



**Railway Accident
Investigation Unit
Ireland**



INVESTIGATION REPORT

**Collision between a car and a train at Kilnageer
Level Crossing (XM240), Mayo, 29th April 2020**

RAIU Investigation Report No: 2021 – R001

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Report Description

Report publication

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Report structure

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

Reader guide

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

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

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

Preface

The RAIU is an independent investigation unit within the Department of Transport, which conducts investigations into accidents and incidents on the national railway network, 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 2004/49/EC enshrined in the European Union (Railway Safety) (Reporting and Investigation of Serious Accidents, Accidents and Incidents) Regulations 2020.

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

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

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

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

Summary

At approximately 13:40 hour (hrs) on the 29th April 2020, the 13:10 hrs passenger service from Westport to Dublin (Train A809) was approaching Kilnageer Level Crossing (LC) XM240, located approximately six kilometres (km) from Castlebar, County Mayo. At the same time a car approached LC XM240 with the gates open (left open by a previous user) and began travelling through LC XM240. When the driver of Train A809 (Driver A809) saw the car, he made a *full-service brake application*; however, the train could not stop in time and struck the car. *Causal factors* associated with this accident are:

- The Car Driver failed to stop to look for trains on approach to LC XM240 as required by the Road Safety Authority's (RSA) Rules of the Road, in part, as a result of the level crossing gates being open;
- The sounding of the train horn was not effective at warning the Car Driver of the approaching train.

A *contributing factor* to the accident was:

- There is a high level of misuse and abuse at LC XM240, where the level crossing gates are continuously left open, despite laws being in place for them to be closed.

The RAIU did not identify any *systemic factors* associated with this accident.

The RAIU did not make any safety recommendations as a direct result of this accident. However, the RAIU noted that after the accident, a Decision Support System (DSS) was made operational at LC XM240, this impacts on stakeholders' documentation. The RAIU also noted that further checks need to be conducted in relation to the sound pressure levels of the InterCity Railcar (ICR) train horns. As a result, the RAIU made four safety recommendations related to these additional observations:

- 202101-01 – The RSA should update the “Rules of the Road” to include guidance on the DSS;
- 202101-02 – Iarnród Éireann Infrastructure Manager (IÉ-IM) should update the ‘The SAFE use of Unattended Railway Level Crossings’ booklet to include guidance on the DSS;
- 202101-03 – Iarnród Éireann Railway Undertaking (IÉ-RU) should put systems in place to ensure ICR train horns meet the current standards for sound pressure levels;
- 202101-04 – The Commission for Railway Regulation (CRR) should review and update Section 5, Level Crossings, of their Guidelines for the Design of Railway Infrastructure and Rolling Stock, to ensure that guidance/reference on the DSS is included.

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RAIU decision to investigate

- 1 In accordance with the Railway Safety Act 2005 and European Union (Railway Safety) (Reporting and investigation of Serious Accidents, Accidents and Incidents) Regulations 2020, the RAIU investigate all serious accidents; the RAIU may also investigate and report on accidents and incidents which under slightly different conditions might have led to a serious accident.
- 2 On the 29th April 2020, the RAIU received a notification from IÉ-IM, of Train A809 colliding with a car at LC XM240, Kilnageer, County Mayo. After the RAIU conducted a Preliminary Examination Report, 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)*), as under slightly different circumstances this accident may have led to serious accident with the potential fatalities of the car driver; or for further fatalities or serious injuries due to risk of derailment of the train as a result of the collision.
- 3 In terms of categorisation, the EU Agency for Railways categorisation for this occurrence is a: Level Crossing – Accident.
- 4 The RAIU's Chief Investigator allocated RAIU Senior Investigators, trained in accident investigation, to conduct this investigation, in accordance with recognised investigation techniques. In this instance, no external parties were required to assist with the investigation.

Scope & limits of investigation

- 5 The RAIU have established the scope and limits of the investigation as follows:
 - Establish the sequence of events leading up to the accident;
 - Establish, where applicable, the causal, contributing & systemic factors to the accident;
 - Examine the relevant technical management standards;
 - Examine the relevant *level crossing risk model* (LCRM);
 - Review the technical management standards related to *user worked unattended level crossings* (what IÉ-IM refer to as UWLCs) on the IÉ rail network, including risk and hazard identification;
 - Review the documentation available to users of UWLCs;
 - Review of new safety mechanisms introduced at LC XM240, post-accident.

Communications & evidence collection

- 6 During this investigation, the RAIU collate evidence through the submission of Requests for Information and interviewing. Related to this investigation, the RAIU collated and logged the following evidence:
- Witness statements from parties involved in the accident;
 - All IÉ-IM technical management standards in relation to UWLCs (including technical management standards on new safety mechanisms introduced) on the IÉ Network;
 - Risk documentation in relation to UWLCs;
 - Publicly available documentation in relation to the use of UWLCs. Commissioning documentation in relation to the introduction of additional safety measures at LC XM240.
- 7 All relevant parties co-operated fully with the RAIU investigation; with no difficulties arising.

Other stakeholder inputs

- 8 Emergency services (ambulance and doctor) attended the accident site to attend to the car driver.
- 9 As this accident involved a road vehicle, An Garda Síochána attended the scene of the accident and are conducting a separate investigation.

Other information relevant to the investigation process

- 10 In relation to this RAIU investigation, there is no other information relevant to the investigation process.

RAIU report format

11 The RAIU report is divided into a number of key sections, namely:

- Summary of the accident & background information – Provides factual information surrounding the accident including:
 - Synopsis of the accident, which provides an abridged version of accident events;
 - External circumstances surrounding the accident or accident location;
 - Consequences of the accident, including fatalities, injuries or material damage;
 - Parties and roles associated with the accident;
 - Description of the relevant parts of infrastructure, rolling stock, signalling and communications, operations or other equipment associated with the accident.
- Evidence – Provides further factual details on the above descriptions, if necessary. It also provides details on relevant: Safety Management System (SMS) documentation; standards and procedures; risk assessments, etc;
- Events before, during and after the accident – Outlines a proximate chain of events:
 - Leading up to the occurrence including actions taken by persons involved; the functioning of rolling stock and technical installation and the operating system;
 - During the occurrence, by describing the occurrence;
 - After the occurrence including: consequences of events; measures taken to protect the site of the occurrence; and, the efforts of the rescue and emergency services.
- Similar occurrences – Outlines occurrences similar in nature to this accident.
- Analysis – Analyses the combined findings from the above established facts which resulted in the causation of the occurrence, such as: roles and duties; rolling stock and technical installations; human factors; control mechanisms; trends related to similar occurrences.
- Conclusion – Concluding information from the analysis of the factual findings; measures taken since the occurrence; additional observations.
- Safety Recommendations – where appropriate, safety recommendations will be made with the sole aim of preventing a similar occurrence in the future; safety recommendations may also be made as a result of additional observations with the aim of prevent another type of occurrence. The absence of safety recommendations shall be explained.

Summary of the accident & background information

Synopsis of the accident

12 At approximately 13:40 hrs on the 29th April 2020, the 13:10 hrs passenger service from Westport to Dublin (Train A809) was approaching Kilnageer LC XM240, located approximately six kilometres from Castlebar, County Mayo, see Figure 1.



Figure 1 – Location of the accident

13 At the same time a car approached LC XM240 with the gates open (left open by a previous user) and began travelling through LC XM240. When Driver A809 saw the car, he made a full-service brake application; however, the train could not stop in time and struck the car, see Figure 2.



Figure 2 – Car after the collision with Train A809

External circumstances at the accident location

Weather

- 14 The weather at the time of the accident was dry, with Met Éireann recording a temperature of approximately 9°C. The visibility was good at the time of the accident.
- 15 The weather conditions, or the time of the day, did not contribute to the accident.

Road vehicle

- 16 The road vehicle involved in the accident was a white 2010 Kia Soul Shaker, similar to the car in Figure 3; it has an approximate weight of 1.3 tonnes.



Figure 3 – Kia Soul

Parties & roles associated with the accident

Parties involved in the accident

17 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 Commission Regulation (EU) 1169/2010; the authorisation was renewed on the 24th March 2018 for a period of four 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. This Department carries out the inspections and maintenance of track and structures, including level crossings.

18 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 2004/49/EC and S.I. 249 of 2015; the Safety Certificate was renewed on the 23rd March 2018 for a period of five years. The IÉ-RU department involved in the accident and relevant to this investigation is:

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

Roles involved in the accident

19 The roles involved in the accident were the:

- Car Driver – The Car Driver held a full Irish driving licence. He was familiar with LC XM240.
- Driver A809 – Driver A809 was first passed competent as a Driver on the 10th May 2013 and held a current Train Driving Licence. The records for Driver A809 showed that he was in date for his rules exams and relevant competence assessments for train driving at the time of the accident. The actions of Driver A809 did not contribute to the accident.

Parties not directly involved in the accident

Commission for Railway Regulation

- 20 The CRR is the national safety authority, which is responsible for the regulatory oversight of the 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.
- 21 The CRR publish the “Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway”, referenced in paragraph 71. In addition, the CRR have issued “Guidelines for the Design of Railway Infrastructure and Rolling Stock”, Section 5 Level Crossings, RSC-G-006-B, discussed in paragraphs 57 and 58.

Road Safety Authority

- 22 The RSA's aim is to save lives and prevent injuries by reducing the number and severity of collisions on the road. Some of the ways that the RSA works to improve road safety in Ireland are by:
- Developing and implementing information and education campaigns to increase awareness of road safety and promote safer driving;
 - Improving vehicle standards;
 - Establishing and monitoring a standard for driver instruction;
 - Overseeing the system of driver licensing and undertaking certain enforcement activities;
 - Working with stakeholders to ensure a co-ordinated response and ensure our collective resources are used wisely and efficiently;
 - Undertaking collision and road safety research in order to develop measures and recommendations to improve road safety;
 - Advising the Minister for Transport on road safety policy;
 - Producing road safety strategy documents and monitoring their implementation.
- 23 The RSA produce the “Rules of the Road” discussed in paragraphs 73 to 77. The Rules of the Road are for all road users – drivers, pedestrians, motorcyclists, horse riders and cyclists. The rules form the basis of road safety in Ireland. A road user must know these rules well in order to be a safe and socially responsible driver and pass the driver theory test and practical driving test.

Department of Transport

- 24 The Mission Statement of the Department of Transport is: “As a central government department, serving the government and the people of Ireland, our mission is to shape the safe and sustainable development of transport, to support economic growth and social progress”.
- 25 The Department of Transport produce the Traffic Signs Manual, discussed in paragraph 64.

