



improving
public transport
through technology

Low Bridge Strikes

RTIG Library Reference: **RTIGT044-1.2**

February 2026

Availability: Public

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Status of this document

This document is Published.

If there are any comments or feedback arising from the review or use of this document, please contact us at secretariat@rtig.org.uk

1 Introduction

1.1 About this document

- 1.1.1 This document has been produced for the Real Time Information Group (RTIG). It seeks to raise awareness of Low Bridge strikes and provides advice on approaches to mitigating the risk.

1.2 Background and context

- 1.2.1 This paper updates the report of an RTIG research project first published in 2021 into Low Bridge strikes. This has been a problem for high-sided vehicles such as HGVs and buses for a long time and can be very costly - both in economic and human terms. Bus operators have understandably been focussing on the issue in light of the continued incidence of serious bus bridge strikes. The primary function of the research and this report is to raise awareness of the problem in the UK bus industry; and offer some guidance on how bus operators might prevent and ultimately - eradicate the problem
- 1.2.2 The original research involved web searches to identify the incidence, scale, consequences and costs of the problem and give some examples of high-profile strikes. Sections 2 to 5 set this out. This document updates that - wherever more up-to-date information was found to be available. Section 6 sets out the law in relation to low bridges; and Section 7 provides information on the various types of bridge and the traffic signs related to them. Section 8 onwards of the report seeks to identify ways in which bus operators can make efforts to alleviate the problem. Section 9 sets out operator processes and systems and was gleaned from information provided by bus operators. Section 10 sets recent industry initiatives to identify opportunities to minimise risk.. Section 11 sets out updated details of the technology warning aids identified. Finally, Appendix 1 brings together web references for the plethora of guidance already available, together with additional reading.
- 1.2.3 Despite technological advances, the driver remains the ultimate decision-maker and the final line of defence against a bridge strike. Operator systems and technological aids can support the driver, but do not remove their responsibility for the safe operation of the vehicle. Indeed, although classified as "driving aids," these are not infallible safety devices.
- 1.2.4 The challenge remains around the fact that any system or process can generate false-positive warnings, which can become a distraction to the driver and are therefore ignored - undermining their purpose. Even when the problem of false positives is overcome, the challenge highlighted in studies of dynamic route

optimisation is that there can be a barrier to adoption if drivers do not trust an automated system. Conversely, over-reliance may lead to a degradation of manual skills and situational awareness, which are critical if the technology fails or encounters an unexpected scenario. Effective implementation requires managing this balance through training and clear communication.

1.3 Scope

- 1.3.1 This report has no statutory or other legal basis and is purely to provide advice to suppliers, authorities and bus operators.

1.4 Limitations and the Future

- 1.4.1 This report reflects the available technology and those practices which have been found to be effective at the date of publication. However, technology and its applications are evolving, and it is therefore probable that new technologies, new developments of existing technologies, and new ways to adopt them on buses will evolve.
- 1.4.2 RTIG also understands that technologies and practices which are not on the market at the time of writing this document will evolve, and that such developments should not be excluded from consideration.
- 1.4.3 Operators and authorities are encouraged to consider new approaches - bearing in mind the general principles promoted in this document.

1.5 Acknowledgements

- 1.5.1 RTIG is grateful to Graham Pether (Go-Ahead); Louise Simpson (Stagecoach); Simon Gold (Reading Buses); Lisa May (TfL – London Buses); Tom Wilsher (Ticketer); Karen Heylen (Timespace); Jason Stevens-Read (Transmach); Jose Villamarin (Network Rail) and GreenRoad for contributing to the construction and validation of this document.

2 Background

2.1 What is a bridge strike?

2.1.1 A bridge strike is an incident in which a vehicle, its load or equipment collides with a bridge. Most strikes occur where roads pass under railway bridges, but incidents do occur with high vehicles travelling across bridges over the railway. As can be appreciated on such an intensive network, any disruption due to a bridge strike can severely impact the operation, resilience, and safety of the rail and road networks.

2.2 The Rail infrastructure

2.2.1 Network Rail owns and operates the railway infrastructure in England, Wales, and Scotland and is responsible for 9,785 miles of routes in 2024/25; and over 30,000 bridges and viaducts: on the oldest commercial network in the world and the busiest mixed modal network in Europe. Over 1.7 billion passenger movements are carried out every year on the network.

2.2.2 The vast majority of bridges where strikes occur are rail. Very few non-rail bridges appear to be struck.

3 Incidence, history, consequences, and costs

- 3.1.1 High sided vehicles and other vehicles colliding with bridges caused over 120 days (186,384 minutes) of delays to journeys in 2024/25. From 1 April 2024 to 31 March 2025, there were 1,666 reported bridge strikes – one every five hours: up from 1,532 the previous year and the highest since 1,864 in 2021/22. The cost to the rail industry amounted to around £12m in delays and cancellations. The number of strikes peaked in late July/early August, rising to almost 6 per day.
- 3.1.2 On average, each strike delays trains for 2 hours. Sorting out the aftermath of a bridge strike costs an average of £13,000 per bridge – costing the UK taxpayer around £23m per annum.
- 3.1.3 Other costs and consequences include repairs to bridges and vehicles, increased insurance premiums, road congestion, and general deterioration in the public's confidence in the public transport network.
- 3.1.4 To the casual observer, with professional drivers and proper signposting, it may seem that bridge strikes should never happen, but it does remain a problem. In 2012, the UK Rail Safety and Standards Board (RSSB) research Brief T854 found that when it came to drivers:
- 32% didn't know their vehicle heights and tended to use maps with no height restrictions marked;
 - 56% didn't consider low bridges in their route selection;
 - only 10% used satellite navigation; and
 - 31% of drivers did not get any guidance from their employers.
- 3.1.5 In a 2014 driver survey by Network Rail, drivers were asked: "What is the maximum height of vehicle you can safely take under an unsigned bridge?"
- 52% of drivers were incorrect;
 - 27% did not answer; and
 - only 21% were correct.
- 3.1.6 The most frequently struck rail bridges in 2024-25, according to Network Rail were:
1. Watling Street, Hinckley, Leicestershire - struck 22 times
 2. Harlaxton Road, Grantham, Lincolnshire - struck 18 times
 3. Stuntney Road, Ely, Cambridgeshire - struck 15 times

