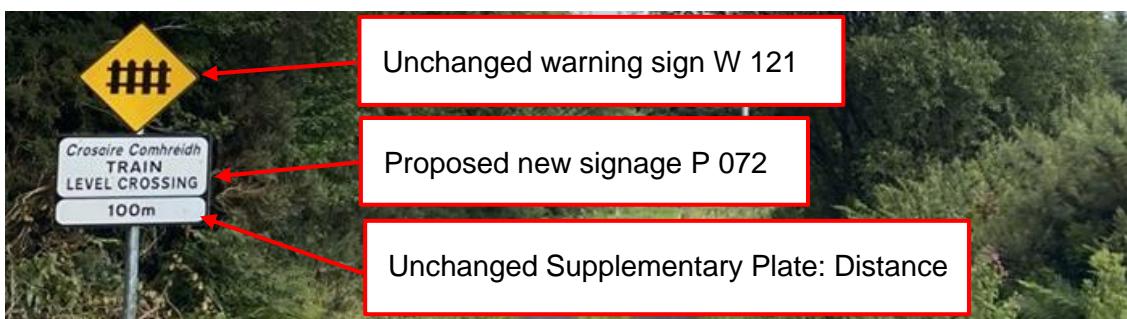


Figure 30 – Proposed new signage arrangement

163 The pilot signage also included advance warning signage, W 145, for cyclists to dismount (see Figure 31). The Traffic Signs Manual, states “In places where there is a risk of bicycle wheels becoming trapped in tram tracks, or at shared crossing points, Sign W 145, Cyclists Dismount, should be provided”. The Rules of the Road, states, in terms of IÉ Level Crossings “Cyclists – cross at right angles to the tracks or else dismount to avoid getting the wheels caught in the groove. Cyclists and horse riders – dismount and walk across the railway line at iron-gated level crossings and at passages”.



Figure 31 – W 145

Road demarcations & painted gates

164 The trial included new road demarcations, with red painted on the road to enhance the "Stop" road markings and level crossing visibility. The pilot trialled full surface covering in red paint at three level crossings, see example from LC XM122 in Figure 32.



Figure 32 – Full surface covering in red paint

165 The pilot also included part surface covering in red paint at one level crossing, see part surface covering at LC XM220 in Figure 33.



Figure 33 – Part surface covering in red paint at LC XM220

166 The road demarcations also include yellow bar marks, which are tapered, on approaches to the red paint surface covering (see Figure 34).



Figure 34 – Tapered yellow bar marks

167 In addition the gates, which close across the road, are painted red and white, see Figure 35, for an example of a level crossing before and after photographs of the gates painted red and white. These give a greater visibility to level crossing users and also give train drivers great visibility as to whether the gates are open or closed on their approach to the level crossing.



Figure 35 – Gates before and after painting

Pilot timeline

- 168 The installation of the pilot signage and road demarcations at four level crossings occurred in second quarter of 2023 with a view to monitor the performance of the pilots for a period of six months³⁷. The performance was to be assessed on measuring: safety improvements; road user awareness and understanding; quality of the finished product; feedback from level crossing users; feedback from rail operative's. This was to be achieved through site visits (involving a survey questionnaire of the level crossings users) and monitoring driver behaviour to assess driver habits on approach to the level crossings.
- 169 Note the pilot programme did not include a comprehensive survey, static testing or virtual reality trials as part of the testing (these types of tests will be outlined in paragraphs 192 to 202).

Further actions by the LC Working Group

- 170 The findings of the pilot and measures taken as a result of the pilot (completed after the accident). It should be noted that further measures were taken by the LC Working Group, after the issuance of the RAIU's draft report (issued on the 25th July 2024) into the accident at LC XM190 on 9th September 2023, these will be discussed in paragraphs 242 to 250.

³⁷ Note the pilot was ongoing at the time of the accident at LC XM190 on the 9th September 2023.

RAIU Safety Recommendation 202101-03 – Train horn

171 RAIU Investigation Report, “Collision between a car and a train at Kilnageer Level Crossing (XM240), Mayo, 29th April 2020”, (Report No: 2021 – R001), published on the 18th February 2021, identified a causal factor as “the sounding of the train horn was not effective at warning the Car Driver of the approaching train”. In part this was as a result of the train horn sound pressure levels not meeting the requirement of GM/RT 2180³⁸, it could not be determined whether this was a result of a deterioration of the train horn as there were issues in relation the commissioning of the train horn sound pressure levels.

172 As a result, the RAIU issued, Safety Recommendation 202101-03, “IÉ-RU should put systems in place to ensure ICR train horns meet the current standards for sound pressure levels”.

173 At the time of the accident, this safety recommendation remained open with the CRR, however, measures were being taken to address this safety recommendation, as outlined in paragraphs 261 and 262.

³⁸ Railway Group Standard GM/RT 2180 Issue 3, Visibility and Audibility Requirements for Trains, published in February 2000; which requires that a “horn of an approaching train shall be audible for a distance of at least 400 m along the track and up to 5 m to each side of the track, in conditions which are predominantly still and with non-excessive background noise levels”.

Research related to user worked level crossing signage

General introduction to advance warning signs

174 According to the Traffic Signs Manual:

- Warning signs are used to alert drivers to danger or potential danger ahead. They indicate the need for special caution and may require a consequent manoeuvre or reduction in speed. Appropriate use of warning signs assists with road safety. The application of the signs should be consistent, so that the signs are accepted by drivers as warnings of potential hazards;
- Most warning signs are diamond in shape (square with one diagonal vertical) with a black border and encompassing a black symbol on a yellow background. The black symbol is usually a pictorial representation of the hazard;
- The higher the speed of the road, the further the sign should be sited in advance of the hazard. This will allow sufficient time for the warning message to be absorbed and any necessary action taken before the hazard is met.

175 In terms of other advance warning signage, some portray clear meanings and indicate the severity of not adhering to the warning, see examples in Figure 36.



W 160:
Unprotected Water



W 142:
Children Crossing



W 111:
Overhead Electrical Cables

Figure 36 – Examples of other warning signs

176 These examples give a clear indication of the hazard and the severity of not adhering to the warning, for example:

- Sign W 160 – Placed wherever a public road approaches an unprotected body of water (hazard) and the severity of not adhering to the warning is for a car to enter the water;
- Sign W142 – May be used to alert drivers to the danger of children crossing roads in residential areas other than at schools and playgrounds (hazard), the severity of not adhering to the warning is for a car to collide with a child;
- Sign 111 – Normally required where electrified railways or tramway crossroads or where other electrical cables cross a road (hazard), the severity of not adhering to the warning is electrocution.

Introduction to Sign W 121

177 The Department of Transport initially wished to retain Sign W 121, however, the RAIU maintained that this sign should be re-designed so users on approach to UWLCs, “see train, think” train on three occasions on their approach to UWLCs, allowing sufficient time for the warning message to be absorbed and any necessary action taken before the hazard is met (paragraph 174).

178 This section of the report outlines the history of the “picket fence” diagram, how it is used in other countries and comprehensive research undertaken in the UK in relation to signage at level crossings.

179 The “picket fence” symbol has been in use in countries for over a hundred years, primarily as level crossings resembled a “picket fence”, see Figure 37.



Figure 37 – “Picket fence” type barriers at a full barrier level crossing

Vienna Convention on Road Signs and Signals

180 Article 36 of the Vienna Convention on Road Signs and Signals (2006) states that “because of the special danger presented by level-crossings, the Contracting Parties undertake: To have one of the danger warning signs bearing one of the symbols A, 25; A, 26 or A, 27 placed in advance of all level-crossings.