Fatalities, injuries & material damage

Fatalities & injuries

- 26 There were no fatalities or injuries to the train driver or passengers as a result of the accident.
- 27 An ambulance paramedic and doctor assessed the Car Driver on site, he was uninjured.

Material damage

- 28 IÉ-RU's Chief Mechanical Engineer's (CME) Department reported that there was €25,000 worth of damage to the following areas of Train A809: valance and framework; steelwork; levelling arm and associated bracket; front end hose; horn pipe; electrical-head cover; paintwork; manual pull cord release box; and, side exterior.
- 29 IÉ-IM estimate the cost of repairs to LC XM240 totalled €3,220 plus VAT.
- 30 The car was undrivable after the accident.

Other consequences as a result of the accident

- 31 There was one passenger service (seven passengers) delayed as a result of the accident with a total of sixty-four minutes of a delay experienced. A replacement train worked from Manulla Junction to Athlone to connect into the 14:35 hrs passenger service Galway to Heuston (Train B701), which operated in the path of Train A809 from Athlone to Heuston. The seven passengers on board the train involved in the occurrence were conveyed by train back to Castlebar where road transfers were provided for their onward journey, with bus and taxis costing a total of €870.
- 32 The line reopened for normal traffic at 16:15 hrs; approximately two hours, forty minutes after the accident.

Infrastructure

Track

- 33 The accident occurred on a bi-directional single line section of track between Manulla Junction and Castlebar Station; which is plain line with flat bottom *continuously welded rail* (CWR) mounted on concrete sleepers in ballast.
- 34 The maximum permitted line speed at the location is 70 mph (113 km/h), which reduces to 60 mph (96.6 km/h) over the level crossing.
- 35 No factors in relation to the condition of the track were found to have contributed to the accident.

Level Crossing

- 36 This designation, physical features and operation of LC XM240 is discussed in paragraphs 59 to 70 of this report.

Rolling Stock

General description

- 37 The train involved in the accident was the 13:10 hrs passenger service from Westport to Heuston, Dublin, Train ID A809. This service was operated by a three-piece 22000 class Diesel Multiple Unit (DMU) ICR, set 47; with the train consist being 22347 (leading unit), 22447, 22247.

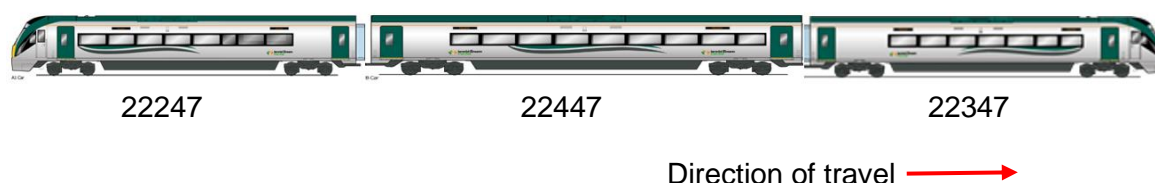


Figure 4 – ICR set 47

- 38 The total length of the train is approximately seventy metres with a mass of 189 tonnes. The maximum permitted speed of this train is 100 mph (160 km/h).

On-Train Data Recorder

39 The on-train data recorder (OTDR) on Train A809 indicated that the:

- Lights were illuminated at full beam;
- *Horn* was sounded four times on the approach to LC XM240, the horn is further discussed in paragraphs 40 to 45;
- Train was travelling at 57 mph (92 km/h) on approach to LC XM240;
- At 13:28:31.641 hrs, at a distance of 266 m before LC XM240, there was a full-service brake application (see Figure 5);
- At 13:28:36.081 hrs (4.44 seconds after the full-service brake application), Train A809 travelled through the centre of LC XM240, striking the car;
- At 13:28:38.362 hrs (2.281 seconds after travelling through the centre of LC XM240 and striking the car; and, 43 m past the centre of LC XM240) Driver A809 made an *emergency brake application*¹;
- At 13:28:52.546 hrs the train comes to a stop, 125 m after the emergency brake was applied and 168 m past LC XM240.

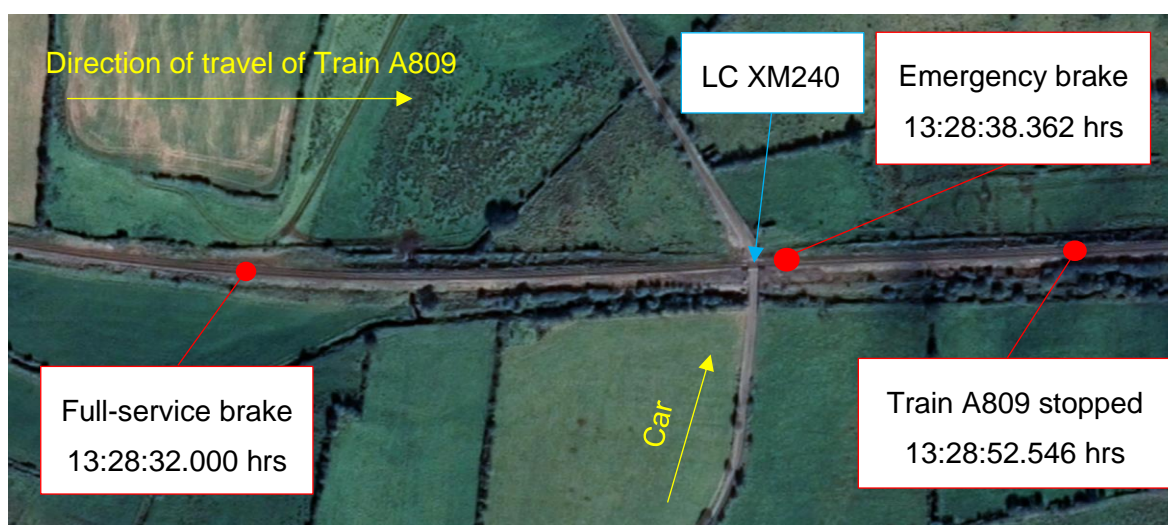


Figure 5 – Braking and stopping position of Train A809

¹ It is noted that the full-service brake is the maximum braking for the train and is a similar braking pressure to that of the emergency brake.

Train horn

General description

- 40 The horn audible warning device on the ICR fleet consists of two individual horns, high and low tone horns, fitted on either side of the front underframe of the cab.
- 41 The horns were damaged as a result of the collision, it was noted during a post-accident inspection that the non-drivers side horn (circled yellow) does not align with the louvre cuts in the quarter panel fairing (circled red), see Figure 6.

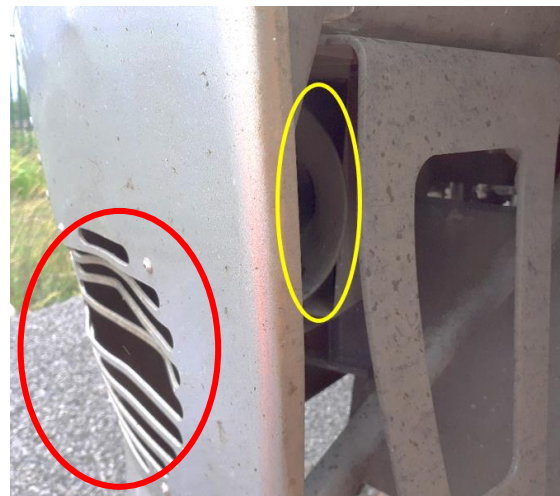


Figure 6 – Train horn ICR 22347

Sound pressure levels (GM/RT 2180)

- 42 IÉ-RU have confirmed that the horn fitted to the ICRs were required to be supplied, by Rotem, in accordance with Railway Group Standard GM/RT 2180 Issue 3, Visibility and Audibility Requirements for Trains, published in February 2000 (to be referred to as GM/RT 2180 for the remainder of this report).
- 43 GM/RT 2180 required that the “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”. As an ICR has a maximum speed of 160 km/h, the *C-weighted sound pressure level* produced by the horn should have been in accordance with the numbers set out in Figure 7.

Distance in front of vehicle	5 metres		100 metres
	Minimum dB	Maximum dB	Minimum dB
Trains for 160km/h or less: horns in "loud" mode	120	125	94
horns in "soft" mode	115	119	89

Figure 7 – Horn sound pressure levels

- 44 During commissioning, sound pressure level testing carried out by Rotem on the ICRs, in July 2007, were measured as *A-weighted sound pressure levels* and not the *C-weighted sound pressure levels* as required by GM/RT 2180, see Figure 8. Given that there is no provision for changing weights, it cannot be determined whether the sound pressure levels were correct. However, had Rotem thought the *A-weighted* levels were the correct pressure measurement levels, it can be seen that, for the 100 m readings, half the measurements would not have met the minimum requirements (circled red in Figure 8).

Test	5 Meters		100 Meters	Result		Pass / Fail
	Minimum dB	Maximum dB	Minimum dB	5 Meters	100 Meters	
Move Horn Lever Switch "High" position	120 dB(A)	125 dB(A)	94 dB(A)	124.7	90.0 1st 94.7 2nd 93.8 3rd	
Move Horn Lever Switch "Low" position	115 dB(A)	119 dB(A)	89 dB(A)	118.9	83.1 1st 90.6 2nd 89.9 3rd	

Figure 8 – Rotem sound pressure measurements

45 On 3rd July 2020, post-repair, the C-weighted sound pressure levels were taken at distances of 5 m and 100 m from the front of the train along the centre-line of ballasted track at a height of 1.6 m above the upper surface of the

ICR 22347	Ambient sound pressure 81dB(C) wind direction towards the meter		Ambient sound pressure 75 dB(C) wind direction towards the train	
Distance	5 metres	100 metres	5 metres	100 metres
Loud horn	90.2dB(C)	87.3dB(C)	89.2dB(C)	87.4dB(C)
Soft Horn	90.2dB(C)	85.9dB(C)	90.3dB(C)	86.4dB(C)

Figure 9 – ICR 22347 sound pressure levels

rail; each measurement sample was not less than 5 seconds and not greater than 10 seconds; and, measurements were taken for difference wind directions, see Figure 9 for the results of the testing. The testing indicates that none of the measurements now meet the original requirements set out in GM/RT 2180.

46 See the following sections of this report for Conclusions (paragraphs 142 - 143) and Safety Recommendations as a result of Additional Observations (paragraph 186) related to the train horn.