- 3= Stonea Road, Stonea, Cambridgeshire - struck 15 times
- 3=. Lower Downs Road, Wimbledon, London - struck 15 times
- 6. Station B4105, Berkswell, Solihull - struck 14 times
- 7= Ickleton Road, great Chesterford, Essex - struck 11 times
- 7= Barrowby Road, Grantham, Lincolnshire – struck 11 times
- 7= Abbey Farm, Thetford, Norfolk – struck 11 times
- 7= Coddendam Road, Needham Market, Suffolk - struck 11 times



A low bridge in Leicestershire has regained the dubious honour of being the most bashed in Britain.

Network Rail said the A5 Watling Street bridge in Hinckley was struck 22 times between 1 April 2024 and 31 March 2025.

That placed it ahead of Harlaxton Road in Grantham, Lincolnshire, which was hit 18 times in the same period and Stuntley Road in Ely, Cambridgeshire, which saw 15 crashes.

Network Rail has urged haulage drivers to check their vehicle heights and plan suitable routes after reporting 1,666 bridge strikes nationally - an 8.75% increase on the previous year.

Plans have been drawn up to lower the road under the bridge to reduce the number of crashes, but National Highways **warned in November 2025 that the project will not happen quickly**. Research **carried out by transport body Midlands Connect in 2023** concluded that delays caused by four of the crashes at the bridge cost the economy an estimated £126,000.

Martin Frobisher, Network Rail's group safety and engineering director, said: "Every bridge strike endangers lives, disrupts rail services, and delays tens of thousands of passengers while we inspect and repair the damage to the bridges.

"Each incident also costs millions of pounds that could instead be spent improving the network."¹

¹ [Britain's most bashed bridges revealed by Network Rail - BBC News](#)

4 Bus incidence and impact

4.1 Incidence of Strikes by Passenger Transport Vehicles

4.1.1 Over the past decade – from 2015 to 2025, there have been 607 bridge strikes involving passenger transport vehicles reported to Rail Authorities. Recently, buses and coaches accounted for around 70 strikes annually, which represents about 4% of the total number of strikes each year. Although this incidence rate is significantly lower than that for heavy goods vehicles (HGVs), the financial impact on the network and the overall economy remains the same. However, the human cost in the case of a bus strike can be much higher: often resulting in severe injuries to passengers.

4.1.2 The causes of bridge strikes involving passenger transport vehicles include:

- Drivers going offline of a planned route, including under diversion; or taking wrong turnings.
- Drivers operating 'not in service' and taking a short cut.
- Staff with insufficient route knowledge returning a vehicle to the depot for maintenance.
- Drivers who normally drive a single deck vehicle taking a double deck vehicle on a single deck route.
- In some cases, buses running rail replacement services.

4.2 Consequences

4.2.1 On the railway:

- Strikes jeopardise the safety of the public travelling by train and a serious incident could result in a train being derailed - with catastrophic loss of life.
- Every bridge strike causes delays and disruption.
- The damage caused to railway bridges.

4.2.2 On other road users:

- The death or serious injury of another road user.
- Serious disruption on the road network – likely to be significantly more so with a bus or coach than with an HGV strike: because the involvement of human casualties will lead to a greater number of emergency vehicles involved.

4.2.3 On passengers:

- The strike could cause death or serious injury.

4.2.4 On the bus driver. The driver could:

- Be seriously injured or killed.
- Suffer serious economic loss through losing their job.
- Be prosecuted for offences which can result in imprisonment or the loss of their driving licence.
- Be forced to pay increased personal car insurance premiums.

4.2.5 The Senior Traffic Commissioner's Statutory Document No. 6: Vocational Driver Conduct² stated that that the starting point for action against a driver that causes a bridge strike through carelessness or negligence, will be revocation of their licence and disqualification for six months.

4.2.6 On the operating company. They:

- Could lose their operating licence.
- Will be liable for the costs of examining and repairing the bridge; recovering the damaged vehicle; and delays to train services.

2

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/973208/Stat_Doc_6_Driver_Conduct_-_Version_5.0.pdf

5 Media Publicity about Bus bridge strikes

5.1 Eight people have been injured, including one person in a critical condition, after a double-decker bus crashed into a railway bridge in Glasgow city centre.

5.1.1 The following is taken from a BBC website report of a serious low bridge strike in Glasgow in December 2024.

<https://www.bbc.co.uk/news/articles/clyk3pyp7yno>

Part of the roof of the Operator Y bus was torn off, with the vehicle wedged under the bridge on Cook Street at the junction with Commerce Street. Five people were taken by ambulance to Queen Elizabeth University Hospital for treatment after the crash at about 18:00 GMT on Saturday, while three others were assessed at the scene and attended hospital. Spike Turner, a passenger who was third from the front of the bus, said the driver had taken a wrong turn and crashed "straight into the bridge". The street is one-way and the bridge, near the O2 Academy, is located shortly after a turn - though is clearly marked for vehicles under 3.8 metres (12.5 ft).