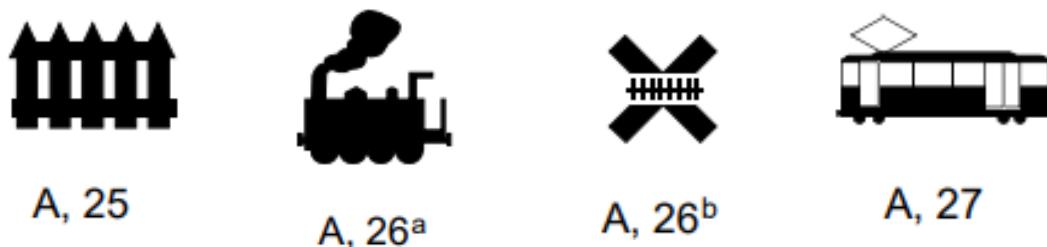


Figure 38 – Advance warning signs set out in Vienna Convention

Use of “picket fence” symbol in other countries

Northern Ireland & Great Britain

181 The RAIU reviewed the signage in Northern Ireland and Great Britain, in terms of the use of the “picket fence”.

182 Northern Ireland uses the same “picket fence” symbol, (with red and white triangle (referred to as Diagram 770)). The symbol is used as advance signage for automatic half and full barriers. See Figure 39 for an example of advance warning signs for an automatic half barrier level crossing in Ballymoney, Northern Ireland. There are no UWLCs on public roads in Northern Ireland.



Figure 39 – Balnamore Level Crossing, Ballymoney
warning signs for an automatic half barrier level crossing in Ballymoney, Northern Ireland.
There are no UWLCs on public roads in Northern Ireland.

183 Great Britain also uses Diagram 770. Again, as with Northern Ireland, they are used on automatic half barriers (see Figure 40 for an example (note the retained element of picket fence)) and automatic full barrier level crossings. Diagram 770 is not used at UWLCs in the Great Britain. Other level crossing signage in the United Kingdom will be discussed further in paragraphs 185 to 187.



Figure 40 - Signage at Athelney automatic half barrier, Somerset, United Kingdom

Other European Countries

184 The RAIU requested from other national investigation bodies, responses in terms of how the “picket fence” symbol is used in their respective countries; and what signs are used at unattended user operated level crossings.

185 In terms of the following countries, these countries use the “picket fence” for automatic half and full barrier level crossings (i.e. protected), however, they do not have any UWLCs; the countries that do not have UWLCs are as follows: Czech Republic; Finland; Italy; Portugal; and Romania. Sweden does not have UWLCs on public roads (but does use a train icon at level crossings without barriers (Figure 41).



Figure 41 – Sweden

186 In Germany, until 2013, the “picket fence” symbol was used at automatic barriers (protected), however, due to “mirror understanding” of the “picket fence” symbol and “less awareness to approach of trains”, this was changed to the train symbol (Figure 42); this train symbol is used for advance signage for all level crossings a distinction is made between technically secured and technically unsecured level crossings. Also of note, in Germany all level crossings are being abolished without replacement or replaced by overpasses or underpasses.



Figure 42 – Germany & Croatia

187 In terms of the following countries, all the below countries use the “picket fence for automatic half or full barrier level crossings (i.e. protected); the advance warning signs used for unprotected level crossings are as follows:

- Austria – The advance warning signs for level crossing without gates/barriers is a train symbol (Figure 43);
- Belgium – The advance warning signage for level crossings without gates/ barriers, is a sign depicting a train (same as Austria’s sign, see Figure 43);



Figure 43 – Austria & Belgium

- Bulgaria – The advance warning sign for level crossings without gates/ barriers is a train and the crossbuck is used on level crossings where there are one or more tracks that are not protected by barriers (see Figure 44);
- Croatia – The advance warning signage for level crossings without barriers is a sign depicting a train is used (same as Germany's sign, see Figure 42);



Figure 44 – Bulgaria & Slovenia

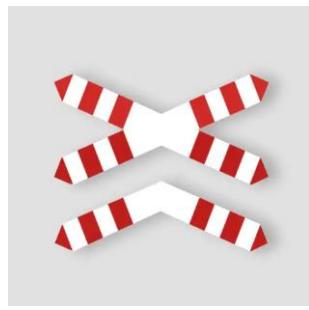


Figure 45 – Denmark

- Denmark – For advance warning signage for level crossings without barriers (which have an audible warning and flashing lights), a sign with a train symbol is used (see Figure 45);
- Estonia – The advance warning signage for level crossings without barriers, is a sign depicting a train (see Figure 46), some of these also have lights at the level crossing;
- France – The advance warning signage for level crossings without barriers, is a sign depicting a train symbol (see Figure 47);



Figure 46 – Estonia



Figure 47 – France & Spain



Figure 48 – Lithuania

- Lithuania – At level crossing without barriers a train symbol is used as advance warning signage, see Figure 48;
- Slovenia – The advance warning signage is the same as Bulgaria (see Figure 44);
- Spain – The advance warning signages is the same as the French signage (see Figure 47).

RSSB research into signs and signals at public road level crossings (T756)

188 The Rail Safety and Standards Board (RSSB) in the United Kingdom carried out a research programme, entitled "Research into signs and signals at public road level crossings" (T756), published in 2014, with the scope of the research stating "RSSB, along with Network Rail, have identified the need for a root and branch review of signing requirements at level crossings to determine, without the influence of the legacy of previous requirements and constraints, the types of signs, signals and markings that would be most effective in reducing road user errors at level crossings, and consequently whether improvements can be made. The overall aim of the project is to investigate signs, signals, markings and other road design elements that best convey the particular points of information that road users need when approaching public road level crossings. The scope of the project includes exploring potential changes to the design of the road environment leading up to the crossing, without changing the way that the crossing is operated". Part of the research included "Expert workshops with human factors and road safety specialists to highlight problems with the current provision of signs and generate ideas for improvement".

189 Irrespective of the fact it is not used at user worked level crossing, below are some of the generic suggestions were made by experts about the design of signs used at level crossings:

- A strong link should be made between the warning and the hazardous condition that the road user is approaching; appropriate use of symbols and words on signs could help to achieve this;
- The use of symbols on signs was deemed to be a good feature because legibility is enhanced by having a symbol rather than text. Where symbols are used, they should portray clear meanings and indicate the severity of not adhering to the warning;
- Concerns were raised about the use of word signs because non-English speaking road users might be unable to comprehend them;
- The message that is being conveyed should be consistent with other elements of the sign such as the colour and the shape.

190 Some of the key findings from the expert workshop were:

- Signing schemes differ significantly by type of level crossing (with further variation possible between level crossings of the same type); consistency in the design of key warnings should be considered;
- Strategies for signing and signalling which take into account approach speed, direction and eye point for all types of road user are likely to be more successful;
- Road users travelling at speed need warnings in advance of the level crossing;
- Signing in the environment around level crossings should be prioritised such that signs for less significant hazards do not reduce the impact of signs for level crossings.

191 Phase two of the research “Research into signs and signals at public road level crossings” was published in 2014, with “the overall aim of the project was to investigate signs, signals, markings and other road design elements that best convey the particular points of information that road users need when approaching public road level crossings. The scope of the project included exploring potential changes to the design of the road environment leading up to the crossing, without changing the way that the crossing is operated. Although noting that this RSSB research looks at signage, road demarcation, etc, the RAIU are focusing on the advance warning signage.

192 The designs of the proposed signs were evaluated using focus groups, road user comprehension survey, static image trials and virtual reality. Four new signs and two existing advance level crossing warning signs, Diagrams 770 and 771, (see Figure 49) were included in the comprehension survey.