Signalling and communications

47 The line is signalled using two and three aspect colour light signals, controlled by the Mayo Line Signaller located in Athlone. Track Circuit Block regulations apply to this route and train detection is achieved by a combination of track circuits and axle counters.

48 The means of communication between the train drivers and the signaller on this route is through train radio.

49 No factors in relation to the condition of the signalling and communications systems were found to have contributed to the accident.

Operations

50 Trains travelling towards Dublin, are travelling in the Up Direction. Trains travelling towards Westport are travelling in the Down Direction.

- 51 The maximum line speed at the location of the accident is 60 mph (95 km/h), this is under a permanent speed restriction; as other parts of the route operate at 70 mph (110 km/h).
- 52 Train A809 was carrying seven passengers at the time of the accident.
- 53 No factors in relation to the operation of the trains were found to have contributed to the accident.

Evidence

O/OP Type Level Crossings on the IÉ Network

- 54 *OP Type Level Crossings* are unattended UWLCs, on public roads, where the level crossing gates are normally closed to road traffic. O Type Level Crossings are UWLCs located on a private road providing access to a private dwelling(s) or in a limited number of cases, a business premises.
- 55 Currently there are forty-two OP Type Level Crossings on the IÉ Network; of these twenty-two are on the Mayo Line (Athlone to Westport) and the Ballina Branch (Manulla Junction to Ballina), which accounts for 52% of the entire OP Type Level Crossings. By county, thirteen OP Type Level Crossings are in County Mayo, this accounts for 30% of the entire OP Type Level Crossings resulting in County Mayo having the largest number of OP Type Level Crossings on the entire IÉ network.
- 56 In terms of O Type Level Crossings on the IÉ Network, currently there are ninety-two on the entire network; of these twenty-one are on the Mayo Line (Athlone to Westport) and the Ballina Branch (Manulla to Ballina), which accounts for 27% of the entire O Type Level Crossings. By county, twenty-one O Type Level Crossings are in County Mayo, this accounts for 23% of the entire O Type Level Crossings.

CRR Guidelines for the Design of Railway Infrastructure & Rolling Stock

- 57 Section 5, Level Crossings, of the CRR's "Guidelines for the Design of Railway Infrastructure and Rolling Stock", document number RSC-G-006-B, authorised on the 29th July 2008, sets out general guidance "on the positioning of, and equipment that applies at, all types of level crossings" (Section 5.2.1.1) and "is applicable when alterations are made to the protection arrangements at existing crossings" (Section 5.2.1.2). The guidance requires that "all equipment and controls used for the operation of crossing equipment should be designed and documented to appropriate safety standards" (Section 5.2.4.1).
- 58 Section 5.8, "User-Working Crossings (UWC) with Gate of Lifting Barriers" provides a general description of UWLCs and their method of operation. Section 5.14, "The Crossing" provides more detailed requirements for level crossings, such as profiles and alignments, crossing approaches and surfaces, etc. Section 5.18, "Traffic Signals, Traffic Signs and Road Markings" provides guidance on the traffic signs and road traffic light signals at level crossings, as well as the road markings. It should be noted that there is no reference to the DSS in Section 5, Level Crossings, of the CRR's Guidelines for the Design of Railway Infrastructure and Rolling Stock given the publication date of the CRR's guidance is 2008.

Level Crossing XM240

Designation

59 IÉ-IM have designated LC XM240 (Figure 10) as an OP Level Crossing.



Figure 10 – LC XM240 (photograph taken on the 11th May 2020)

Access to LC XM240

60 LC XM240 is located on local road, L5760, which runs from national secondary road N60, which links Roscommon to Castlebar, County Mayo. The road has a tar and chip surface, which was recently resurfaced, and has a speed limit of 80 km/h.

61 The gates of LC XM240 comprise of 4.26 m (14 feet) wide metal gates positioned on each side of LC XM240, which open away from the railway. The surface of the intersection of the road with the track is covered in stone mastic asphalt, providing a level surface over the track. Cattlegrids are installed on each side of the roadway, where it crosses the track. There is concrete post and wire fencing running between the gates and the boundary hedges. See Figure 10 for a photograph of the level crossing.

62 On the day of the accident, LC XM240 was not protected by roadside traffic signals. Installation and testing was underway on a new DSS, however, it was not operational, and covered in orange tarp, at the time of the accident, see Figure 10.

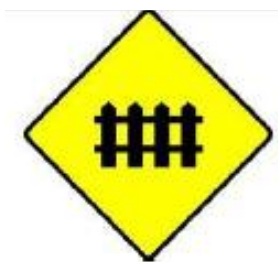
Level Crossing Signage on the Railway

63 In terms of signage on the level crossing associated with the level crossing, there are *whistleboards* located at 300 m and 150 m on the Up Line and 330 m and 150 m on the Down Line.

Road & Level Crossing Signage

Signage on the approach to and at LC XM240

64 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 11.



W121 – Level Crossing with no flashing red signals



P 001 – Supplementary Plate: Distance



RUS 027 – Stop Sign

Figure 11 – Required road signage on approach to and at gated crossings

65 These signs were present at LC XM240, see Figure 12 for examples of the warning signage at the approach to and at LC XM240.



Figure 12 – Examples of Warning Signs at the approach to and at LC XM240

66 IÉ-IM CCE Technical Management Standard, CCE-TMS-380, Technical Standard for Management of User Worked Unattended Level Crossings, Version 2.1, operative since the 27th November 2017 (which will be referred to as CCE-TMS-380 for the remainder of the report) sets out the requirements for IÉ-IM signage at level crossings.

- 67 The signage was upgraded in April 2019 at LC XM240 to meet the requirements of CCE-TMS-380, and included (for each side of the level crossing): one “Puffing Billy” (Diamond Type) signs (opposed to the triangle steam train version which are now redundant); two “Danger Railway Level Crossing” signs (one English language, one Irish language) and two “Stop” signs, one “Keep These Gates Shut”, see Figure 13 for signage at LC XM240.



Figure 13 – Signage at LC XM240 related to CCE-TMS-380

Road Markings at LC XM240

- 68 IÉ-IM have painted Stop Lines 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 is located approximately 2 m from the running edge on each side of the level crossing road approaches, see Figure 14.



Figure 14 – LC XM240 Stop Lines on either side of the railway

Viewing distances at LC XM240

- 69 The maximum permitted line speed for the section of railway line through LC XM240 is 60 mph (96.6 km/h) in the both the Up and Down directions; meaning that the required *viewing distances*, as set by CCE-TMS-380, is a minimum of 300 m.
- 70 The viewing distance at LC XM240 measured on the Down side (the position of the Car Driver on the day of the accident), looking in the Down direction (the direction from which Train A809 was approaching) was measured at 346 m. Figure 15 is a photograph taken in front of the Stop sign and behind the Stop Line.



Figure 15 – From the Down side of the line, looking in the Down direction

Operation of O/OP Type level crossings

Introduction to the operation of O/OP type level crossings

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

- The RSA's 'Rules of the Road', Revision No. 6, published in June 2019;
- IÉ-IM's 'The SAFE use of Unattended Railway Level Crossings', last updated in February 2019 (to be referred to as IÉ-IM Booklet for the remainder of this report);
- The CRR's 'Third Party Guidance on Railway Risk, Volume 3, Crossing the Railway', document number RSC-G-012-A, published in April 2008²;
- Safety at Level Crossings, an RSA document with contributions from the CRR, published by the RSA in June 2016.

72 Knowledge of the '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, this document is outlined below.

² At the time of publication of this report, this document was not available on the CRR's website, pending possible review.

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

73 The RSA's 'Rules of the Road' introduce level crossings in a full-page warning, composed by the RSA, IÉ-IM and the CRR (Figure 16), stating:

- Stop, look both ways, listen;
- When the railway is clear, cross quickly;
- Shut and fasten the gates – it's the law;
- Never stop on the railway;
- Always expect a train.

74 The document 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. It's the law”. The legal requirement to close the gates is highlighted in several places in the document.



Figure 16 – Illustration from Rules of the Road

75 The Rules of the Road describes actions that the driver “should” and “must” do when operating the level crossing; driver should prepare by doing the following:

- Stop clear of the gates;
- Switch off phone and music systems;
- Open windows on driver and passenger sides;
- Read instructions at the crossing;
- Get a helper to operate the gates if possible.

76 Drive across safely by doing the following:

- 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;
- Stop well clear of the tracks on the opposite side.

77 Drivers must shut the gates at unattended level crossings, by conducting the following:

- 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 gates is an offence.

Level Crossing Inspections

78 In terms of the inspections of level crossings, the relevant technical management standards are:

- CCE-TMS-360, Technical Standard for Track and Structures Inspection Requirements, Version 2.3, operative since the 19th June 2018 (to be referred to as CCE-TMS-360 for the remainder of this report);
- CCE-TMS-361, Technical Standard for Track Patrolling, Version 1.9, operative since the 2nd March 2020 (to be referred to as CCE-TMS-361 for the remainder of this report);

79 CCE-TMS-360 requires inspections and surveys to be conducted annually, as set out for operational level crossings, which included a measurement survey for views. The RAIU found that these inspections and surveys had been completed, as required.

80 Track patrols are carried out every Monday in the locality of XM240 by *Patrol Gangers* and CCE-TMS-361 (Appendix G.18) sets out the “conditions to be looked for” (Figure 17), which includes “open gates at user-worked crossings” (see yellow highlight).

G.18 Level Crossings	
Action	Conditions to be looked for
B	Obstructions in flangeways
	Damage to head of rail
D	Damaged or faulty barriers, gates
	Open gates at user-worked crossings – close these if observed during patrol
D	Damaged or faulty telephones (if applicable)
	Signs damaged, missing, dirty or obscured by vegetation
	Vegetation requiring cutting back
	Whistle boards on approach to level crossing in poor condition or missing
	Increase in use of crossing
	Yellow box markings need to be repainted
	Cattle grids in poor condition or missing
	At level crossings with surface crossing units:
	- movement of rubber crossing units under traffic
	- poor condition of road surface

Figure 17 – Appendix G.18, CCE-TMS-361

81 The RAIU reviewed a sample selection of track patrol records; these indicate that the gates were continuously left open by the users of LC XM240.