The bus became wedged under the railway bridge after travelling in the wrong direction. Mr Turner said: "I was fine, the lady in front of me might have been concussed. The bridge itself wasn't high enough to hit anyone's heads but parts of the bus exterior have swung down. "The man in the front seat was in a really, really bad state. He's got a lot of blood and a massive gash on his head." A number of roads were closed in the area but have now reopened after the bus was removed. Operator Y earlier said it was aware of numerous injuries. A spokesperson said: "We have launched an immediate investigation and are also assisting Police Scotland with their inquiries." ScotRail closed a number of lines due to the crash but services resumed later in the evening. In May last year (2023), 10 people were taken to hospital after a bus crashed into the same railway bridge. (see Para 5.1.5 below)

Network Rail said a team had inspected the bridge and found there was no structural damage - but that rail passengers had experienced "unnecessary delays". A spokesperson said: "The incident caused significant disruptions and cancellations to train services. "Bridge strikes like this cost taxpayers millions of pounds each year and are entirely preventable. "We urge drivers to always consider the height and size of their vehicles, including any loads they are carrying, and to carefully plan their routes to avoid incidents that put our infrastructure at risk."

5.2 Man charged after Glasgow bus strikes bridge – leaving eight people injured.

<https://www.glasgowlive.co.uk/news/glasgow-news/man-charged-after-glasgow-bus-30799531>

A man has been charged after a bus 'struck a railway bridge' leaving eight people injured and one person fighting for their life. Emergency services scrambled to Cook Street, in the southside, following the incident which took place just before 6pm on Saturday, December 14..... A 57-year-old man has now been arrested and charged in connection with road traffic offences. He has been released on an undertaking and will appear in court at a later date. We previously reported how eight people were left injured, and one person in critical condition.....

5.3 Double decker bus driver admits rail bridge crash

<https://www.bbc.co.uk/news/articles/cn4xw1wxe72o>



The bus hit the bridge in Tradeston on 21 May 2023

A man has been disqualified from driving for one year for crashing a double decker bus into a railway bridge, which left a number of his passengers injured. Driver X, smashed into the bridge in Tradeston, Glasgow, near the O2 Academy on the morning of 21 May 2023. Driver X....., had mistakenly taken a wrong turn at a road diversion while he was employed with (Operator Y).

He pled guilty at Glasgow Sheriff Court to a single charge of dangerous driving. He was also sentenced to 96 hours of unpaid work. His case concludes just days after a similar incident at the same railway bridge. An Operator Y bus crashed into the bridge on Saturday night, leaving one man critical in hospital.....Diversions had been placed on the route for the Race For Life charity run. As the bus passed Eglinton Street there were signs that told drivers that there were low bridges with maximum height restrictions. (Driver X) mistakenly took the wrong turn onto Cook Street which did not follow the diverted path. The driver failed to notice warning signs on the road advising him of a low bridge ahead and the maximum height of vehicles.....He managed to pass under the first railway bridge which had a sign marked for a maximum vehicle height of 4.6 metres (15ft) but went on to strike a second bridge which tore the top of the roof off.

A number of passengers suffered cuts and wounds due to windows smashing. There were also whiplash injuries including sprains and strains. Ten more seriously injured passengers were taken to hospitals and were released hours later.

Prosecutor Ross Gunn said the crash caused the roof of the top deck to become detached and fall backwards, and for the bus to become "wedged" under the bridge. He said: "The roof was propped up against its rear at a 45-degree angle and passengers were seated on the top deck when the collision took place." CCTV later reviewed showed Driver X in a "distressed state" as he made his way to the top deck to check on passengers. Emergency crews attended and police officers were met with people who were visibly injured on the pavement. The railway bridge - used between Glasgow Central and Paisley stations - was put out of action while an inspection was carried out. Operator Y have confirmed that Driver X is no longer an employee of the company.

5.4 Children hurt as school bus roof ripped off by bridge

<https://www.bbc.co.uk/news/articles/cp34nyenqpk0>

3 December 2025

An eight-year-old boy suffered a "nasty cut to the head" when the roof of a double-decker school bus was ripped off when it hit a low bridge. The bus was carrying pupils from Wood Fold Primary School in Standish, Wigan, when it crashed on Spendmore Lane in Coppull, Lancashire, at about 12:30 GMT. Lancashire Police said everyone on board was taken safely off the bus and about 30 children were assessed at the scene by paramedics. The boy was taken to hospital but Northwest Ambulance Service said the rest of the children had all been discharged from its care. A Lancashire Police spokesperson said: "Emergency services attended and all those on board were taken safely off the bus. "Around 30 children were assessed by medical staff and eight were treated by paramedics for minor injuries."

The bus driver and two teachers who were on board were unhurt, police added.



5.3 Bus driver arrested after 20 injured in bridge crash

<https://www.bbc.co.uk/news/articles/c1lj31l6rm1o>

22 July 2025

The driver of a double-decker bus that crashed into a canal bridge, injuring 20 people, has been arrested.

A passenger was thrown from the top deck when the vehicle's roof was torn off as it struck the Bridgewater Canal Aqueduct on Barton Lane in Eccles, Salford on Monday, Greater Manchester Police (GMP) said. The force said a 19-year-old woman, and two men, one aged in his 20s and another in his 40s, sustained serious injuries and remain in hospital in a stable condition. The driver, a man in his 50s, was arrested on suspicion of causing serious injury by careless driving and has been bailed pending further inquiries.



Police said 12 other people were treated at the scene for injuries that were "non-life threatening or life-changing" and five others had injuries which didn't require treatment. Barton Lane has since been reopened, and Transport for Greater Manchester (TfGM) said it has launched an "immediate and urgent" investigation into the circumstances of the crash. This includes why the 100 service bus was "not taking its usual route", a TfGM spokesman said.



Police said there are height restriction warnings in place by the bridge, including hanging chains and signs. Transport Commissioner for Greater Manchester Vernon Everitt said: "We are working closely with the investigation team at Greater Manchester Police and the bus operator "This is clearly a distressing situation for everyone involved and we'd like to thank emergency services for their swift response." The road was closed into Monday evening with diversions in place as authorities worked to move the damaged bus.