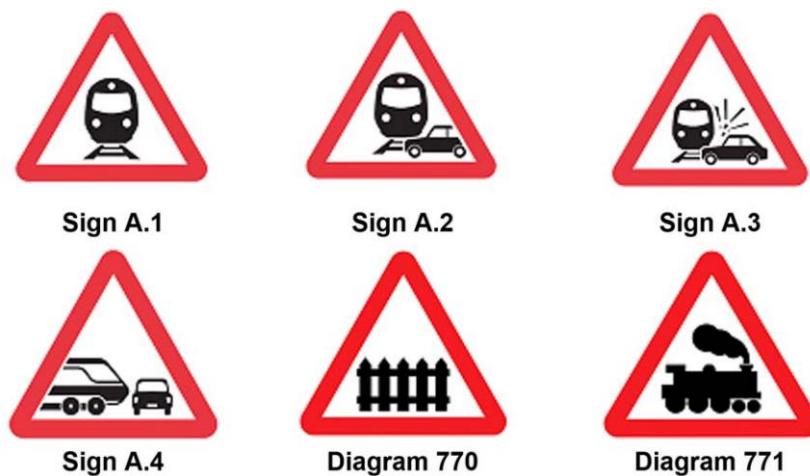


Figure 49 – Signs included in the comprehension survey

193 The results of the comprehension survey were:

- Sign A.1 – For participants who associated the designs with the presence or possible presence of a level crossing ahead, there was little difference between the six signs in the frequency of responses that reported the presence of light signals or barriers (except Diagram 770 which performed badly);
- Sign A.2 – Sign A.2 performed well for all measures included in the comprehension survey. Signs A.2, along with Sign A.3, were the mostly likely designs to elicit responses that included the presence or possible presence of a level crossing ahead;
- Sign A.3 – Sign A.3 performed well for all measures included in the comprehension survey. Sign A.3, along with Signs A.2, were the mostly likely designs to elicit responses that included the presence or possible presence of a level crossing ahead. Sign A.3 was associated with the most risk.
- Sign A.4 – Sign A.3 was associated with the most risk, followed by Signs A.2 and A.4. Sign A.3 was ranked as the most clear and understandable design and was closely followed by Sign A.4;
- Diagram 770 – Diagram 770 was the least understood, received low ratings for associated risk, and was ranked as the least clear and understandable design. Diagram 770 was the least likely to be associated with a level crossing. For participants who associated the designs with the presence or possible presence of a level crossing ahead, there was little difference between the six signs in the frequency of responses that reported the presence of light signals or barriers; the exception was Diagram 770, which was more likely to be associated with level crossings protected by barriers;
- Diagram 771 – Signs A.2 and A.3 were the mostly likely designs to elicit responses that included the presence or possible presence of a level crossing ahead, followed by Diagram 771.

194 Although both Signs A.2 and A.3 performed well in the comprehension survey, a decision was made not to take Sign A.3 forward for static testing. Despite their similarities, it was felt that the additional “collision” element depicted on Sign A.3 would make the sign less legible if implemented on the road. Diagram 771 was also taken forward for further testing as it performed reasonably well in the comprehension survey, and it was felt that there were some benefits in testing it further since it is in current use; Diagram 770 was also brought forward for comparison purposes.

195 In terms of the static testing, the three signs brought forward are shown in Figure 50. Initial inspection of the different accuracy levels produced by the three signs tested showed that Diagram 770 was identified the least accurately.



Sign A.2



Diagram 771



Diagram 770

Figure 50 – Advance warning signs included in the static image test

196 In terms of the virtual reality trial, the new design for the universal advance warning sign was altered slightly to make the car depicted in the image look more like a modern vehicle, see Sign A.2.1³⁹ (Figure 51). Participants' situation awareness and comprehension of Sign A.2.1 was high, particularly in the third and fourth video presentations. The key findings from the VR trial were:

- After the second video presentation, 61% of participants recalled the presence of Sign A.2.1 and 96% of these participants correctly stated that the sign indicated a level crossing ahead;
- After the third video presentation, 87% of participants recalled seeing Sign A.2.1 and 97% of these participants correctly stated that the sign indicated a level crossing ahead;
- After the fourth video presentation, the number of participants who identified the presence of Sign A.2.1 increased to 93% and 97% of these participants correctly stated that the sign was warning of a level crossing.



Sign A.2.1

Figure 51 – Sign A.2.1

³⁹ Note, the sign size is 600 mm width and 530 mm height, given an area of 159,000 mm.

RSSB research into signs at private road crossings (T983)

197 The RAIU also reviewed the RSSB's research undertaken by the Transport Research Laboratory, into "Signs at private level crossings"⁴⁰, published in 2015. Private level crossings are UWLCs. At the time of the research, there was approximately 2,600 private road level crossings in Great Britain which have a relatively high when compared with other types of level crossing⁴¹.

198 The overall aim of the project was to investigate signs, signals, markings and other road design elements that best convey the particular points of information that road users need when approaching private road level crossings. The scope of the project included three types of UWLC: UWCs, UWCs with telephones and UWCs with miniature stop lights (UWCMSL). The research activity method included: site assessment, task and error analysis for UWCs, expert workshops, online surveys, comprehension survey of existing signs and second survey of new signs, laboratory based trials, virtual reality trials, etc.

199 The research made twelve recommendations to improve the information available to roads users at UWCs. Relevant to UWLCs in Ireland, are the following recommendations:

- Use one universal level crossing sign at all UWCs to provide a consistent user experience;
- Use a universal stop look listen sign at all UWCs which applies to all road users;
- Clearly convey the necessity to use the telephone at UWCTs, possibly by using a universal stop and telephone sign which applies to all road users;
- Provide simple, well understood instructions which are clearly related to the intended road user groups;
- Reduce sign clutter by removing unnecessary information and appropriately locating all information;
- Use ground markers, such as projected or fixed warnings on the pavement on the users approach, to aid pedestrians;
- Increase the conspicuity of gates and barriers to speed up recognition of a UWC, possibly by mounting a roundel or applying retroreflective tape, and standardising the appearance of gates and barriers at UWCs;

⁴⁰ Private level crossings in this context are mainly field-to-field level crossings along with footpaths and bridleway crossings (i.e. horse riding path).

⁴¹ Which would be similar to UWLCs in Ireland.

- Differentiate the look of UWCs from crossings with automatic barriers to reduce misinterpretation of barrier operation and crossing procedure;
- Use back-to-back MSLs or MSL repeaters to ensure all users can see the signal aspect;
- Supplement MSLs with an audible warning;
- Standardise information and location of information;
- Use a coloured level crossing surface for all road users to mark the “danger” area.

200 Based on these recommendations for improvement, a number of new designs were developed in conjunction with a traffic sign design consultancy; and were then assessed in a second comprehension survey and virtual reality trial and refined accordingly. Five universal user-worked crossing signs were shown in the surveys as seen in Figure 52.



Figure 52 – Survey signage

201 The result of the survey were that:

- Sign A.1 performed well overall, as it was associated with level crossings, user worked gates and warnings, however, a small, but significant minority also associated it with pedestrians only;
- Sign A.2 performed to a similar level to A.1, except it was associated with no barriers (and not pedestrians only);
- Sign A.3 seemed to be the best at communicating the presence of a level crossing; however, it was worst at communicating warning;
- Sign A.4 did a good job of communicating warning; however, it was less good at communicating level crossing or the presence/absence of barriers;
- Sign A.5 was excellent at communication warning; however, it did not communicate anything else.

202 It was decided that Sign A.1 would be taken forward for testing in the virtual reality trial with some minor refinements. Sign A.1.1 (Figure 53) had the pedestrian removed from the image for further testing as the sign is aimed at drivers as well as pedestrians. The key findings from the virtual reality trials were that a large number of participants recalled seeing the universal UWC sign, suggesting that the sign was good at drawing attention, and where three signs were provided on the approach to the level crossing, participants were significantly more likely to identify a crossing ahead for the new scenario compared with the existing scenario, demonstrating the importance of providing early warnings wherever possible.



Figure 53 – Sign A.1.1

The Private Crossings (Signs and Barriers) Regulations

203 The UK's Department for Transport launched "Improving Signage at Private Level Crossings" after working closely with Network Rail, the Office of Rail and Road (ORR) and the RSSB to develop a new set of signs for use at private crossings, reflecting the RSSB's research projects. After a consultation process, the outcomes of the RSSB research were accepted and, with Sign A.1.1 now identified as Diagram 101.

204 Statutory Instruments, 2023 No. 1112, The Private Crossings (Signs and Barriers) Regulations 2023, was laid before Parliament and came into force in November 2023.

205 Another Statutory Instruments is being considered for level crossings on public roads.

RAIU Draft Safety Recommendation as a result of RSSB Research

206 Based on the research outlined in the previous section (174 to 205), when the RAIU issued the draft report into the accident at LC XM190 on the 25th July 2024; there was one safety recommendation in relation to Sign W121, this safety recommendation maintained that Sign W 121 does not identify the hazard or the severity of not adhering to the sign; the safety recommendation in the draft was as follows:

Safety Recommendation 2024003-01

The Department of Transport should continue to review, in consultation with the relevant stakeholders, their current advance warning signage for UWLCs (Sign W 121) with a view that the sign portray clear meanings (i.e. the road user is approaching a live railway) and indicate the severity of not adhering to the warning (i.e. possible collision with a train).