Usage & operation of LC XM240

82 A survey undertaken at LC XM240 in late 2018, found the average daily usage to be:

- 195 Car/ Vans
- 3 Lorries/ Heavy Good Vehicles
- 1 Motorcycle
- 0 Large boned animals
- 0 Buses
- 3 Tractors/ Farm machinery
- 5 Pedestrians
- 0 Abnormal vehicles

83 Since the date of the last survey, Belcarra Post Office, located six kilometres south of LC XM240, closed. IÉ-IM consider that this has resulted in a likely increase in the average daily usage, as customers are now travelling over LC XM240 to get to the Post Office in Breaffy, using the most direct route over local road, L5760, which runs from national secondary road N60, which links Roscommon to Castlebar (Mayo), see Figure 18. However, this cannot be fully established due to COVID-19 travel restrictions.

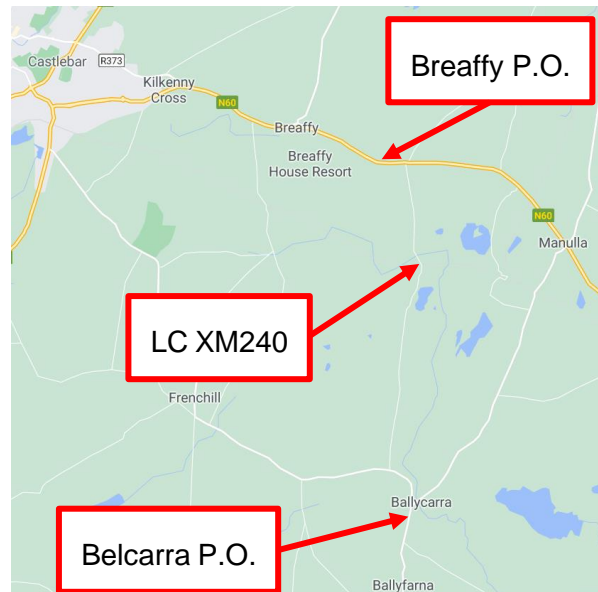


Figure 18 – Post office locations & LC XM240

84 There is a known history of misuse/ abuse³ at LC XM240, and at one time was the highest risk OP Type Level Crossing on the IÉ Network.

85 As a known misused/ abused level crossing, safety campaigns were held at LC XM240 in 2014, demonstrating the safe use of UWLCs; another campaign was held with the: Road Safety Officer of Mayo County Council; the RSA; An Garda Síochána; the Mayo Fire and Ambulance Department; and, IÉ-IM in March 2014.

³ Some level crossing users may not be aware of the requirement to close the gates, despite the requirements being set out in the RSA's Rules of the Road and the instructional signage at the level crossing; this may be termed as misuse of the level crossing. Where level crossing users knowingly leave the gates open, despite knowingly the potential dangers to unfamiliar users; this could be termed abuse.

86 IÉ-IM have a stall at the annual National Ploughing Championship, where the key focus is safety at level crossing; and are a participant in the annual International Level Crossing Awareness Day Campaign.

87 There are no recorded users of LC XM240 i.e. users that have been previously identified by IÉ-IM through attendance at the level crossing or safety campaigns.

Level Crossing Risk Model

88 The *Level Crossing Risk Model* (LCRM) identifies the:

- Individual risk to exposed groups: road vehicle drivers/ occupants and pedestrians;
- Unfamiliar user risks per million crossing usages for road vehicle drivers and pedestrians;
- Crossing ranking (*collective risk* and *individual risk*).

89 At the time of the accident, the results of the LCRM for LC XM240 were as follows:

- Medium individual risk to exposed groups (individual risk to road vehicle drivers/occupants was medium; and low for pedestrians; giving an overall maximum of a medium risk rating);
- In terms of the rankings at the time of the accident in the Athlone Division, the individual risk was 15 of 42⁴ i.e. the 15th highest individual risk crossing in the Athlone Division; and, 2 of 42 for the collective risk ranking i.e. the 2nd highest collective risk crossing in the Athlone Division.

90 Risk drivers at LC XM240, ranked in order of importance, are as follows: Level of abuse; distractions; fog; gates left open; familiarity; approach view of crossing from road; lighting; viewing distance – vehicles; line speed; speed limit; train approach speed.

⁴ Since the time of the accident, the Decision Support Systems has been introduced, which has affected the LCRM scoring; this is outlined in 'Measures Taken Since the Accident' section of this report.

Events before, during & after the accident

Events before the accident

- 91 Driver A809 booked on duty at 12:00 hrs, his rostered shift for the day included the 13:10 hrs passenger service from Westport to Heuston, Dublin, Train A809. This service departed Westport on time and served Castlebar; it departed Castlebar, for Manulla at approximately 13:23 hrs.
- 92 The Car Driver was visiting a local person in an area close to LC XM240 before the accident.
- 93 Train A809 was travelling at 57 mph (92 km/h) on approach to LC XM240.
- 94 At 13:28:10 hrs, Train A809 sounded the train horn at the location of the first whistleboard.
- 95 The gates of LC XM240 were left open by the previous user of the level crossings, although, it should be noted that the gates were, in the most part, left open to road traffic by the users of LC XM240 (paragraph 81).

Events during the accident

- 96 As Train A809 approached LC XM240, Driver A809 saw a car slowly travelling towards LC XM240 from his right-hand side. Driver A809 sounded the horn, three more times, with the final sounding of the horn being a continuous sounding of the horn at 13:28:31 hrs.
- 97 Driver A809 saw that the car continued travelling towards LC XM240 (the car windows were raised); and at 13:28:32 hrs Driver A809 made a full-service brake application (at a distance of 266 m before LC XM240).
- 98 Six seconds later, as the car continued to travel onto LC XM240, Driver A809 made an emergency brake application (after striking the car); Train A809 was travelling at 41 mph (66 km/h).
- 99 Train A809 continued through LC XM240, collided with the car at 13:28:45 hrs; before coming to a stop at 13:28:52 hrs at a distance of 168 m past LC XM240. The car was pushed clear of the line and came to a stop approximately thirty metres from LC XM240, see Figure 19.



Figure 19 – Car and Train A809 stopped

Events after the accident

- 100 At 13:28:58 hrs Driver A809 contacted the Mayo Line Signaller to report the accident and requested emergency services, in line with post-accident procedures.
- 101 Driver A809 walked back to LC XM240 to check on the Car Driver, who stated that he was “fine”. The Car Driver also stated that he heard a train horn (despite the car windows being raised); however, at the time, he did not associate the horn with an approaching train.
- 102 Emergency protection was arranged for the line and relevant members of IÉ staff arrived on site, including the IÉ Incident Officer (IÉIO), members of staff from the IÉ-IM CME and IÉ-IM Safety Departments; and, a relief driver.
- 103 An Garda Síochána and an ambulance arrived on site. The Car Driver was uninjured, and the ambulance left the site at 14:10 hrs. An Garda Síochána handed back the site at 15:30 hrs on completion of their evidence gathering, they were assisted by the IÉIO.
- 104 The IÉIO reported the line safe and clear at 15:50 hrs and Train A809 departed site at 16:00 hrs, operated by the relief driver.

Similar Occurrences

Incidents & accidents at LC XM240

105 In terms of the history of LC XM240, there has been a number of occurrences in the previous seven years:

- On the 27th August 2018, a white van approaching LC XM240. The driver of the 07:15 hrs Westport to Heuston passenger service saw the car, slowed the train and sounded the horn and the van cleared the level crossing without being struck.
- On the 19th December 2017, the driver of the 12:45 hrs Heuston to Westport service saw a car approaching LC XM240. The train driver slowed the train and sounded the horn. The car slowed and then accelerated over the level crossing without being struck.
- On Friday 11th August 2017, the driver of the 18:15 hrs Westport to Heuston passenger train saw a red car approaching LC XM240, the train driver sounded the horn and applied the emergency brakes. The car driver stopped past the regulatory Stop Sign and the Stop Line and reversed off the level crossing as the train travelled through. The car was not struck and proceeded through the level crossing after the train came to a stop.
- On the 2nd June 2017, the driver of the 07:15 hrs Westport to Heuston passenger service saw a car approaching the level crossing at speed. The train driver applied the full-service brake and sounded the horn. The car came to a sudden stop, close to the rails. The train travelled through the level crossing without striking the car.
- On the 23rd March 2014, a silver Toyota drove onto LC XM240 in front of the 17:45 hrs Westport to Heuston passenger service.
- On the 19th July 2014, a jeep drove onto LC XM240 in front of the 13:10 hrs Westport to Heuston train.
- On the 20th December 2013, a car drove in front of the 07:15 hrs Westport to Heuston passenger service.
- On the 17th December 2013 there was a near miss reported, where a jeep drove in front of the 09:45 hrs Westport to Heuston passenger service.
- On the 25th October 2013, a white van crossed over LC XM240 while a train was approaching. The driver was convicted of careless driving and fined €350; he was not disqualified from driving.

Accident & serious accidents investigated by the RAIU

Introduction

106 Since the establishment of the RAIU in 2007, the RAIU have investigated eleven similar occurrences of collisions between trains and road users at O and OP Type Level Crossings UWLCs. Of the eleven occurrences, five are located in County Mayo (as in the case of the Kilnageer accident); this is primarily as a result of the prevalence of O and OP Type Level Crossings being located in County Mayo (paragraphs 55 - 56).

- Report into the Collision at Level Crossing XN 104, between Ballybrophy and Killonan on the 28th June 2007 (no injuries), located in County Tipperary;
- Fatality at level crossing XX032 between Manulla and Ballina on the 28th February 2008 (one fatality), located in County Mayo;
- Collision between a train and a road vehicle at level crossing XN125, Cappadine, on the Ballybrophy to Killonan line 31st of July 2008 (no injuries), located in County Tipperary;
- Person struck at level crossing XE039, County Clare, 27th June 2010 (one fatality);
- Road vehicle struck at level crossing XM096, County Roscommon, 2nd September 2010 (one fatality);
- Car Strike at Knockaphunta Level Crossing XM250, County Mayo, 24th October 2010 (no injuries reported);
- Car Strike at Morrough Level Crossing, XG173, County Galway, 14th February 2011 (no injuries reported);
- Tractor struck train at level crossing XE020, County Clare, 20th June 2012 (no reported injuries);
- Vehicle struck by train at Corraun level crossing, XX024, County Mayo, 12th February 2014 (road vehicle driver injured);
- Car strikes train at level crossing XM250, Knockaphunta, County Mayo, 8th June 2014 (no injuries reported);
- Vehicle struck by train at Cartron level crossing, XM220, County Mayo, 17th August 2018 (no injuries reported).

107 To date the RAIU have made thirty-seven safety recommendations in relation to UWLCs, as outlined in the paragraphs below.