Labour MP for Worsley and Eccles Michael Wheeler said the crash was "unacceptable". "It's not the first time this has happened, so after understanding what's happened we need to do everything we can to make sure it doesn't happen again," he told BBC Radio Manchester. The Bridgewater Canal team said it was "deeply shocked and saddened" by the incident and said it wished all those affected a speedy recovery. The team said it was investigating the effect on the aqueduct which is part of the Bridgewater Canal infrastructure and have also reached out to Salford City Council as the local highways authority to establish the events which led up to this incident.

A bus has previously had its roof ripped off after striking the same bridge in April 2023.



5.4 Fatal double-decker bus crash into bridge

Fatal double-decker bus crash into bridge happened after driver took shortcut to avoid traffic jam.

The following is taken from a newspaper report of a court case in December 2020 which centred on a bridge strike by a bus in Swansea in December 2019.

<https://www.walesonline.co.uk/news/wales-news/bus-crash-bridge-driver-swansea-19682421>

The driver of a double-decker bus which slammed into a low railway bridge and killed a passenger had taken a different route to try to avoid a traffic jam. The driver had taken the road in question many times before but only in small single-decker vehicles. Much of the upper deck of the bus was ripped away when he took the bus under the bridge in the Landore area of Swansea in December 2019, causing catastrophic and fatal injuries to university academic..... and injuring a dozen more passengers. The driver.....pleaded guilty to causing death by dangerous driving and causing serious injury by dangerous

driving when he appeared at Swansea Crown Court. The court heard the defendant had been a bus driver for 40 years and was well-regarded. The judge told the defendant his decision to take a different route that day was born of impatience and would have saved him just a few minutes, but that "fatal error" led to "carnage".

The driver was sentenced to two and a half years in prison.



Pictures taken on-board show the black and yellow markings of the bridge coming through the bus's top deck. It sheared off the roof of the bus over the first half a dozen rows of seats.

6 The Law

6.1 Road Vehicles (Construction and Use) Regulations 1986

6.1.1 The Road Vehicles (Construction and Use) Regulations 1986 No. SI 1078 as amended, requires passenger transport vehicles having a height of 9ft 10ins (3.0 metres) or above to have a notice in the cab displaying the maximum height of the vehicle.

6.2 Vehicle Height notice in cab

6.2.1 The maximum travelling height of the vehicle must be displayed on a notice (in a prominent position) in the cab of a vehicle when the overall travelling height of the vehicle, its load or equipment exceed 3 metres (10 feet):

- In feet and inches, or in both feet and inches and metres.
- Not less than the overall travelling height of the vehicle.
- Not more than 150 mm above the overall travelling height of the vehicle.

6.2.2 This applies when trailers are being towed.

6.2.3 It is an offence for an operations manager to cause or permit a vehicle to be used in breach of the regulations.



6.2.4 It is the operations manager's responsibility to ensure that a procedure is in place for drivers to check that the correct maximum height is displayed in their vehicle

6.3 Action to be taken when a bridge strike occurs

6.3.1 Any road traffic collision that damages a third party is required to be reported.

6.3.2 Steps to be taken:

a) at a railway bridge:

Step 1: Report the bridge strike to the Rail authority immediately so that trains may be stopped from crossing the bridge.

Telephone the number shown on the identification plate on the bridge.



Do not wait until you return to your depot before reporting the bridge strike

Step 2: Advise the police using the 999 system.

Step 3: Report the bridge strike to your employer.

Step 4: Keep the public away and do not move your vehicle

b) At any other bridge:

Step 1: Report the bridge strike to the Police using the 999 system and then inform your employer; and

Step 2: Keep the public away and do not move your vehicle.

6.3.3 Section 9 of the guidance document: “Network Rail Bridge Strike Protocol: Prevention of strikes on bridges over highways – a protocol for highway managers and bridge owners” (see Appendix 1 of this document for the weblink)

provides more detailed information on the procedures to follow when a bridge strike has occurred.

7 Types of bridges and traffic signs

7.1 Traffic signs

7.1.1 Red circles prohibit - If a vehicle is higher than the dimension(s) shown on a circular traffic sign, the driver must stop and not pass the sign.



7.1.2 Red triangles warn – if the vehicle is higher than the dimension(s) shown on a triangular traffic sign at the bridge, the driver should not pass the sign.



7.2 Types of bridge and their signage

7.2.1 Arch Bridge



7.2.3 Arch bridge with diminishing head room



7.2.4 bridge with flat soffit



7.2.5 Skew bridge



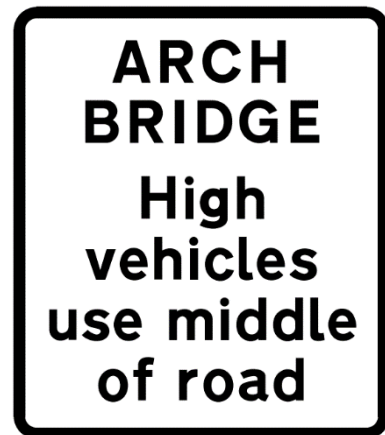
7.3 Arch bridges

7.3.1 Signs will be triangular and, on the bridge/ immediately in advance of the bridge; and will be in imperial only; metric only; or both metric and imperial.

7.3.2 An example of both metric and imperial:



7.3.3 In addition, white lines on the road and chord marks (goal posts) on the bridge may be provided to indicate the extent of the signed limit on vehicle height, normally over a 3-metre width. There may be an additional set of 'goal posts' showing lower limits towards the kerb. Vehicles should pass between these "goal posts."