A note of the safety recommendation: Serious consideration should be given to a sign design similar to Sign A.2.1 (train and a car) as opposed to Sign A.1.1 (train and gate) given the high level of misuse and abuse at UWLCs with gates being left open.



Sign A.2.1



Sign A.1.1

Figure 54 – Sign examples

207 The LC Working Group reconvened to discuss the above safety recommendation, and further actions were taken, these are discussed in paragraphs 247 to 250.

Analysis

Actions of the Car Driver

208 The account from the Car Driver was that they were travelling from Galway to Longford, along the N60, when they took the wrong exit at a roundabout in Claremorris and travelled onto the N17 instead of remaining on the N60. A mobile phone satellite navigation system then re-routed the car to leave the N17 and onto local roads which the Car Driver was unfamiliar with (paragraphs 116 to 120). It is estimated in as little as fifteen minutes after taking the wrong exit, the car approached LC XM190.

209 As the Car Driver was unfamiliar with the area and UWLCs, the Car Driver did not react to the advance warning signage or signage for LC XM190 by slowing the car (paragraph 123) and approached the level crossing "a bit fast" (paragraph 127).

210 At LC XM190, the gates were left open by a previous user (paragraph 125), and the car continued onto the level crossing without looking for approaching trains (see Figure 28). It should be noted that the actions of the Car Driver were unintended, and the Car Driver mistakenly drove onto LC XM190.

211 The Car Driver does not remember the accident; however, it is possible the Car Driver heard the train horn in the final seconds before impact as the driver side window was half open (Figure 20) and the car slowed and came to a standstill on the tracks moments before impact (paragraph 129).

Actions of Driver A804

212 Although noting that Driver A804 did not sound the train horn at all whistle board locations on the day of the accident (paragraph 121); Driver A804 did sound the train horn at the location of LC XM190⁴². On seeing the car, Driver A804 sounded the train horn, applied the full service brake and then the emergency brake, all within three seconds, showing a good reaction time (paragraphs 123 to 128); however, Train A804 did not have sufficient time to come to a stop before colliding with the car.

213 Driver A804 followed all post incident procedures correctly (paragraphs 132, 135 and 140).

⁴² The RAIU conducted a test of audibility of the train horn, When located at the Stop Line at LC XM190, the activated train horn for approaching ICRs could be heard for the whistle board at LC XM190 and some previous level crossings with normal background noise.

Damage to Skoda Octavia

214 The coupler (which was extended) was the first part of Train 804 to strike the car. The area of impact of the coupler was in front of the passenger tyre near the front of the wing (see circled in Figure 55); damage outlined in paragraph 23.

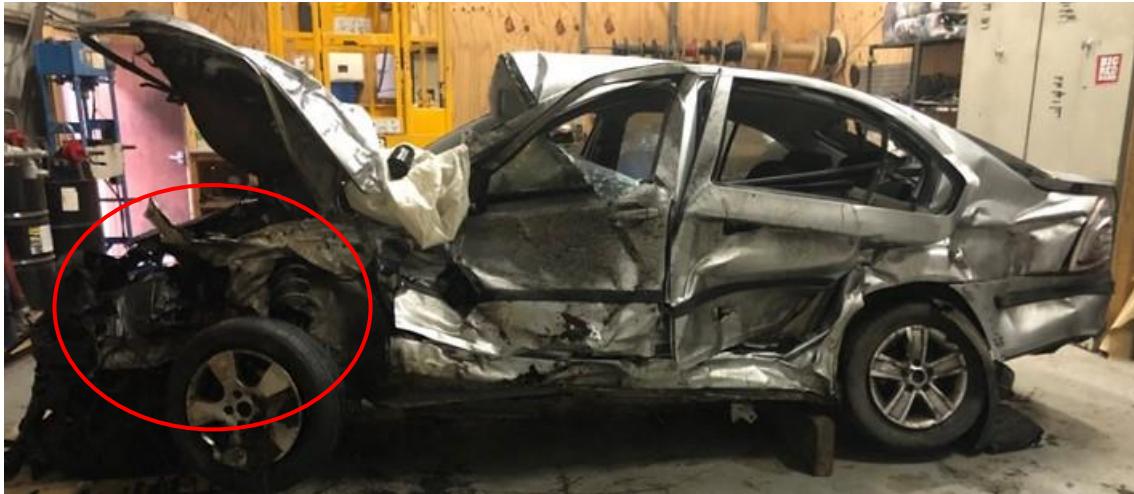


Figure 55 – Damage to the car

215 The impact caused the front of the car (which was stationary) to rotate in a clockwise motion. The area behind the front passenger wheel and the front passenger door wrapped around the front right-hand corner of Train A804 (see Figure 56); (the reason there wasn't more of a bow further forward of the front passenger door ("A" pillar) was because the car's front wheel and engine would have absorbed some of the impact and thus resisting the bowing effect that was evident behind the passenger side front wheel, see Figure 56).



Figure 56 – Bowing effect from wrapping

216 The damage at the leading edge of the rear passenger door ("B" pillar) back to the rear quarter panel is consistent with the car having rotated into the right-hand side of the train (this is also evidenced from the imprints on the rear door area being consistent with some of the pipes and castings on the side of the train). The car was then spun out into the field by the forward motion of the train.

217 Had the coupler been retracted, it would likely have reduced the rate of rotation of the car from the initial impact and may have reduced the damage sustained by the car and in turn, the injuries to the occupants. However, it cannot be determined, what damage the car would have sustained had the coupler been retracted (i.e. there could have been potentially worse damage; and in addition, there could have been other unwanted consequences).

LC XM190 condition and use

218 LC XM190 was well maintained, and the post-accident inspection found that all the signage (including whistle boards) was in place, the road surface over the level crossing was good, the minimum sighting distances was in excess of those required (paragraph 109).

219 LC XM190 is recorded as having a high level of misuse (paragraph 95) with the track patrolling records showing the gates open almost 46% of the time (paragraph 100)⁴³.

Signage & road demarcations for UWLCs

Signage & road demarcations at and on the approaches to LC XM190

220 The required signage, as set out by Chapter 6, Warning Signs of the Traffic Signs Manual was present at LC XM190 (paragraphs 61 and 65).

221 In addition, IÉ signage and road markings for OP Type level crossings as set out in CCE-TMS-380 were present at LC XM190 (paragraphs 67 to 70).

222 A DSS had been installed at LC XM190 but had not been commissioned at the time of the accident as a result of the unwillingness of a local landowner to agree a proposed route for the electricity cable⁴⁴.

⁴³ In general, UWLC abuse and misuse is a regular occurrence for UWLCs, in the year before the accident, there were 242 reports of gates open by drivers across the IÉ network, although none of these were recorded at LC XM190 (paragraph 107).

⁴⁴ The DSS was commissioned at LC XM190 on the 11th November 2024 (paragraph 252).

Advance warning sign, Sign W 121

Actions before the draft RAIU report

223 In 2019, the RAIU directed the Department of Transport (in consultation with the relevant stakeholders) to review advance warning sign, Sign W 121, with a view changing the signage to make it clear to road users that they are approaching a user operated level crossing, Safety Recommendation 2019003-03 (paragraph 157).

224 In 2022, the LC Working Group convened and commenced pilot trials in terms of the road demarcations and advance warning signage, the trials were ongoing, at four level crossing locations, at the time of the accident (paragraphs 159 to 160).

225 On completion of the trials, in terms of the road and gate demarcations, were agreed, namely: part surface covering of the road on the approaches to the level crossing in red paint (paragraph 165); yellow bar marks (which have been extended over the whole width of the road, instead of being tapered); and the painting of the level crossing gates. These changes have greatly improved the visibility of the level crossings (paragraphs 164 to 167).