Safety recommendations from RAIU Investigation Reports

Collision at LC XN 104 between Ballybrophy and Killonan on the 28th June 2007

108 The RAIU report (Report No. 07062801), made the following safety recommendations:

- IÉ-IM⁵ to review the various sources of information relevant to level crossings and develop a standard, or suite of standards, consolidating information on: civil engineering specifications; signage specifications; visibility of approaching trains; and inspection and maintenance. Ensuring effective implementation and compliance;
- IÉ-IM to develop a robust system that identifies current landowners who have crossings on their property and records the delivery of information to them. This should include the distribution of information to known contractors and should consider timely reminders coming up to the silage season;
- IÉ-IM to develop and implement a vegetation management programme that addresses vegetation management on a risk basis, prioritising high risk area;
- IÉ-IM to ensure that a system is put in place for effective implementation of existing standards and to manage the timely introduction of new and revised standards, this should include departmental instructions;
- IÉ-RU to review the standards relating to on-board data recorders, ensuring that correct operation, accuracy and post incident downloads are effectively addressed;
- IÉ-RU to review the 'Monitoring the Speed of Trains' standard, including assessing the effectiveness of monitoring by means of signal cabin train registers;
- The CRR⁶ to review and issue 'Guidelines for the Design of Railway Infrastructure and Rolling Stock.

Fatality at level crossing XX 032 between Manulla and Ballina on the 28th February 2008

109 The RAIU report (Report No. 08022801) made the following safety recommendations:

- The CRR should carry out a review of the suitability of this type of level crossing on public roads. This review should include, but not be limited to, factors such as continual misuse, signage, user mobility, environmental and human factors;

⁵ IÉ-IM were previously not separated into IM and RU; this report will refer to current IÉ-IM and IÉ-RU to avoid confusion.

⁶ The CRR were previously known as the Railway Safety Commission; they will be referred to as the CRR for this section of the report to avoid confusion.

- IÉ-IM should, taking into account the close proximity of the three level crossings, close or upgrade some or all of these crossings;
- IÉ-IM must identify crossings that are regularly misused and take proactive action to manage the increased risk created by this misuse;
- IÉ-IM are to put in place procedures that will capture and manage near miss reports.

Collision between a train and a road vehicle at LC XN125, Cappadine, 31st July 2008

110 The RAIU report (Report No. 08073101) made the following safety recommendations:

- IÉ-IM should assess the risks relating to road users' behaviour in identifying a safe stopping position at User Worked Level Crossings and based on the outcome of this risk assessment, IÉ-IM should introduce measures to allow safe use of this type of level crossing;
- IÉ-IM should carry out risk assessments on level crossings that fail to meet the viewing distances specified in the CRR guidance and implement appropriate measures in order to meet this guidance as a minimum.

Person struck at level crossing XE039, County Clare, 27th June 2010

111 The RAIU report (Report No. 2011-R005) made the following safety recommendations:

- IÉ-IM should ensure that risk assessments are produced for all user worked level crossings to identify all hazards specific to particular level crossings;
- IÉ-IM should review their documentation on the measurement of viewing distances at existing user worked level crossings to ensure that the viewing distances provide sufficient views of approaching trains to allow level crossing users cross safely;
- IÉ-IM should review their procedures for the management of accidents to ensure that communication with the emergency services is clear and provides the necessary information to locate an accident site without undue delay and access it by the most appropriate point;
- IÉ-IM to develop and implement a vegetation management programme that addresses vegetation management on a risk basis, prioritising high risk areas (re-iterated safety recommendation).

Road vehicle struck at level crossing XM096, County Roscommon, 2nd September 2010

112 The RAIU report (Report No. 2011-R006) made the following safety recommendations:

- IÉ-IM should put in place a formal process for identifying and communicating with known users of user worked level crossings;
- IÉ-IM should review the effectiveness of its signage at user worked level crossings, and amend it where appropriate, taking into account the information provided in the level crossing user booklet. The review should include the information on the use of railway signals, what to do in case of difficulty when crossing the railway and ensuring the signage is illustrated in a clear and concise manner, taking into account current best practice and statutory requirements;
- IÉ-IM should update its risk management system to ensure that interim control measures are put in place where longer term controls to address risks require time to implement;
- IÉ-IM should review how it determines the safe crossing time for user worked LCs to ensure the safe crossing time allows adequate time for movements and includes a safety margin, over and above the crossing time;
- IÉ-IM should review its use of disused rail as fencing at user worked LCs to ensure it cannot potentially increase the severity of a collision and where this is the case, replace the disused rail with appropriate fencing;
- IÉ-IM to develop and implement a vegetation management programme that addresses vegetation management on a risk basis, prioritising high risk areas (re-iterated safety recommendation).

Car Strike at Knockaphunta Level Crossing (XM250), County Mayo, 24th October 2010

113 The RAIU report (Report No. 2011-R007) made the following safety recommendations:

- IÉ-IM should upgrade the Level Crossing to ensure that the operation of the Level Crossing is not reliant on any direct action by the level crossing user;
- IÉ-IM must identify crossings that are regularly misused and take proactive action to manage the increased risk created by this misuse (re-iterated safety recommendation);
- IÉ-IM should assess the risks relating to road users' behaviour in identifying a safe stopping position at UWLCs and based on the outcome of this risk assessment, IÉ-IM should introduce measures to allow safe use of this type of level crossing (re-iterated safety recommendation).

Car Strike at Morrough Level Crossing, XG173, County Galway, 14th February 2011

114 The RAIU report (Report No. 2012–R001) made the following safety recommendations:

- IÉ-IM should review the suitability of the signage at user worked crossings on public and private roads, ensuring that human factors issues are identified and addressed;
- IÉ-IM should liaise with local authorities where private road level crossings can be accessed from a public road to ensure there is advance warning to road users;
- IÉ-IM should ensure that they adopt their own standards in relation to design changes to any plant, equipment, infrastructure or operations that have the potential to affect safety;
- The CRR should ensure that they adopt a formal approach to submissions made by IÉ-IM in relation to design changes to any plant, equipment, infrastructure or operations that has the potential to affect safety.

Tractor struck train at level crossing XE020, County Clare 20th June 2012

115 The RAIU report (Report No. R2013-002) made the following safety recommendations:

- IÉ-IM should close, move or alter the level crossing in order to meet the required viewing distances in CCE-TMS-380;
- IÉ-IM should review their systems of managing level crossings that fail to meet the viewing distances in CCE-TMS-380 to ensure that any mitigation measure that is introduced is effective at reducing the risk to level crossing users;
- IÉ-IM should audit their LCRM, to ensure it correctly identifies high risk level crossings; and identifies appropriate risk mitigation measures for individual level crossings;
- IÉ-IM should review their procedures for the management of accidents to ensure that communication with the emergency services is clear and provides the necessary information to locate an accident without undue delay and access it by the most appropriate point.

Vehicle struck by train at Corraun level crossing, XX024, Co. Mayo, 12th February 2014

116 The RAIU Report (Report No. R2015-001) made the following safety recommendations:

- IÉ-IM should consider options to upgrade the crossing to minimise direct action by the users;

- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and either upgrade the level crossing or introduce measures to minimise their misuse;
- IÉ-IM should ensure that where a Decision Line⁷ is present at a level crossing, that the purpose of this Decision Line is appropriately conveyed to the level crossing users.

Car strikes train at level crossing XM250, Knockaphunta, Co Mayo, 8th June 2014

117 The RAIU report (Report No. R2015-002) made the following safety recommendations:

- The CRR, RSA and IÉ-IM in consultation with any relevant stakeholders should agree a common policy in connection with instructions and warnings related to user worked level crossings;
- IÉ-IM should upgrade the level crossing to ensure that the operation of the Level Crossing is not reliant on any direct action by the level crossing user (re-iterated safety recommendation);
- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and either upgrade the level crossing or introduce measures to minimise their misuse (re-iterated safety recommendation);
- IÉ-IM should ensure that where a Decision Line is present on a user worked level crossing, that the purpose of this Decision Line is conveyed to the level crossing users (re-iterated safety recommendation).

Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17th August 2018

118 The RAIU report (Report No. 2019-R003) made the following safety recommendations:

- IÉ-IM should consider options to upgrade LC XM220 to minimise the requirement of direct action by the users;
- IÉ-IM should carry out a full review of known misused UWLCs on public and private roads and should develop a programme to either close or upgrade the level crossings to minimise misuse; where possible, level crossings with the highest risks should be addressed first;

⁷ What IÉ-IM refer to as a Stop Line

- The Department of Transport⁸ 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.

RAIU safety recommendation status

119 From the eleven investigation reports regarding collision of trains with users at UWLCs, the RAIU have made thirty-seven standalone safety recommendation (i.e. not counting reiterated safety recommendations). Of the thirty-seven safety recommendations:

- Thirty-one have been closed, meaning that the CRR has reviewed a submission (or further submission) and is satisfied that the safety recommendation has been addressed.
- Four have a “Further Evidence Required” (FER) status, meaning the CRR has reviewed a submission (or further submission) but considers that further evidence is necessary to close the safety recommendation, these safety recommendations are:
 - IÉ-IM should review how it determines the safe crossing time for user worked level crossings to ensure the safe crossing time allows adequate time for movements and includes a safety margin, over and above the crossing time. (Road vehicle struck at level crossing XM096, County Roscommon, 2nd September 2010 (published 04/10/11));
 - IÉ-IM should consider options to upgrade the crossing to minimise direct action by the users (Vehicle struck by train at Corraun level crossing, XX024, Co. Mayo, 12th February 2014 (published 30/04/15));
 - IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and either upgrade the level crossing or introduce measures to minimise their misuse (Vehicle struck by train at Corraun level crossing, XX024, Co. Mayo, 12th February 2014 (published 30/04/15));

⁸ The Department of Transport was known as the Department of Transport, Tourism & Sport at the time of the recommendation, however, will be referred to as the Department of Transport for the avoidance of confusion.

- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and should develop a programme to either close or upgrade the level crossings to minimise misuse; where possible, level crossings with the highest risks should be addressed first (Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17th August 2018 (published 3rd September 2019)).
- One safety recommendation remains open, as follows:
 - The Department of Transport 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 (Vehicle struck by train at Cartron level crossing, XM220, Co. Mayo, 17th August 2018 (published 03/09/19)).

Analysis

The Level Crossing

Signage & road markings on the approach to and at LC XM240

120 The signage and road markings are set out as in: Section 5, Level Crossings, of the CRR's Guidelines for the Design of Railway Infrastructure and Rolling Stock (paragraphs 57 - 58); IÉ-IM's CCE-TMS-380 (paragraphs 64 - 68); and, the Department of Transport's Traffic Signs Manual (paragraphs 64 - 65).