7.3.4 Advance road markings and sign instruct high vehicles to use the centre of the road

7.3.5 Arch bridges – Advance traffic signs



7.3.6 Triangular signs which show an arch may be provided near the bridge

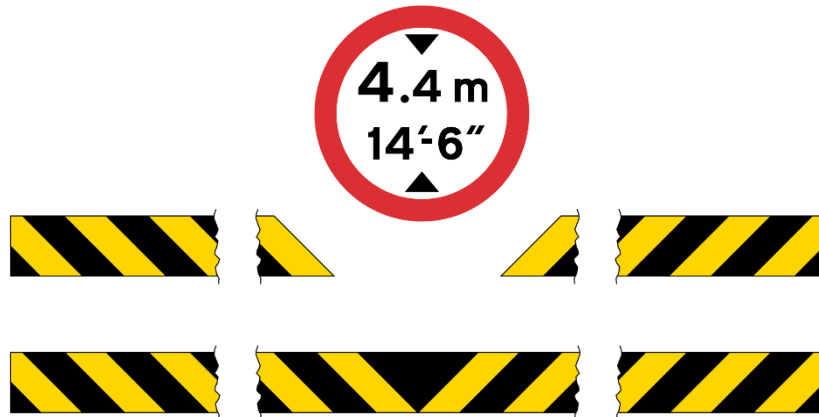
- Dimensions will either be imperial only; or
- an imperial sign above a metric sign.



7.3.7 Triangular signs may give warning of a restriction at:

- A named location.
- A distance from the sign.

7.4 Flat soffit bridges



7.4.1 Signs should be roundels

- On the bridge.
- Immediately in advance of the bridge.

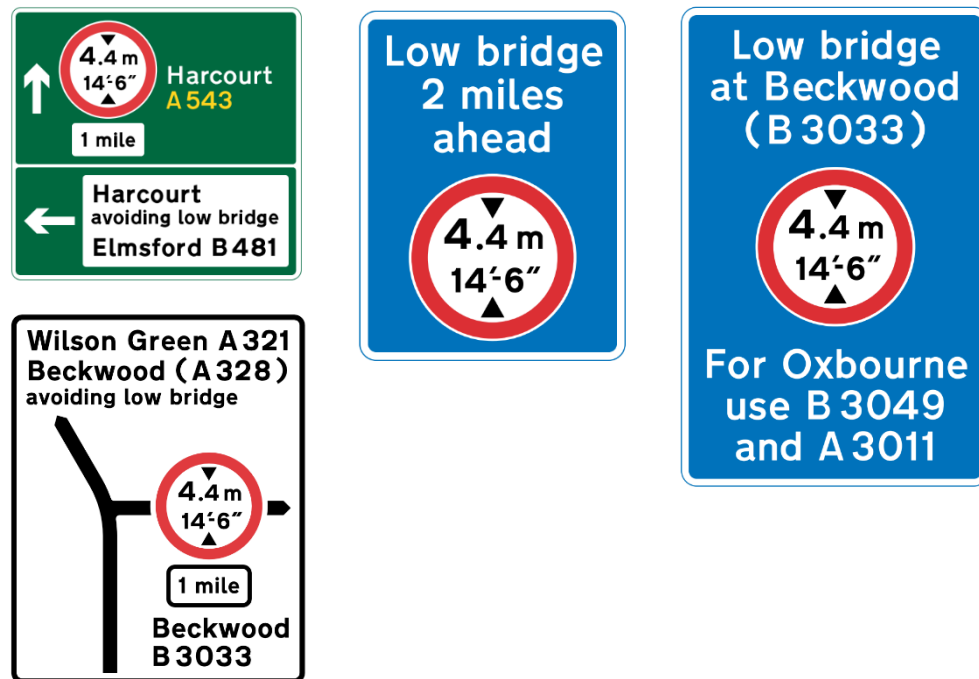
7.4.2 Roundel signs PROHIBIT- they mean

“Do not pass this sign if your vehicle is higher than the dimension shown”

- Dimensions will be either Imperial only or both imperial and metric.

7.4.3 Advance signs come in several forms and give warning of a restriction at:

- A named location.
- A distance from the sign.
- An alternative route may be indicated.



7.5 Discrepancies between OS survey height and the height marked on road signs

- 7.5.1 An important point to note which emerged during the research, is that there is a discrepancy between the OS survey height (used in the Ordnance Survey Highways MasterMap) and the height marked on the road signs. One of our operator contacts – in developing their solution with a supplier, spent some time in liaison with Network Rail and Ordnance Survey to understand the discrepancy.
- 7.5.2 Network Rail directed their attention to Chapter 4 of the Traffic Signs Manual, which specifically mentions that road signs only display bridge heights in 3” increments, and the sign will also account for at least 3” safety margin. This is in regulation 7.4, which is reproduced below along with its metric counterpart (which is vastly different).
- 7.5.3 The Ordnance Survey data that is in the MasterMap dataset should be an accurate reflection of the surveys conducted by Network Rail’s National Bridge Strike Initiative (NBSI), which are completed at least once a year, and include some level of tolerance. Network Rail were also keen to point out that NBSI assessments should indicate accurate clearances at bridges, but these

accurately measured clearances can change due to Highways Authority Road surfacing over time. The operator/supplier had found occasion in the MasterMap dataset where the recorded height of the bridge is lower than the relevant signed bridge heights. For some bridges this might make sense, for example, where collision protection measures have recently been installed. However, this flags up a need for operators and suppliers alike to be mindful of this potential discrepancy, when developing their approaches to avoiding bridge strikes.

7.6 Calculating bridge headroom

7.6.1 Extract from Traffic Signs Manual, Chapter 4:

7.4 Imperial height

The imperial figure shown on signs to indicate the available headroom should be at least 3 inches less than the measured height to allow a safety margin. If the resulting figure is not a multiple of 3 inches, it should be rounded down to the nearest lower multiple of 3 inches.

Example 1: measured height 15'-2":

Step 1: subtract 3" to create a safety margin 14'-11"

Step 2: round down to nearest multiple of 3"

Step 3: sign as 14'-9".

Example 2: measured height 14'-6":

Step 1: subtract 3" to create a safety margin 14'-3"

Step 2: sign as 14'-3" (rounding down not required as already a multiple of 3")

Thus, the maximum headroom that will normally appear on a sign is 16'-0".