226 However, after the completion of a pilot programme, the LC Working Group decided to retain Sign W 121, partially as a result that the “picket fence” is internationally recognised through its inclusion in the Vienna Convention for Signs (paragraph 180). However, the RAIU have highlighted that Ireland appear to be an outlier in terms of the use of the “picket fence”, in that Ireland use the “picket fence” at UWLCs, other countries use the “picket fence” for protected automatic half and full barriers (paragraphs 177 to 187). It is also noted that the Traffic Signs Manual, in terms of Sign W 121 says that as “Level Crossing with no flashing red signals (with barriers or gates)” (Figure 10), however, Sign W 121 is not used at automatic full barrier level crossings in Ireland.

227 In relation to the commentary of over 70% of driver theory test candidates recognising Sign W 121 (paragraph 161); it should be noted that the question is a multiple choice question (paragraph 162), which candidates have studied for prior to the test. It does not reflect whether road users retain this information; noting that the Car Driver was twenty at the time of the accident, and therefore a recently qualified driver. To address this 30%, new signage information plate, P 072, was proposed which states “Crosaire Comhréidh” (Irish for level crossing) and “TRAIN LEVEL CROSSING” along with distance and if required direction, to the hazard (paragraph 162).

228 In terms of research related to the “picket fence”, the RSSB have conducted large scale research into the signs at level crossings (paragraphs 188 to 202); and England, Scotland and Wales have passed The Private Crossings (Signs and Barriers) Regulations 2023 and the signs are being changed to Diagram 101 (paragraphs 203 and 204, Figure 53); with similar legislation being progressed for signs on public roads (paragraph 205).

229 As part of the research a comprehensive study, using six variations of signs, found that the “picket fence” symbol was the: least understood; received low ratings for associated risk; ranked as the least clear and understandable design; and for those who associated the design with the presence or possible presence of a level crossing ahead, the “picket fence” was more likely to be associated with level crossings protected by barriers (bullet 5, paragraph 193). Similarly, a static test found the “picket fence” sign was identified the least accurately (paragraph 195).

230 Suggestions by experts about the design of signs used at level crossings (public roads) found that: there should be a strong link between the warning and hazards; and, that symbols were a good feature (especially for non-English speaker) and should be used to portray a clear meaning and indicate the severity of the risk (paragraph 189). Given that the “picket fence” does not depict a train, the hazard, (i.e. a live railway) and the severity of the risk (i.e. the possibility of being in a collision with a train). The success of this type of sign, is highlighted by the fact, that the survey group identified Sign A.3 (train, car and “collision” element) as a level crossing and associated it with the most risk due to the “collision” element (paragraph 193). Sign W121 is also dis-similar to other warning signs in Ireland which give a clear indication of the hazard and the severity of not adhering to the warning e.g. Sign 160 (unprotected water), Sign W 142 (children crossing) and Sign W 111 (overhead electrical cables) (paragraphs 175 and 176), all which similar to Sign W 121 can result in potential fatalities.

231 Sign W 121 does not identify the hazard or the severity, and in fact given the gates are continuously left open (242 reports of gates being left open in the year previous to the accident, throughout the IÉ network, but not at LC XM190 (paragraph 107)), the road users are likely to approach the UWLCs without a gate or barrier.

232 It has also been identified that road users, travelling at speed, need advance warning of the level crossing (paragraph 190) and need sufficient time for the warning message to be absorbed and any necessary action taken before the hazard is met (paragraph 174). Given that the speed limit on local roads is currently 80 km/h and users may not be familiar with the “picket fence” for the reasons outlined in the previous paragraph, these users

maybe particularly vulnerable. As shown on the day of the accident, where the users, approached the level crossing “a bit fast” and did not react to the advance warning signage.

233 In addition, another reason unfamiliar users are also particularly vulnerable, which can be seen on the day of the accident, was that the Car Driver had gotten lost and in the space of under fifteen minutes went from travelling on a national road to a local road and onto LC XM190 (paragraphs 208 to 211).

234 If Sign W 121, gave a clear depiction of the hazard and the severity of the consequences of not adhering to the signage, it would give road users, three opportunities to “see train, think train”, allowing sufficient time for the warning message to be absorbed and any necessary action taken before the hazard is met i.e. stopping at the location of the hazard.

235 In terms of the addition of Sign W145 (cyclist dismount) at UWLCs (paragraph 163), this sign appears to be primarily to stop wheels getting caught in the groove of the rails therefore should be positioned at locations where there is an identified risk (e.g. rails are not at right angles to the road), this would remove sign clutter (bullet 5, paragraph 199).

Actions after the draft RAIU report

236 The LC Working Group reconvened after the RAIU issued the draft into this accident; the safety recommendation associated with the draft RAIU report was that the RAIU maintained that Sign W121 should be replaced (paragraph 206). Further measures were taken by the LC Working Group in terms of Sign W121, these are discussed in paragraphs 247 to 250.

Conclusions

Causal, contributing, and systemic factors

237 On the 9th September 2023, a Car Driver, travelling from Galway to Longford on the N60, took a wrong exit and travelled onto the N17, instead of remaining on the N60. Google Maps (satellite navigation system) diverted the car off the national road and onto local roads that the Car Driver was unfamiliar with. In space of approximately fifteen minutes, the Car Driver was approaching LC XM190. The Car Driver did not react to the advance warning signs (Sign W 121) and approached LC XM190 "a bit fast"; as the gates were left open by a previous user, the car drove onto LC XM190 before coming to a standstill, possibly as a result of hearing the train horn in the moments before the train struck the car (paragraphs 208 to 211). Driver A804 reacted quickly on seeing the car, and applied the emergency brake, however, Train A804 did not have sufficient time to come to a stop before colliding with the car. As the coupler was extended, increasing the rate of rotation of the car from the initial impact and may have contributed to the extensive damage sustained by the car and in turn, the injuries to the occupants.

238 The RAIU have identified the following causal factors to Train A804 colliding with a car as follows:

- CaF-01 – The gates at LC XM190 were left open by a previous user (paragraph 210);
- CaF-02 – The Car Driver was unfamiliar with OP Type level crossings (paragraph 209) and as a result the Car Driver did not:
 - React to the three advance warning signs (Sign W 121) on approach to LC XM190 by slowing the car;
 - Obey the instructions listed in the "Danger Live Railway Crossing" sign at LC XM190;
 - Stop at the Stop Sign or Stop Line to look for approaching trains as required by RSA's Rules of the Road.

239 The following may have been a contributory factor to the damage and injuries sustained to the car occupants and car:

- CoF-01 – The coupler was in the extended position (as a result of issues related to retracting the coupler). Had the coupler been retracted, it may have reduced the rate of rotation of the car from the initial impact and may have reduced the damage sustained by the car and the subsequent injuries to the car occupants. However, it cannot be determined, what damage the car would have sustained had the coupler been retracted (i.e. there could have been worse damage; and in addition, there could have been other unintended unwanted consequences) (paragraph 214).

240 The RAIU have identified the following likely systemic factor to the accident:

- SF-01 – Sign W 121 does not portray clear meaning that the user is approaching a UWLC, a hazard (i.e. live railway) and does not indicate the severity of not adhering to the warning (i.e. being struck by a train).

Additional observations

241 Although not causal, contributing, or systemic to the accident, the RAIU make the following additional observations:

- AO-01 – The CSO was in the driving cab despite not being authorised to do so at the time of the accident;
- AO-02 – The train horn of Train A804 was not sounded at all whistle board locations on the day of the accident.

Measures taken by IÉ & other parties since the accident

Pilot programme at OP Type Level Crossings

Painting of OP Type Level Crossings

242 The pilot measures taken by the LC Working Group in relation to a previous RAIU safety recommendation are outlined in paragraphs 159 to 169.

243 The pilot trials in terms of the painting of roads and gates, at the four UWLCs, was a success in terms of improving visibility of UWLCs for users. It was determined, in consultation with human factors experts, that the part surface covering with red paint was the most impactful and that the tapering of the yellow bar marks should be extended over the whole width of the road for greater impact (paragraph 225). The application of these can be seen at LC XM190, see Figure 59.

244 Following completion of the pilot, a further phase of upgrades to OP Type level crossings has commenced (see paragraph 271).

Advance warning signage at OP Type Level Crossings

245 After the completion of a pilot programme, the Department of Transport initially decided to retain Sign W 121, and add a supplementary plate signage information plate, P 072, was proposed which states “Crosaire Comhréidh” (Irish for level crossing) and “TRAIN LEVEL CROSSING” (paragraph 162).