121 Of note to this investigation is one safety recommendation previously made by the RAIU in relation to signage on the approach to or at UWLCs; this recommendation is currently an open status with the CRR, namely:

- The Department of Transport 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 (made in 2019).

122 The RAIU consider that there are four opportunities to highlight to level crossing users that they are approaching a live railway; three on approach (using the W121 signs with supplementary plates (paragraph 64 & Figure 11)); and, one at the level crossings (using IÉ-IM's signage (paragraph 67 & Figure 13)). The completion and closing of this safety recommendation should ensure advanced warning of level crossings for road drivers.

IÉ-IM Technical Management Standards

123 The RAIU found that IÉ-IM have been conducting the required: annual inspection and surveys as required by CCE-TMS-360 (paragraph 78); and the required weekly track patrols as set out in CCE-TMS-361 (paragraph 80).

124 In addition, the viewing distances also met the requirements of this standard (paragraphs 69 - 70).

Use, Misuse & Abuse of LC XM240

125 A survey carried out in late 2018 indicated that LC XM240 is used over 200 times daily (paragraph 82), however, it is likely to have increased since the closure of a local post office (paragraph 83).

126 In terms of the history of LC XM240, there was been nine near miss occurrences in a seven year period (paragraph 105); and, LC XM240, was at one time the highest risk level crossing on the IÉ network, and as such safety campaigns were held at the level crossing (paragraph 85). However, misuse /abuse continues to remain high at the level crossing with the gates continuously left open (paragraph 81).

127 Of note to this investigation are the following FER safety recommendations:

- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and either upgrade the level crossing or introduce measures to minimise their misuse (FER);
- IÉ-IM should carry out a full review of known misused user worked level crossings on public and private roads and should develop a programme to either close or upgrade the level crossings to minimise misuse; where possible, level crossings with the highest risks should be addressed first (FER);

128 These safety recommendations are related to the identification and closure /upgrading of misused level crossings, with a focus on the highest risk level crossings. The completion and closure of these safety recommendations would ensure the continued upgrading /closure of level crossings over time with an emphasis on the highest risk level crossings.

Level Crossing Risk Model

129 The highest risk driver for the collective and individual risks at LC XM240 is the level of abuse at LC XM240; making it the 15th and 2nd highest risk OP Type level crossing in terms of individual and collective risk, respectively, at the time of the accident.

Duties of the parties directly or indirectly involved in the accident

Duties of users of LC XM240

130 The previous user of LC XM240 did not close the gates after traversing over the level crossing (paragraph 95) which is contrary to the requirements set out in the RSA's Rules of the Road (paragraph 77).

131 The non-closure of gates is common at this UWLC (paragraph 81). As a known misused/ abused level crossing (paragraph 84) a safety campaign was held at LC XM240 in 2014 (paragraph 85), however, this did not result in the misuse /abuse reducing or stopping.

Actions & inactions Car Driver

132 The Car Driver was an experienced driver and was familiar with LC XM240.

133 The Car Driver may not have been familiar with three of the four documents outlined in paragraph 71, namely, the IÉ-IM Booklet, the CRR's Third Party Guidance on Railway Risk or the RSA's Safety at Level Crossing documents.

134 However, as a holder of a valid driving licence the Car Driver is expected to be familiar with the RSA's Rules of the Road (paragraph 73 - 77), which requires road users to follow a number of steps, including: stop clear of gates; and, look right and left and listen for trains (paragraphs 75 - 77).

135 On the day of the accident (despite approaching LC XM240 at a slow speed) the Car Driver did not adhere to the requirements set out in the RSA's Rules of the Road in order to prepare (paragraph 75) to drive across safely (paragraph 76), as he did not:

- Stop clear of the gates (two metres clear of the railway line) and apply the handbrake (at the location of the Stop sign and Stop line);
- Open the windows on the driver and passenger sides;
- Look right and left and listen.

136 Instead, the Car Driver proceeded through the Stop sign, over the Stop line and across LC XM240 without caution. After the accident, the Car Driver acknowledged that he heard the train horn but did not associate the horn with an approaching train (paragraph 101).

Conclusion

The Level Crossing

137 The signage and road markings on the approach to and at LC XM240 are as set out as required by: Section 5, Level Crossings, of the CRR's Guidelines for the Design of Railway Infrastructure and Rolling Stock (paragraph 120), IÉ-IM's CCE-TMS-380 and Chapter 6 of the Department of Transport's Traffic Signs Manual (paragraph 120). The RAIU have previously made recommendations to IÉ-IM on signage at UWLCs and to the Department of Transport in relation to signage on the approach to UWLCs level crossings (paragraph 121). The recommendations are currently being progressed by the relevant parties and completion of these should ensure clear signage for users to encourage users to stop before attempting to cross the railway (paragraph 122).

138 The inspections, survey and track patrols are being conducted at LC XM240, as required (paragraph 123) and the viewing distances are to standard (paragraph 124).

139 A 2018 survey indicated that LC XM240 is used over 200 times a day, a figure which has likely increased over time (paragraph 125). There have been nine near misses over a seven year period; and despite effort by IÉ-IM and other stakeholders, the level of misuse/abuse remains high as the gates are continuously left open (paragraph 126) with the LCRM identifying that the risk (due to abuse/misuse) was high at the time of the accident, in particular in relation to collective risk (paragraph 129). The RAIU have previously made recommendations in relation to misused / abused UWLCs level crossings in relation to their identification, upgrading and closure. These recommendations are currently being progressed and their completion should ensure a programme for upgrading/ closure of UWLCs on a risk-based approach, over time (paragraph 128).

Duties of the parties directly or indirectly involved in the accident

Duties of users of LC XM240

140 The previous user of LC XM240 did not close the gates after traversing over the level crossing which is contrary to the requirements set out in the RSA's Rules of the Road (paragraph 130). The non-closure of gates is continuous at this UWLC despite safety campaigns to promote the importance of the closure of gates at LC XM240 (paragraph 131).

Actions & inactions of the Car Driver

141 The Car Driver was an experienced driver and was familiar with LC XM240 (paragraph 132). However, on the day of the accident, the Car Driver did not adhere to the requirements set out in the RSA's Rules of the Road, in that he did not stop clear of the railway line or look for approaching trains (paragraph 135). The Car Driver did not open the car windows to listen for trains, but did acknowledge that he heard the train horn, but did not associate it with an approaching train (paragraph 136).

Additional observations

142 In relation to the train horn, the 2007 commissioning of the train horn was carried out using the A-weighted sound pressure level measurements (paragraph 44) instead of the C-weighted sound pressure level measurements (paragraph 43) and as such there is no means of assessing if the horn performance met the requirements of GM/RT 2180 (Figure 7) at the time. Post-accident testing of the horn, indicate that the horn levels do not meet the requirements of GM/RT 2180 (paragraph 45); this may be partly due to the horn not aligning with the louvre cuts in the fairing (paragraph 41, Figure 6).

143 However, it should be noted that the driver did hear at least one of the four train horn soundings; and listening for the train horn is not the only warning to drivers of approaching trains.

144 Section 5, Level Crossings, of the CRR's Guidelines for the Design of Railway Infrastructure and Rolling Stock (paragraphs 57, 58, 120, 137) was in place at the time of the accident. It is noted that, although not functioning at the time of the accident, the DSS was being installed at LC XM240, however, there is no reference to the DSS in the CRR's Guidelines for the Design of Railway Infrastructure and Rolling Stock given the publication date of the CRR's guidance in 2008.

Causal, contributing & systemic factors

145 On the 29th April 2020, a white Kia Soul car approached and drove onto LC XM240 and was struck by Train A809.

146 Causal factors to this accident were:

- CaF-01 – The Car Driver failed to stop (at the location of the Stop sign and Stop line) to look for trains on approach to LC XM240 as required by the RSA's Rules of the Road, in part, as a result of the level crossing gates being open;
- CaF-02 – The sounding of the train horn was not effective at warning the Car Driver of the approaching train.

147 Contributing factors to the accident were:

- CoF-01 – There is a high level of misuse and abuse at LC XM240, where the level crossing gates are continuously left open, despite laws being in place for them to be closed.

148 The RAIU have not identified any systemic factors related to IÉ-IM's regulatory framework conditions, the design and application of the SMS, skills of the staff, procedures or maintenance.

149 The RAIU conclude that misuse / abuse is likely going to continue at LC XM240. However, measures taken by IÉ-IM, at LC XM240, since the accident, to improve safety, will be discussed in the "Measures taken since the accident" section of this report.

150 The RAIU also note that IÉ-IM and the CRR continue to address and close RAIU safety recommendations, made as a result of previous accidents at UWLCs.

Measures taken since the accident

IÉ-IM measures taken since the accident

Internal investigation report

151 IÉ-IM Safety Department completed an investigation report into the accident, which was published on the 1st October 2020, entitled “Report of Investigation: Train A809 collided with a car at XM240, 29th of April 2020”, this report found the immediate cause of the accident to be: “the driver of the car did not stop at the designated Stop sign and Stop line and drove directly onto the level crossing into the path of the Dublin bound approaching train”. Causal factors were identified as: “The driver of the car did not adhere to the correct procedure for using the crossing by not stopping at the crossing Stop sign/line, as set out in the Road Safety Authority’s Rules of the Road and the IÉ User Operated Unattended Level Crossings Booklet”; and, “From the time the car came into the view of the Driver of train A809 and he applied the train brakes there was insufficient distance to stop the train before reaching the level crossing and colliding with the car”. No underlying causes were identified.

152 There were no recommendations made as a result of the investigation, however, the following actions were listed:

- All damaged level crossing equipment was re-instated.
- The Infrastructure Manager CCE, Athlone sent correspondence to the Chief Superintendent at Castlebar Garda Station querying whether the Car Driver would be prosecuted.
- On the 19th May 2020, the Vamos DSS was commissioned at LC XM240, this is further discussed below.

Decision Support Systems at User Worked Crossings

General information

- 153 Although not operational at the time of the accident, IÉ-IM were in the process of trialling the DSS. Since the accident, this equipment is live at LC XM240. IÉ-IM are in the process of installing one DSS every month at UWLCs.
- 154 This RAIU report will outline some of the features of the DSS in terms of: the selection process for the installation of a DSS and how the user operates a DSS; it will not discuss the technical installation elements of a DSS.
- 155 CCE-TMS-382, Technical Standard for Decision Support Systems at User Worked Crossings, Version 1.2, operative since the 23rd July 2019 (which will be referred to as CCE-TMS-382 for the remainder of this report) describes the requirements of a DSS and it is “additional to and is directly supported by CCE-TMS-380”.