7.5 Metric height

To obtain the metric figure shown on signs, the bridge height should be measured to two decimal places, rounding down to the nearest 0.01 m. The following method is then used to calculate the appropriate signed height:

1. If the second decimal digit is 8 or 9, delete it and sign the bridge with the remaining whole number and the first decimal digit;

Example 1: measured height 4.19 m:

- a) Step 1: remove the final 9 (subtract 0.09 m)
- b) Step 2: sign as 4.1 m

2. if the second decimal digit is 7 or less, delete it and reduce the first decimal digit by 1. Sign the bridge with the remaining whole number and first decimal digit, as reduced;

Example 2: measured height 4.17 m

- a) Step 1: remove the final 7 (subtract 0.07 m)
- b) Step 2: reduce first decimal digit by 1 (subtract 0.1 m)
- c) Step 3: sign as 4.0 m

The height shown on the sign must be to only one decimal place. The maximum headroom that will normally appear on a sign is 4.9 m.

8 Limiting the incidence of bus bridge strikes

8.1 Introduction

8.1.1 The research identified two areas in which operators can work and invest to reduce and ultimately, eliminate the incidence of bus bridge strikes:

- Operator systems and management control– covered in Section 9; and
- Technological aids – covered in section 11.

8.1.2 A key point to stress is that in any overall strategy to alleviate low bridge strikes by buses, internal operator systems can only ever play a role to a certain point: ultimate responsibility for the safe operation of the vehicle lies with the driver; and accountability for the operation of all vehicles lies with the management teams putting in place safe systems of work to ensure that driver is able to operate the vehicle safely.

8.1.3 Similarly, the application of technological safety solutions can never be more than a “driving aid.” Indeed, as the increased use of technology has not resulted in the complete eradication of strikes, the industry is now also looking to human behavioural psychology for answers. Nonetheless, a strategy that incorporates sound systems and the right tools can make the serious job of operating a bus safely that much easier.

9 Core system processes

9.1 Core system processes

9.1.1 There are four core processes that are fundamental to safety:

- Robust risk assessments that are supported by both management and colleagues.
- Proper driver training – both for new and existing drivers - including route training and familiarisation.
- Consistent, repeated review of accidents to ensure we understand and learn from the causes of accidents.
- Ongoing liaison with “mutual interest” bodies.

9.2 Robust risk assessments

9.2.1 In some areas of the country, there are few or no railway bridges, so this makes assessment of this risk quite simple. But in all areas where there are bridges, then risk assessment will be vital. Routes should be reviewed regularly to identify low bridge risks. This is best performed by driver trainers actually undertaking the route, perhaps with management riding along with them.

9.2.2 Wherever a new vehicle type is introduced into a fleet, a risk assessment for route suitability should take place.

9.3 Driver training

9.3.1 It is important that trainee drivers are made “low bridge” aware from the outset. They can be assigned a mentor who localises the training, taking the driver out on routes with low bridges in the area. The mentor can focus on the law – particularly the signage which warns of low bridges. In addition, where bridge alert technology is fitted to the vehicle, the mentor/trainer can give thorough tuition in the use of the technology and the alerts that are likely to sound or appear in the cab. Once the driver has come through initial training, there will need to be a continued focus on the location of all low bridges (including those not on established bus routes) in the operational area served by the depot to which the driver has been assigned.

9.3.2 Notwithstanding the above, there will be instances whereby drivers are transferred either permanently or temporarily to other unfamiliar depots or areas.

In these cases, it will be important that they are given comprehensive bridge awareness training before embarking on new routes with which they are unfamiliar.

- 9.3.3 Operators can produce a low bridge information pack to be issued to every driver. This will detail every bridge within the operational area.
- 9.3.4 Whilst initial driver training is vital, there is evidence that familiarity can breed complacency and so it is equally important to ensure that existing drivers are continually made aware of the potential hazard of low bridges on their routes. Moreover, where drivers are moved to routes with such hazards, there should be an established routine for familiarisation and briefing. Comprehensive in-depot information and day-to-day procedures can go a long way to assisting with this. Where operators have a high turnover of drivers, then a more stringent routine will be required.

9.4 Certificate of Professional Competence (CPC)

- 9.4.1 Driver CPC is the Driver Certificate of Professional Competence. It is required by law that professional drivers of lorries, buses, coaches, and minibuses hold a Driver CPC to continue their work. The DVSA requires that those requiring Driver CPC undertake regular top-up training amounting to 35 hours every 5 years.
- 9.4.2 This statutory requirement provides an ideal opportunity for operators to stipulate that their existing drivers incorporate an element of low bridge awareness training in their 35 hours.

9.5 Accident review

- 9.5.1 Operators should have formal Accident reporting and follow up processes in place utilising - not only driver reports, but CCTV, telematics data and customer input.

9.6 Liaison with appropriate local bodies

9.6.1 Operators should establish and maintain routine liaison processes with mutual interest partners. This could include all or some of the following:

- Local borough and city councils.
- Involvement in local safety and emergency planning forums.
- Network Rail – have regional safety champions that can be contacted to engage on prevention of bridge strikes.³
- Local road network managers.

9.7 Day to day in-depot information and operations procedures

9.7.1 Depot information boards

Every depot should keep a central register of low structures in the control room and this information should also be clearly displayed on a board placed where drivers will regularly see it. This board can also be used to keep drivers up to date with short term diversions.

9.7.2 Vehicle Allocation

Vehicle allocation is a key part of the safety procedure – particularly as typically, a single vehicle will cover more than one route for both the bus and the driver in a day - as it is generally more efficient to mix things up. Careful management of vehicle allocation is therefore required to ensure the vehicle is suitable for all routes on that bus board.