246 The RAIU issued the draft report into this accident on the 25th July 2024 maintaining that Sign W 121 does not identify the hazard (i.e. live railway) or the severity of not adhering to the sign (i.e. being struck by a train) and made another safety recommendation, looking for the removal of the “picket fence” (paragraph 206) for the reasons outlined in paragraphs 174 to 205 and paragraphs 223 to 235.

247 The LC Working Group reconvened in October 2024 and a new sign was designed (with proposed number W126).

248 This signs is 600 mm x 600 mm in size and includes a train, car (as proposed by the RSSB Research, paragraphs 188 to 202) and “collision” element (see Figure 57).



Figure 57 – Sign W126

249 This new sign design clearly illustrates the hazard (i.e. live railway) and the severity of the hazard if the sign is not adhered to the warning (i.e. being struck by a train) and the inclusion of the “collision” element allows for the association of most risk⁴⁵.

250 The trial signage is erected at locations 300 m, 200 m and 100 m from the level crossing, meaning that users see the advance warning three times before they arrive at the level crossing; the sign is not present at the level crossing⁴⁶.

251 This new design sign is currently being trialled at LC XM190 and LC XM250⁴⁷ and was erected in November 2024. It is proposed that feedback from users of the two level crossings be gathered in January 2025⁴⁸ (this would mean that the signs would have been erected for approximately three months); the trial signage at LC XM190 is presented in paragraphs 255 and 256 and Figure 60.

⁴⁵ It is noted that the sign includes the “collision” element. The RSB Research’s survey group identified Sign A.3 (the sign with the train, car and “collision” element) as a level crossing and associated it with the most risk due to the “collision element (paragraph 230). The RSSB Research suggests that the “collision” element may make the sign “less eligible” (paragraph 194); however, the RAIU considers it to be a positive addition to the Irish sign, noting that the Irish signs are considerably larger (diamond shape, 360,000 mm area) than UK signs (triangle, 159,000 mm area).

⁴⁶ The RAIU consider the warning sign should be present at the level crossing as it is the location of the hazard and as such a further safety recommendation is warranted, Safety Recommendation 2024003-02 (paragraph 279).

⁴⁷ The RAIU have previously carried out two investigations into collisions at LC XM250, namely, “Car Strike at Knockaphuntha Level Crossing (XM250), County Mayo, 24th October 2010”, RAIU Report 2011-R007, published on the 19th October 2011); and “Car strikes train at level crossing XM250, Knockaphuntha, Co Mayo 8th June 2014”, RAIU Report R2015-002R1, published the 4th June 2015.

⁴⁸ At LC XM250, the new signage is being trialled with the supplementary plate, P072, “Crosaire Comhréidh TRAIN LEVEL CROSSING” on one approach and not the other, to see if there is a preference with the level crossing users.

Improvements at LC XM190

DSS at XM190

252 The DSS at LC XM190 was commissioned on the 11th November 2024⁴⁹ which provides improved information on the approach of trains at LC XM190. As part of the commissioning process, IÉ-IM have an associated advertising campaign to highlight, to users, the information that is displayed at the level crossings, the campaigns are in the English and Irish language (see Figure 58).



Figure 58 – Advertisement for DSS

⁴⁹ Two other DSSs at LC XX059, Rathbaun, near Foxford, County Mayo on the Manulla Junction to Ballina line and at LC XS121, Ardree, near Ballymote, County Mayo on the Dublin to Sligo line.

Changes to road marking and level crossing gates at LC XM190

253 In terms of LC XM190, the painting of the gates (red and white) and the roads (part covering in red paint and yellow bar marks) was completed in October 2024, see Figure 59.



Figure 59 – LC XM190 with road markings and painted gates

254 The painting has greatly improved the visibility of the level crossing.

Advance warning signs at LC XM190

255 The new trial signage, Sign W126 (paragraphs 247 to 251), has been erected at LC XM190, see Figure 60 for signage at locations 300 m, 200 m and 100 m in advance of LC XM190.

256 These new design signs give road users clear information on the hazard they are approaching, irrespective of whether they are familiar or unfamiliar with UWLCs.



Figure 60 – New trial signage, Sign W126, at LC XM190

257 Initial feedback from users is positive and users have indicated a preference for the new sign, W126, over the older "picket fence" sign, Sign W121.

258 However, the IÉ-IM "Warning Trains" (Diamond Type), sign remains at the level crossing the location of the risk⁵⁰, noting that this is an IÉ-IM sign (complaint with CCE-TMS-380 (paragraph 67)).



Figure 61 – IÉ-IM's "Warning Trains" sign

Coupler

259 On the 3rd April 2024, the Head of Health & Safety IÉ-RU issued a Shed Notice (700/29 RU23, issue 2) for the 22000 Class DMU (ICR), stating "This notice supersedes the one issued on the 6th January 2023 ref; 700/29/RU23 Issue 1. The coupler extend/ retract function is being re-instated on all ICR units over the coming weeks. As each coupler is reinstated a small label will be installed in close proximity to the extend/ retract buttons indicating that the function is now restored. Where these labels are installed, the coupler should be returned to the retracted position when not in use".

260 All units have been reinstated since the 29th August 2024; some may need to be isolated on occasion.

⁵⁰ The RAIU considers that there should be consistency in terms of the signage on the approaches to and at the level crossing and consider that a safety recommendation is warranted, Safety Recommendation 2024003-02 (paragraph 279).

Train Horn

- 261 As a result of the RAIU's safety recommendation in relation to ensuring ICR train horns meet the current standards for sound pressure levels (Safety Recommendation 202101-03) (paragraph 172), IÉ-RU engaged an Acoustic Noise and Vibration Consultant (ICAN) to carry out tests of the new proposed single sound 370 Hz horn for the ICR fleet (as opposed to the 311 Hz and 370 Hz dual tone horns) against European Standard, EN 15153-2:2020, Railway applications – External visible and audible warning devices - Part 2: Warning horns for heavy rail (to be referred to as EN 15153-2:2020). The tests verified the new proposed one horn (370 Hz) was compliant with the EN 15153-2:2020 standard.
- 262 As a result, this commenced an ICR fleet replacement programme to replace the horns with the new single horn (370 Hz). The replacement programme began in mid-November 2023; and to date fifty-seven of the sixty-three horns needing replacement, have been replaced with the predicted completion date being the end of 2024.

CSO presence in the driving cab

- 263 IÉ-RU Safety Department issued a Safety Alert, Unauthorised Persons in Cabs (Reference RU Ops SA86), on the 7th November 2023. The CSOs (including the CSO on Train A804) have been briefed on this Safety Alert, which provides the only exceptions that would permit CSOs to enter a driving cab, these are: Where called upon by the driver for a specific reason; Degraded conditions or operational incidents which require the CSO to be in the cab; Place of refuge (report to be submitted to the CSO's supervisor detailing the incident of antisocial behaviour leading to the CSO taking refuge).
- 264 The CSO safety briefing assessment had also been updated to include two new questions regarding when the CSO should be in the driving cab; and when the CSO should be in the rear cab.

Sounding the Train Horn

- 265 The IÉ-IM Head of Health & Safety issued a Shed Notice, entitled "Reminder: Use of Train Horn at Whistle Boards" on the 5th June 2024 which states "Drivers are reminded that they must sound the train horn at all Whistle Boards where provided, as a warning to the presence of an approaching train. Additionally, where a whistle board has been left in place beside a closed level crossing, other operational needs may require the whistle board to remain in situ, and the horn must still be sounded. When no longer required a whistle board will be removed".