Principles

- 156 The following are the “high-level” principles which apply to DSSs at UWLCs:
- CCE-TMS-380 remains the primary requirement for the design/arrangement and management of user worked level crossings;
 - The application of DSSs is permitted at four different types of UWLC (*F Type*, *P Type*, *O Type* and *OP Type*; where a DSS is provided, they will be renamed *F(D) Type*, *P (D) Type*, *O (D) Type* and *OP (D) Type*, respectively);
 - The application of DSSs is permitted on single lines only, with permissible speeds up to 100 mph (160 km/h);
- 157 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.

Selection of DSS

158 The selection criteria for the introduction of a DSS at a UWLC are prioritised based on the following: Ranking in the LCRM; Accident statistics; 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); Local knowledge.

Train detection

159 Train detection is through one of two ways:

- Type 1 Axle Counter: This shall be used where the system must verify that the train has cleared the crossing before switching the visual indicator to orange (O & OP Type). Axles shall be counted at strike-in and strike-out to verify passage of the complete train;
- Type 2 Timed Wheel Detection: This shall be permitted where there is a slow approach speed to the crossing (F & P Type). Axle/wheel mass shall be detected. The system assumes the train has passed when no further detections have occurred for a set time of 4 +/- 1 second.

160 The train detection alert time (21.5 seconds) is a period of time designed to allow a user to get into a position of safety (clear of the level crossing) with a margin of comfort for both the user and the train driver; the 21.5 seconds is comprised of:

- 11 seconds – An allowance for a large vehicle to complete a crossing based on a crossing time of 3 mph (4.8 km/h);
- 5 seconds – An additional margin of time such that users are not unduly pressurised in reaching a position of safety before the train arrives at the crossing;
- 0.25 seconds – An allowance for latency in the equipment – time for the wheel detector to communicate with and switch the light from orange to red;
- 0.25 seconds – An allowance for the distance from the front of the train to its first axle;
- 5 seconds – Additional five seconds in accordance with the CRR's RSC-G-006-B which states that "the time required by reasonably foreseeable users to traverse the crossing length should be at least 5 seconds greater than the available warning period of the approach of a train".

161 A train may only initiate the operation of the DSS as it approaches the crossing (strike-in). A train shall cancel the red warning light automatically when the train has left the level crossing area on its path away from it (strike-out).

DSS Status

162 The status of the DSS is either:

- Status 1 – Normal Operation (meaning the system is fully functional) and has one of two configurations, either:
 - Always On: Meaning the systems is continuously displaying a light aspect and audio shall activate when a train has been detected;
 - On Demand: The warning lights remain unlit until activated by the user using a button.
- Status 2 - Degraded – meaning one or more faults have been detected and the system is no longer working as normal and so enters degraded mode and has one of two configurations, either:
 - No lights or alarm provided, meaning the light aspects are not showing to the user and the audible alarm is not functional;
 - No lights, no alarm and no backlight shows, meaning the system shows no light aspect as well as there being no backlight on the 'on-demand' button and the audible alarm is not functional.

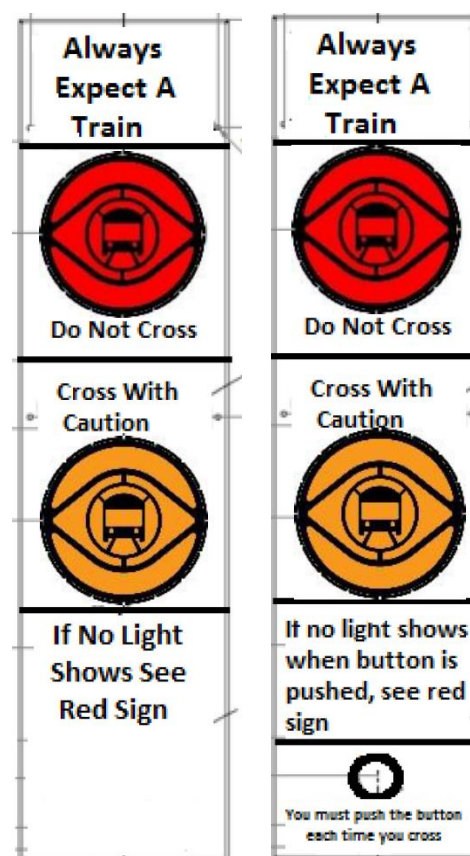
163 The system can recover from degraded mode in one of two ways: Manual Reset (onsite intervention) or Automatic Reset (off-site intervention).

164 For installations at O and OP type crossings the system shall be able to verify that the train has cleared the crossing before switching the visual indicator to orange.

165 A renewable source of energy shall be provided to operate the equipment in areas where no main power source is available. The system shall have a battery backup system to maintain operation for 12 hours in the event of a power failure. The system shall contain an event logging facility and store event data for download in the event of system failure or user incident.

Visual indications, audible warnings & associated signage

166 The system shall utilise a two-aspect colour light warning to crossing users, Figure 20. 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 shall be displayed to the user. When a train is being detected, the Red light shall be displayed to the user. The system shall provide a standard tone for the Audible Warning Device to signify a train is approaching the level crossing, and this shall be maintained until the warning light is switched back to orange. Where On Demand is configured and operational, the indications and Audible Warning shall be suppressed and replaced by an illumination of the On Demand button until the user activates the system by polling the button.



167 The positioning of the visual indications together with the On Demand Button shall be ahead of the stop line, or where there is no stop

Figure 20 – User Lights (Always On (RHS) and On Demand (LHS))

line, at least 2m back from the nearest rail, such that a person and vehicle are always in a position of safety when using the on-demand system. The indication lights of the DSS should be installed at least one meter inside the gate to ensure that the user opening the second gate will see the warning light before returning to a vehicle, the layout of the DSS equipment shall be optimised such that visibility of the warning lights will be maximised in both directions. This principle may be reduced in special circumstances to a half meter based on risk assessment.

168 In addition to the signage requirements for UWLCs, there is additional signage associated with the DSS which should be placed on the left-hand side. Figure 21 illustrated the signage present at UWLCs with DSS (left hand side sign is present at all UWLCs with DSS, centre sign at Always On configuration, right hand side at On Demands configurations).

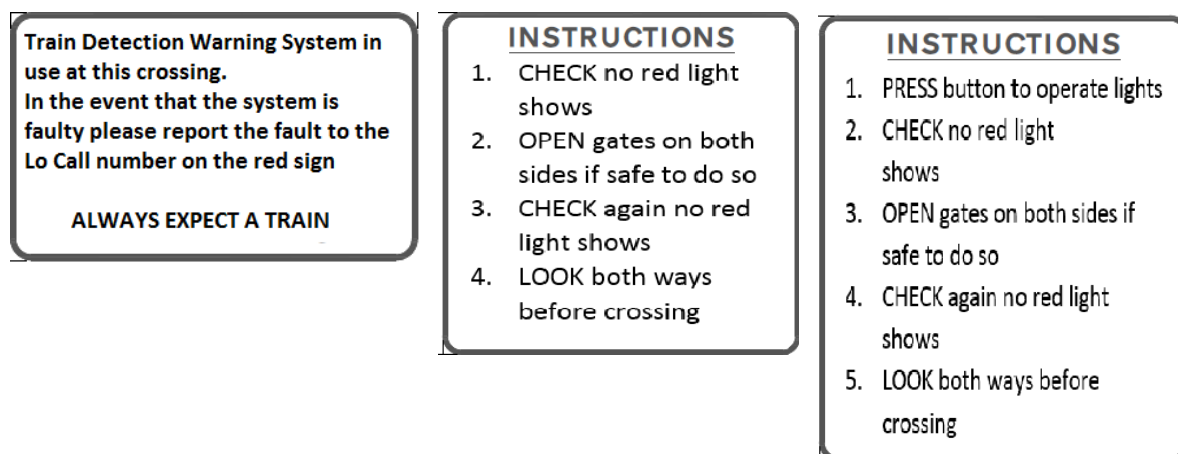


Figure 21 – Signage present at ULCs with DSS

169 Figure 22 illustrates a typical layout of a UWLC with DSS with the visual indications and signage.

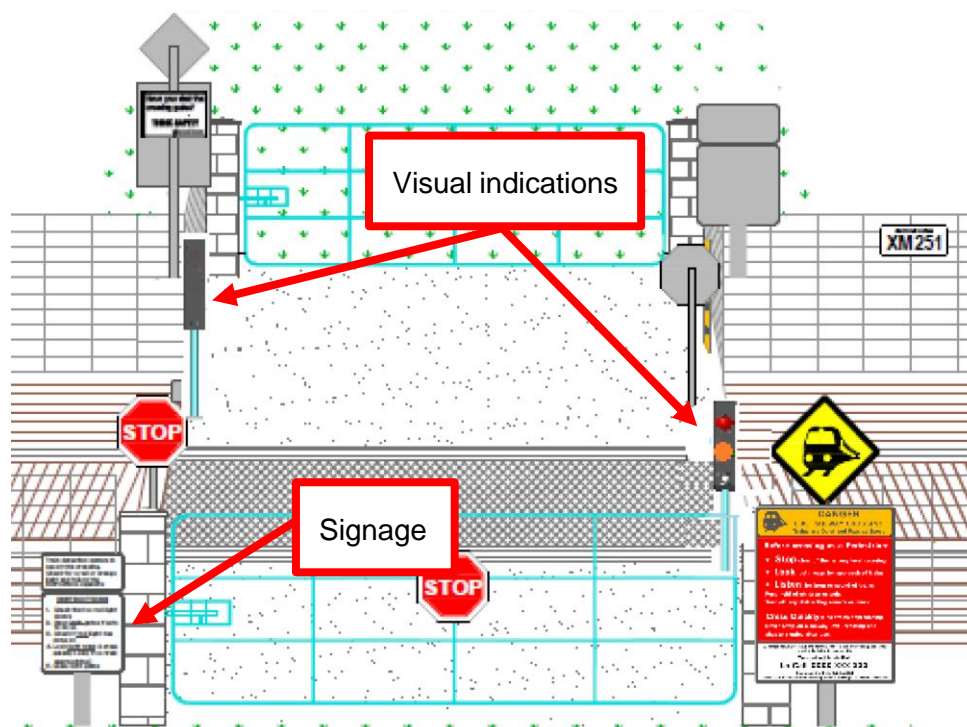


Figure 22 – Typical layout of a UWLC with DSS

DSS at LC XM240

- 170 A DSS is now in full operation at LC XM240, see Figure 23. It was selected as suitable for this location due to its ranking in the LCRM, history of near misses and due to its continued misuse by the users. It was set up as an Always On configuration.