9.7.3 Colour coded magnetic allocation boards

This is a very simple but nonetheless effective way of signifying, and thereby avoiding the mismatch of double decker vehicles with routes on which there is a low bridge hazard. The board is magnetic with colour coded tags. An example is shown below. The bus boards are numbered down the side and colour-coded and the magnets are used to show what vehicle has been

³ <https://www.networkrail.co.uk/running-the-railway/looking-after-the-railway/bridges-tunnels-and-viaducts/the-risk-of-bridge-strikes/>

allocated to each one. Any combination of yellow and red means there is a problem.

All allocation boards have colour coded tags making it visible when a double decker is on the wrong route

Exercise caution with red bus boards – only single deckers should be allocated

Red Board	Single Decker Only to be allocated
Yellow Board	Any vehicle can be allocated
Red Bus Tag	Single Decker Vehicle
Yellow Bus Tag	Double Decker Vehicle
<p>Always Remember:</p> <p>Red Board with Yellow Bus = Dangerous Allocation</p> <p>(Single Decker Only) (Double Decker)</p>	

As bus boards change on Saturday and Sunday, certain tags will need to be flipped.

At the end of run out, allocation boards should be prepared for the next day



Whenever a duty change occurs, the board **MUST** be reviewed by the supervisory team and management prior to any allocation taking place.

The duty dates must also be displayed on or around the allocation board.



Example of a dangerous vehicle allocation

9.7.4 Vehicle duty schedules

Each individual bus will have a schedule which shows what that vehicle will actually do throughout that day. Any routes with low bridges should be identified on these schedules. Copies should be in the bus cab and held by operations managers in the depot.

9.7.5 Vehicle defect cards

Each vehicle will have a standard defect card completed before it leaves the depot to go into service. This will detail any issue with the vehicle (that would not prohibit it from going into service on that day/route). This card stays with that vehicle during the day and will be passed onto a driver replacing the original driver on a new shift. It is good practice for the first driver to record the vehicle height of the bus on the card to serve as a reminder when the vehicle is taken over by a new driver.

9.7.6 Driver duty schedules

9.7.7 Each individual driver will have a duty board showing their schedule for the day – normally issued to them at the start of their shift. This should identify and warn of low bridge hazards on any route to which they have been allocated.

9.8 Management Control

- 9.8.1 Reviewing the investigations undertaken by DVSA in response to a number of incidents affecting a specific operator, highlights that bridge strikes are fundamentally a consequence of management control and driver culture failures, regardless of technology installed.
- 9.8.2 A December 2024 decision provides some empirical evidence that technology alone is insufficient to ensure compliance and avoid risk to bus staff and passengers:
- **Driver Disregard of Alarms:** In a June 2024 incident, the driver was aware he was heading for a low bridge and heard the loud alarm but continued driving. He stated he thought the alarm related to a different, nearby bridge. This demonstrates a failure to adhere to precautionary guidance, such as the mandated "Stop - If you find yourself off route, stop in a safe place".
 - **Supervisory and Management Failure:** The subsequent inquiry found that the driver's decision-making was "aggravated by errors of judgment in his management and supervision". This included the driver being signed off as trained on only a third of routes and the supervisor fraudulently completing development records, which encouraged a "false sense of over-confidence" in the new driver.
 - **Mentor Negligence:** A second incident, in September 2024, involved a newly qualified driver who stopped before the low bridge, believing the bus would not fit. He only proceeded after his mentor told him the bus would fit. The mentor was subsequently dismissed, in part because the Deputy Traffic Commissioner noted, with surprise, that the criteria for being a mentor did not include being entitled to drive a bus (lacking PCV entitlement), undermining the mentor's ability to take control in a crisis.
- 9.8.3 Ultimately, whichever other approaches are put into place, without effort being put into mitigating human factors via consistent audit and management processes, it is likely that bridge strikes will continue to be a significant issue.
- 9.8.4 Recent 'landmark' legal cases mean that Network Rail can now claim back costs from hauliers of any bridge strike, and they clearly state on their website that they aim to claim back 100% of the costs of all repairs and downtime to the network. At an average cost of £13k per bridge strike that could mean that any operator involved in such an accident suffer a substantial material financial impact, even if the operator is covered by its insurance policy.

- 9.8.5 Transport Managers will need to be incentivised to ensure drivers receive training both in bridge strike prevention as well as specific training for routes with height restrictions, particularly where these are infrequent or ad-hoc. Route planning – whether for service routes, rail replacement, or off-service driving - must explicitly address bridge strike risk.
- 9.8.6 Senior Traffic Commissioner Kevin Rooney emphasized in an article for Route One that operators must not rely solely on technology - suitable satellite navigation equipment is not a substitute for effective route planning and risk mitigation.

10 Future Opportunities to Minimise Risk

10.1 Road Safety Investigation Branch

- 10.1.1 The January 2026 published Road Safety Strategy⁴ from the Department for Transport (DfT) includes a commitment to establish a dedicated Road Safety Investigation Branch for the first time.
- 10.1.2 Unlike aviation and rail, previously, road safety incidents have occurred without a consistent national system for learning lessons and making formal safety recommendations. With a dedicated investigative branch, opportunities to prevent future tragedies could be realised.
- 10.1.3 RTIG will work with the DfT whilst the Road Safety Investigation Branch is setup to encourage Bus to be an identified priority.

10.2 Bus Knowledge Sharing and Incident Network

- 10.2.1 To support road safety for buses, the DfT has funded the Bus Centre of Excellence (BCoE)⁵ which has established the Bus Knowledge Sharing and Incident Network.
- 10.2.2 This Network brings together industry experts, safety specialists, and bus professionals to share knowledge, develop best practice, and shape policy and regulatory improvements in bus safety.
- 10.2.3 This group has discussed bridge strikes on multiple occasions and seeks to share lessons from them when they occur.
- 10.2.4 We encourage any bus professional to join the BCoE and the KSI network.