Safety Campaigns

266 IÉ-IM continue to promote level crossing safety, when suitable events to promote, arise, examples are as follows:

- June 2024 – Nine level crossings were attended in recognition of International Level Crossing Awareness Day (ILCAD). IÉ-IM coordinated this initiative with An Garda Síochána Roads Policing Units and the RSA. All level crossing users were stopped and engaged on the day, distributing safety information leaflets and answering any queries. ILCAD is an annual event in which IÉ-IM will be supporting each year;
- June 2024 – IÉ-IM updated all of their UWLC booklets and refreshed the website to highlight these updates;
- June 2024 – IÉ-IM targeted professional road hauliers by publishing a level crossing safety and awareness article in the June edition of Fleet Management Magazine. This included a copy of the IÉ-IM Booklet, with 7,300 hard copies distributed and sold during that month;
- September 2024 – IÉ participated in the WorldSkills Ireland event at the RDS, where IÉ-IM showcased one of the level crossing safety wrapped vans. This was done in collaboration with IÉ-IM's Apprentice Training Centre promoting level crossing safety and awareness;
- Since September 2024 – With roll out of the DSS system, IÉ-IM have had numerous engagements and briefings including local and media channels informing level crossing users that some level crossing have been fitted with the DSS systems (such as local advertising, see Figure 58);
- October 2024 – An IÉ-IM Senior Technical Executives from Track and Structures and the Road Fleet Department supported the annual Road Safety event at Athlone Stadium, organised by Youth Work Ireland Midlands where a presentation was delivered on Level Crossing Safety and Awareness to nearly 1,200 Transition Year students from Roscommon, Westmeath, Offaly and Longford;
- As part of the Foynes rail freight line project, the main contractor, is meeting with locals to brief them on the safe use of their level crossings as the line is being restored.

Internal investigation

267 IÉ-IM Safety conducted their own internal investigation into the accident, publishing “Report of Investigation: Train A804 collision with car at level crossing XM190 9th of September 2023” on the 7th June 2024. This report resulted in two recommendations, the recommendations are addressed to and are as follows:

- Recommendation 1 – The Head of Health and Safety IÉ-IM in conjunction with the Head of Health and Safety IÉ-RU to conduct a review of existing technologies to assist with identifying the exact location of trains post occurrence relative to railway access points and assess how this would be available to all signal control locations⁵¹;
- Recommendation 2 – The Head of Health and Safety IÉ-IM in conjunction with the Head of Health and Safety IÉ-RU to issue a guidance document for occurrences that would not require the full implementation of the Emergency Response Handbook. This should include areas of responsibility both on and off site⁵².

268 At the time of publication of the RAIU report, these recommendations remain open.

⁵¹ This was as a result of the initial confusion as regards to the exact location and access point. Technologies available to IÉ are IÉ’s Remote Diagnostic System, Nexala (an automated communications process by which train system data are collected from the train and transmitted to receiving equipment for monitoring and analysing and IAMS).

⁵² This was as a result of a review of the management of the response was held to identify areas for development; one of the items focussed on was the areas of responsibility both on and off site following an occurrence, and the actions required by each department.

Safety Recommendations

Introduction to safety recommendations

269 In accordance with the European Union (Railway Safety) (Reporting and Investigation of Serious Accidents, Accidents and Incidents) Regulations 2020), RAIU safety recommendations are addressed to the NSA, the CRR, and directed to the party identified in each safety recommendation.

Absence of safety recommendations due to measures already taken

Upgrade to LC XM190 & other OP Type level crossings

270 The DSS has been commissioned in November 2024 and is operational at LC XM190 (paragraph 252) and as such a safety recommendation is not warranted. In addition, DSSs continue to be installed at UWLCs across the network and as such a further safety recommendation is not warranted in terms of installing DSSs.

271 The painting of the gates (red and white) and the roads (part covering in red paint and yellow bar marks) was undertaken at LC XM190 in October 2024, which as greatly improved the visibility of the level crossing (paragraphs 253 and 254). As a result, no further safety recommendations are warranted in terms of road demarcations at LC XM190. In terms of other OP Type level crossings, these are programmed for painting with the works to be completed by Summer 2025 and as such no further safety recommendations are warranted in terms of road demarcations at OP Type level crossings.

Coupler

272 The coupler extend/ retract function has been re-instated, and the coupler should be returned to the retracted position when not in use (paragraph 259).

Train horn

273 The ICR fleet has undergone a horn replacement programme to replace the old dual tone horns with a new single horn (370 Hz) which is compliant with EN 15153-2:2020, and is expected to be completed by the end of 2024⁵³ (paragraphs 261 and 261). As a result of these measures taken, no further safety recommendation is warranted, in relation to the train horn.

CSO presence in the driving cab

274 As a result of the issuance and briefing of Safety Alert, Unauthorised Persons in Cabs, to CSOs; and the update to the CSO safety briefing assessment (paragraphs 263 and 264) a further safety recommendation to address AO-01 (paragraph 241) is not warranted.

Sounding the Train Horn

275 As a result of the issuance of a Shed Notice reminding drivers to sound the train horn at all whistle board locations (paragraph 265), a further safety recommendation to address AO-02 (paragraph 241) is not warranted.

⁵³ In addition, it should be noted that at locations where a DSS is installed, the DSS provides an additional audible warning when a train is approaching the level crossing.

Safety recommendations as a result of this accident

276 Significant improvements, as a result of the LC Working Group's pilot programme, have been made in relation to the visibility of OP Type level crossings through road demarcations and the painting of the level crossing gates (paragraphs 242 to 244) which is currently being rolled out at OP Type level crossings across the IÉ Network.

277 Some additions have been made to the advance waring signage as a result of the pilot programme (paragraphs 162 and 163); however, initially, Sign W 121, remained unchanged (paragraph 226). In October 2024, on receipt of the RAIU's draft report (and associated safety recommendation) the LC Working Group reconvened, and a new sign was designed which clearly illustrates the hazard (train striking a car) and the severity of the hazard if the sign is not adhered to the warning (the "collision" element). This new sign design is currently being trialled at two OP Type level crossings (paragraphs 247 to 251).

278 The RAIU considers that this sign should be promoted and when the trial is completed, this new sign design (with alterations where required) should be erected at OP Type level crossings. Irrespective of the trial outcome the "picket fence" must be removed at these locations, as they have been incorrectly adapted in Ireland (paragraph 226). As a result the RAIU make the following safety recommendation (CaF-02, SF-01):

Safety Recommendation 2024003-01

The Department of Transport should continue to trial the new design sign (Sign W126), in consultation with the relevant stakeholders, with a view to replacing Sign W121 in the Traffic Signs Manual. The RAIU maintain that the advance warning signs on the approaches to OP Type level crossings should portray the hazard (i.e. the road user is approaching a live railway) and indicate the severity of not adhering to the warning (i.e. possible collision with a train).

279 For consistency, the RAIU considers that IÉ-IM's "Warning Trains" sign should be the same as the new sign (Sign W126), as these signs are located at the hazard location; as a result the RAIU make the following safety recommendation (CaF-02):

Safety Recommendation 2024003-02

IÉ-IM should replace their "Warning Trains" sign, located at OP Type level crossings, to the new proposed advance warning sign (Sign W126), once included in the Traffic Signs Manual.

Additional Information

List of abbreviations

CaF	Causal Factors
CCE	Chief Civil Engineer
CME	Chief Mechanical Engineer
CoF	Contributory Factors
CRR	Commission for Railway Regulation
CSO	Customer Services Officer
CWR	Continuous Welded Rail
DIR	Daily Incident Report
DMU	Diesel Multiple Unit
DSS	Decision Support System
ECM	Entity in Charge of Maintenance
EU	European Union
FFCCTV	Forward facing closed circuit television
FWI	Fatalities and weighted injuries
hrs	hours
IAMS	Information Asset Management System
ICR	Intercity Railcar
IÉIO	IÉ Incident Officer
IÉ-IM	Iarnród Éireann Infrastructure Manager
IÉ-RU	Iarnród Éireann Railway Undertaking
km	kilometre
km/h	kilometres per hour
LC	Level crossing
LCRM	Level crossing risk model
m	metre
mph	miles per hour
NSA	National Safety Authority
OC	Open crossing
OP	Occupational Public
OTDR	On Train Data Recorder
PWI	Permanent Way Inspector
PSV	Public Service Vehicle
RAIU	Railway Accident Investigation Unit
RFI	Request for Information

RSA	Road Safety Authority
SI	Statuary Instrument
SI Units	International System of Units
SMS	Safety Management System
TCB	Track Circuit Block
UWLC	User Worked Unattended Level Crossing