Figure 23 – DSS at LC XM240

- 171 IÉ-IM have sent out flyers locally to describe the DSS and some feedback has been received by IÉ-IM in relation to the DSS e.g. positioning of the lights in relation to cars; and IÉ-IM are working with the local users and CRR to address this feedback.

Operation of Level Crossings with the DSS

- 172 It is noted that the RSA's Rules of the Road and the IÉ-IM Safety Booklet have not been updated, to date, to include information on the DSS.

Level Crossing Risk Model

- 173 The introduction of the DSS System has resulted, in part, to decreases in risk rankings on the LCRM. In terms of the individual risk to exposed groups, this remains as a rating of medium. In terms of the rankings for O type level crossings in the Athlone Division, the individual risk has decreased from 15 of 42 (paragraph 89) to 33 of 42 i.e. now the 33rd highest individual risk crossing in the Athlone Division; and, from 2 of 42 (paragraph 89) for the collective risk ranking to 6 of 42.

Communications with the local community

174 IÉ-IM held a two-day communications event at LC XM240 where the DSS new technology was introduced – this involved an IÉ-IM presence at LC XM240 to introduce the system, hand out literature and provide guidance to users of the crossing.

175 IÉ-IM have stated that “there are on-going communications and discussions with local users and local representatives of the Level Crossing XM240 at Kilnageer. These have been progressive discussions involving good communications which have for example, resulted in a number of minor improvements to the crossing environment based on feedback and interactions with local users”.

176 IÉ-IM have held a series of meetings with local community groups as well as with local representatives around the safe use of LC XM240; this included attending Mayo Council Chambers where the issues related to LC XM240 were debated at length.

177 IÉ-IM have also conducted site meetings, at LC XM 240, with the local resident groups and local representatives (Kilnageer and Breaffy Parishes) for feedback on LC XM240 where a number of improvements were discussed following this positive engagement. These improvements included:

- Structural modifications to the Up-Side gate to accommodate the new DSS’s lights for an improved visibility;
- Readjustment of the newly installed DSS’s light head on the Up-Side to further increase its advance approach visibility for vehicle drivers;
- Realignment of passive signage to further improve road users views of Westport bound trains;
- Installation of yellow hatch road markers to discourage users from parking on the *five foot* while permitting road traffic to pass which was travelling in the opposite direction.

Construction of a bridge at LC XM240

178 Since the accident, some local residents have protested in relation to the absence of a bridge at LC XM240. IÉ-IM have engaged extensively with Mayo County Council in relation to LC XM240 with the outcome being that IÉ-IM have applied for planning permission for the elimination of the crossing, which would be replaced by a bridge. The estimated cost to construct the bridge is approximately €2.2 million.

179 IÉ-IM have confirmed that, at this stage, funding is not available for the construction of a bridge; and that any available funding would have to be prioritised on a risk-based

approach e.g. funding would be directed towards higher risk level crossings on the IÉ network. However, IÉ-IM have committed to continue to communicate with users and local representatives in relation to LC XM240; and in the event that funding does become available, a bridge scheme can be quickly progressed in agreement with IÉ-IM, Mayo County Council, local representative and users of LC XM240.

General measures taken in relation to O/ OP Type Level Crossings

180 In relation to O/OP Type Level Crossings, the following measures have been undertaken:

- On-going level crossing closures, sixty-seven in the past five years;
- A national programme of development, implementation and roll-out of technological enhancements;
- A full review of all IÉ-IM passive user information signage has been undertaken with a new suite of signage manufactured and installed;
- Acutely skewed level crossings have been identified and Durabel Ice Free Traffic Mirrors have been installed to assist users crossing the level crossings;
- Alternative anti-trespass/ cattlegrids have been developed, procured and installed resulting in a substantial drop in slips, trip, falls and illegal access;
- Stop lines have been clearly defined and Stop signs and been installed;
- Level crossings with intolerable risks have either been removed from the network or have mitigations applied to reduce the risk and make them tolerable;
- Annual risk assessments are carried out at all O/OP Type Level Crossings;
- Bespoke communications materials for specific user groups e.g. hauliers, emergency services, farmers, pedestrians etc has been developed;
- There are on-going initiatives of engagement with all stakeholders;
- Improved interaction/recording/reporting with the local authorities responsible for approach signage and vegetation control where issues have been identified;
- Traffic counts continue to be carried out at all public road level crossing to capture the continuously changing usage figures and user profile type;
- Installation of Vegetation 'V' boards at all level crossings to assist in retaining the minimum viewing/sighting distances.

Safety Recommendations

Introduction to safety recommendation

181 In accordance with the Railway Safety Act 2005 (Government of Ireland, 2005a) and the European railway safety directive (European Union, 2004), recommendations are addressed to the national safety authority, the CRR. The recommendation is directed to the party identified in each recommendation.

Absence of safety recommendations due to measures already taken

182 IÉ-IM have upgraded LC XM240 with the installation of the DSS, which provides users of LC XM240 with real time information on approaching trains i.e. when trains are approaching the DSS illuminates red and emits an audible warning (CaF-02) (paragraphs 162 and 166). The DSS was made fully operational in May, and at the time of publication of this report, no issues have been identified (paragraphs 153 - 173). IÉ-IM have also provided assurances that when funding becomes available for LC XM240, a bridge will be constructed, but it is noted, that priority will be given to higher risk level crossings (paragraph 178).

183 In addition, The RAIU have previously made recommendations in relation to misused / abused UWLCs level crossings in relation to their identification, upgrading and closure (paragraph 139); as well as making recommendations in relation to signage on the approach to and at UWLCs (paragraph 137). These recommendations are currently being progressed and their completion should ensure a programme for upgrading/ closure of UWLCs on a risk-based approach, over time (paragraph 139). As a result of the above, the RAIU are not making any further recommendations in relation to the upgrading of LC XM240 or other UWLCs.

Safety recommendations as a result of this accident

184 The RAIU have not made any safety recommendations as a result of this accident for the reasons outlined in paragraphs 182 and 183.

Safety recommendations as a result of additional observations

185 The RAIU make the following safety recommendations as a result of additional observations made in this investigation as a result of the installation of the DSS at UWLCs (paragraph 172):

Safety Recommendation 202101-01

The RSA should update the “Rules of the Road” to include guidance on the DSS.

Safety Recommendation 202101-02

IE-IM should update the ‘The SAFE use of Unattended Railway Level Crossings’ booklet to include guidance on the DSS.

186 The RAIU make the following safety recommendation as a result of an additional observation in relation to the commissioning of train horn on the ICRs (CaF-02):

Safety Recommendation 202101-03

IE-RU should put systems in place to ensure ICR train horns meet the current standards for sound pressure levels.

187 The RAIU make the following safety recommendation as a result of an additional observation in relation to the dearth of information on the DSS in the CRR’s Guidelines (paragraph 144):

Safety Recommendation 202101-04

The CRR should review and update Section 5, Level Crossings, of their Guidelines for the Design of Railway Infrastructure and Rolling Stock, to ensure that guidance/reference on the DSS is included.

Additional Information

List of abbreviations

CCE	Chief Civil Engineer
CME	Chief Mechanical Engineer
CRR	Commission for Railway Regulation
CWR	Continuous Welded Rail
DMU	Diesel Multiple Unit
DSS	Decision Support System
FER	Further Evidence Required
FWI	Fatalities and weighted injuries
hr	hour
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
OP	Occupational Public
OTDR	On Train Data Recorder
PWI	Permanent Way Inspector
RAIU	Railway Accident Investigation Unit
RSA	Road Safety Authority
TCB	Track Circuit Block
UWLC	User Worked Unattended Level Crossing

Glossary of terms

A-weighted sound pressure level	The A-weighted sound level discriminates against low frequencies, in a manner similar to the response of the ear.
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.
C-weighted sound pressure level	The C-weighted sound level does not discriminate against low frequencies and measures uniformly over the frequency range of 30 to 10,000 Hz. This weighting scale is useful for monitoring sources such as engines, explosions, and machinery.
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.

Closed safety recommendation	The CRR has reviewed a submission (or further submission) and is satisfied that the safety recommendation has been addressed.
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 Welded Rail	Sections of rail that are welded together.
Contributing Factor	Any action, omission, event or condition that affects an occurrence by increasing its likelihood, accelerating the effect in time or increasing the severity of the consequences, but the elimination of which would not have prevented the occurrence.
Down Direction	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 drive 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.
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 following categories: infrastructure; energy; control-command & signalling; rolling stock; traffic operations & management and others.
Individual Risk	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.
Investigation	A process conducted for the purpose of accident and incident prevention which includes the gathering and analysis of information,

		the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations
Level Crossing Risk Model		Software package authorised by the Board of IÉ for the assessment of risks at Level Crossings on the IÉ network.
O Type Crossing	Level	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 Crossing	Level	User worked unattended occupational level crossing on a public road.
P Type Crossing	Level	User worked unattended pedestrian Level Crossing – for pedestrian use only.
Patrol Ganger		A person who is trained and competent to undertake patrolling duties on a specified length of track on behalf of IÉ in line with IÉ-IM standard, Track Patrolling, CCE-TMS-361.
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”.
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		Towards Dublin.
Up Line		Line where trains are travelling towards Dublin.
User		Person (pedestrian, driver or rider) that requires to cross the railway at the level crossing.
User	Worked Unattended Level Crossing (UWLC)	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.
Whistleboard		Trackside sign which indicates to a train driver that he/she must sound the horn.

References

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IE-IM (2018), CCE Safety Management System, CCE-SMS-001, Version 6.0.

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IE-IM (2017), Technical Standard for Management of User Worked Unattended Level Crossings (CCE-TMS-380), Version 2.1, operative since the 27th November 2017.

IE-IM (2018), Technical Standard for Track and Structures Inspection Requirements (CCE-TMS-360), Version 2.3, operative since the 19th June 2018.

IE-IM (2020), Technical Standard for Track Patrolling (CCE-TMS-361), Version 1.9, operative since the 2nd March 2020.

IE-IM (2019), Technical Standard for Decision Support Systems at User Worked Crossings (CCE-TMS-382), Version 1.2, operative since the 23rd July 2019.

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