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.
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.
Coupler (Automatic)	A device which simultaneously couple two rail vehicles together mechanically, electrically and pneumatically.
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.
Collective risk	The total harm including injuries and fatalities from accidents. It includes the harm to everyone exposed to the hazards including train passengers, IÉ staff and the public using the level crossing. It is

	measured in units of safety loss per year, referred to as fatalities and weighted injuries (FWI) per year.
Continuous Rail	Sections of rail that are welded together.
Welded Rail	
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.
Decision Support System	A system that provides improved information on the approach of trains at level crossings through the use of lights and audible alarm.
Down Direction	For direction movement of trains travelling towards Westport.
Down Line	Line where trains are travelling towards Westport.
Emergency brake application	This is a separate independent circuit that often has far fewer components. It can be operated by drivers 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.
F Type Level Crossing	User worked unattended field Level Crossing used primarily for agricultural purposes.
Five Foot	The area between the two running rails (it is 5 feet 3 inches (1,600 millimetres ((mm).
Full-service brake application	The service brake is operated by the drivers 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.
Hertz	The unit of frequency equivalent to one cycle per second.
Horn	Audible device operated by the train driver to warn people on or near the line of the approach or movement of the train.
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

	<p>following categories: infrastructure; energy; control-command & signalling; rolling stock; traffic operations & management and others.</p>
Individual Risk	<p>Measure of the likelihood that a person is fatally injured per year from their exposure to the railway. It is measured in the units of probability of fatality to an individual per year. For example, if a commuter had an individual risk of 1 in a thousand of 1000 (0.001) they could on average, be expected to travel for 1,000 years before being fatally injured from railway hazards. In more tangible terms, if 1,000 commuters had the same individual risk, it would be expected that one was fatally injured per year. An important factor with individual risk is a person's exposure. For passengers, their individual risk increases with the number of journeys that make per year. For example, if one person (Person A) uses the railway for a particular journey ten times as often Person B, then the individual risk to Person A will be ten times that of Person B. To assess individual risk, it is necessary to assume a level of exposure to railway hazards as it is not possible to assess every individual's use of the railway. IÉ employs the standard approach to assessing individual risk by assessing highly exposed individuals. This approach ensures that individual risk is not underestimated. In the case of passengers, the individual is assumed to be a commuter who uses the railway for travelling to and from work on a daily basis. At level crossings the typical highly exposed individual is defined as using the crossing up to 500 times per year. There is a clear difference between the risk to people who are following rules and behaving in accordance with the prescribed crossing usage procedure, those who follow rules but make an error and those who do not follow the rules. Tolerability criteria would not normally be applied to those hazards whereby people do not follow rules, so this component of the risk is excluded from the individual risk calculation.</p>
Investigation	<p>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</p>
Level Crossing Risk Model	<p>94 The LCRM is a tool used for the calculated ranking of collective and individual risk at LCs and provides a means of understanding the</p>

risk presented by each LC on the IE network. The LCRM provides a means for collecting, storing and recalling data on each LC and also provides a risk assessment for each LC. The LCRM calculates the risk rankings for LCs based on data input related to each LC, ranking the LCs from the highest (1) to the lowest (42 in the case of OP LCs (LC XM190 is an type OP LC)); the risk ranking is recalculated when new data is inputted.

O Type Level Crossing	User worked unattended occupational Level Crossing primarily on a private road providing access to a private dwelling(s) or in a limited number of cases, a business premises.
OP Type Level Crossing	User worked unattended occupational level crossing on a public road.
OC Type Level Crossing	An open Level Crossing on single lines only where the maximum train speed is 10mph and where the road layout, profile and traffic conditions should be such that road vehicles are not likely to ground or regularly to block back obstructing the railway. This type of Level Crossing does not have gates, barriers or road traffic light signals. Road users must give way to trains at the crossing. Train drivers are required to stop trains short of the Level Crossing unless they have observed that the Level Crossing is clear.
P Type Level Crossing	User worked unattended pedestrian Level Crossing – for pedestrian use only.
Patrol Ganger	Patrol Gangers are responsible for inspecting the track, related features and general infrastructure for their respective patrol length and advising the Permanent Way Inspector of any issues.
Risk	CCE-SMS-001 defines risk as “the chance that harm will result from a Hazard; the combination of the severity of the Hazard with the likelihood of its happening, the probable consequence of potential harm or damage resulting from an unmanaged Hazard”.
Risk Assessment	CCE-SMS-001 defines a risk assessment as “a structured assessment to identify the likelihood of a Risk event, the severity of the adverse consequences should the event come about, and the mitigating Risk control actions”.

SAP Software	Computer programme that co-ordinates all resources, information and activity needed to complete an enterprise wide information system, it includes an accounting and finance function.
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.
Systemic Factor	Any causal or contributing factor of an organisational, managerial, societal or regulatory nature that is likely to affect similar and related occurrences in the future, including, in particular the regulatory framework conditions, the design and application of the safety management system, skills of the staff, procedures and maintenance.
Up direction	For direction movement of trains travelling towards Dublin.
Up Line	Line where trains are travelling towards Dublin.
Up Side	Located on the same side as the Up Line.
User	Person (pedestrian, driver or rider) that requires to cross the railway at the level crossing.
User Worked	A Level Crossing which provides access between premises and a road (private/public) or between land and/or land/premises under common ownership and occupation but divided by the railway line e.g. where a railway and a road cross on the same level or where a farmer can cross between fields on each side of the railway line. The gates are operated by the Level Crossing user.
Unattended Level Crossing (UWLC)	
Whistle board	A board at the trackside instructing a train driver to sound his horn on the approach to a level crossing to warn the level crossing users of the approach of a train

References

- CRR (2008), Guidelines for the Design of Railway Infrastructure and Rolling Stock, Section 5 Level Crossings, CRR-G-006-C.
- Department of Transport (2023), User Operated Level Crossings, Report on recommendations for the use of warning sign W 121 at user operated level crossings on the local road network, User Operated Level Crossing Pilot Programme.
- ICAN Acoustics (2023), 22000 ICR Warning Horn Testing and Analysis Compliance Report, Rev 1.6, 03/04/2023.
- IÉ-IM (2017), CCE Hazards and Risk Assessments, CCE-SMS-006, Version 4.0.
- IÉ-IM (2018), CCE Safety Management System, CCE-SMS-001, Version 6.0.
- IÉ (2007), Rule Book.
- IÉ-IM (2018), CCE Technical Standard for Track and Structures Inspection Requirements (CCE-TMS-360), Version 2.3, operative since the 19th June 2018.
- IÉ-IM (2020), CCE Technical Standard for Track Patrolling (CCE-TMS-361), Version 1.9, operative since the 2nd March 2020.
- IÉ-IM (2019), CCE Technical Standard for Decision Support Systems at User Worked Crossings (CCE-TMS-382), Version 1.2, operative since the 23rd July 2019.
- IÉ-IM (2020) CCE Technical Management Standard, CCE-TMS-380, Technical Standard for Management of User Worked Unattended Level Crossings, Version 2.3, operative since the 1st October 2020.
- IÉ-IM (2024), Report of Investigation: Train A804 collision with car at level crossing XM190 9th of September 2023”, Report No. R0604-2024-25.
- IÉ-IM (2019), Technical Standard for Decision Support Systems at User Worked Crossings CCE-TMS-382, Version 1.2, operative since 23/07/2019.
- Railway Group Standard (2000), GM/RT 2180 Issue 3, Visibility and Audibility Requirements for Trains.
- NSAI (2020), Railway applications - External visible and audible warning devices - Part 2: Warning horns for heavy rail
- RSA (2018), Rules of the Road.

RSSB (2014), Research into signs and signals at public road level crossings" (T756).

RSSB (2015), Signs at private level crossings.

United Nations Publications (2006), Vienna Convention on Road Signs and Signals (ECE/TRANS/196).

UK Department for Transport (2023), Consultation outcome, Improving signage at private level crossings: government response, Updated 20 October 2023,
<https://www.gov.uk/government/consultations/improving-signage-at-private-level-crossings-revised-sign-designs/outcome/improving-signage-at-private-level-crossings-government-response>

UK Department for Transport (2023), Improving Signage at Private Level Crossings, Revised Sign Designs.