⁴ <https://assets.publishing.service.gov.uk/media/695e2cff8832ab3a48513809/road-safety-strategy.pdf>

⁵ <https://www.buscentreofexcellence.org.uk/>

10.3 RSSB Research Project and Steering Group

- 10.3.1 There is an RSSB-led research project to update their 2012 report on bridge strikes and RTIG are on the steering group. It includes infrastructure managers, logistics operators, performance agencies, training providers, National Highways, Tesco, police, local authorities, regulators, transport associations, and a London bus operator. It commenced work in October 2025 and will run for 7-8 months - concluding around May 2026.
- 10.3.2 There is also a new media Campaign which launched in late 2025 to raise awareness of bridge strike incidents; and seven Innovate UK projects focused on innovative solutions to prevent strikes - with new products anticipated by the end of 2026.

10.4 Scheduling Systems Enhancements

- 10.4.1 As we in theory we know the locations of road risks, such as low bridges, which are available from a number of sources: open source such as Open Street Map as well as commercial dataset, this could be overlaid in the mapping tool in scheduling systems.
- 10.4.2 The scheduling system could then be used to identify when a bus route crosses the mapped location of the bridge, considering route heading, to:
- Raise a warning to the scheduler where a mapped route passes a low bridge
 - At the point of vehicle type allocation, warn the scheduler that they are allocating a potentially inappropriate vehicle type

11 Technological Warning Aids

11.1 Examples of technological solutions

11.1.1 There are a number of technology solutions available to warn bus drivers of the presence of low bridges in the vicinity of their route. The following content provides some examples of those widely used in the bus industry - as described by their suppliers. **There are others available** – including a number that largely supply their equipment to companies that use HGVs.

11.2 TfL London Buses - iBus

11.2.1 In 2005, TfL invested in a new AVL, radio and RTI platform known as 'iBus' – a key part of the Mayor's Transport Strategy. The initial contract was awarded to Siemens but was later taken over by Trapeze in 2009. In 2007, the contract was amended to include a low bridge warning system which specified:

- two levels of low bridge alarms:
 - an audible alarm; and
 - message on driver screen;
- for safety reasons the driver does not need to acknowledge any low bridge alarm; and
- there is no difference in the operation of the low bridge warning system between the bus running in-service and out of service.

11.2.2 A reporting system is in place for all low bridge events to enable review by location, route and direction - to enable proactive action to be taken to avoid future events.

11.2.3 In addition, in the event of a strike, the data from the iBus system generates a Major Incident Report, which gives full details of the vehicle's movements and the alarms that were set off prior to the strike to assist with post event investigation.

11.2.4 All buses in London have been fitted with iBus since 2008 and the driver warnings - along with the comprehensive incident logging for every bus in the fleet, have led to substantial reductions in strike incidents.

11.2.5 In March 2024, TfL signed an £80 million contract with INIT Innovations in Transportation Ltd. to deliver the iBus2 project, which will include an enhanced low bridge warning system.

- 11.2.6 In respect of averting low bridge strikes, the main points that the iBus2 project sought to address are firstly, strikes to a vehicle when not logged in – the majority of Bridge Strikes have been from engineers and the like moving a vehicle between garages or road testing a vehicle. This led to the requirement for alerts to generate whether a vehicle is logged in or not.
- 11.2.7 Secondly, alerts being missed due to ‘alert blindness.’ There was feedback that many of the audio alerts become ‘background noise’ and risk being ignored/missed by a driver. In part, this is due to false alerts being issued under the current solution, and the number of audio alerts. This led to requirements to 1: avoid false activations and 2: minimise the number of alerts that are accompanied by an audio alert (as the new iBus 2 is intended to be more interactive, ‘information’ alerts can be visual only.)
- 11.2.8 They also introduced 3 rather than 2 alerts, and the requirement that each alert be more ‘intrusive’ than the preceding one, again to avoid the risk of alert being missed/ignored. They did investigate options for the 3rd alerts to actually trigger the bus being stopped, but that was dismissed as a step outside iBus 2 scope or business requirement.
- 11.2.9 The iBus2 solution will use edited polygons to more accurately geofence boundaries around the Limited Height Structure (LHS). These polygons will extend along roads leading to the LHS using default size values. The polygon default size is defined by the three different distance warning parameters (configurable within iBus 2): 10m 50m and 100m as standard. Although it is called a ‘polygon’, it is essentially the shape of the road itself and it extends along and either side of the road according to the warning distance parameters.
- 11.2.10 The polygon would not extend up a non-intersecting road but will be extended up to the point when it reaches a parallel road, so the boundary is only crossed if a vehicle turns off this parallel road.
- 11.2.11 When a vehicle is logged in (including when following a light running path from a garage or stand), the path of the vehicle will also be considered and if the path of that vehicle does not intersect the LHS, then no alert will be raised (unless the vehicle deviates from that route path). Where a vehicle is not logged in and so the path of the vehicle is not known, the vehicle crossing one of the polygons will immediately trigger the appropriate audio/visual alerts on the bus.

11.3 Ticketer’s Road Restrictions Alert (RRA) Feature

Information provided through liaison with a senior representative at Ticketer

Bridge strikes and restricted-access hazards have long posed challenges for the industry, particularly when drivers navigate unfamiliar routes or diversions.

Ticketer’s Road Restriction Alerts (RRA) feature, launched in 2021 in response to industry-wide calls for a solution, has since transformed how customers manage low-bridge strike risks by delivering real-time, accurate alerts.



road restriction a!erts

<https://www.youtube.com/watch?v=Tv5c3prW0Gk>

<https://www.busandcoachbuyer.com/ticketer-launches-driver-alert-feature/>

Ticketer’s RRA feature fully integrates with Ticketer Electronic Ticket Machines (ETMs), enabling rapid deployment without additional hardware or installation costs.

Tom Wilsher, Ticketer Head of Product Management, explains: “Extending the Ticketer ETM to deliver this functionality means there are no additional hardware installation requirements or costs. We’ve developed RRA to provide a swift, cost-effective means for customers to mitigate against low-bridge strikes.”

Ticketer RRA reduces strike risks by cross-referencing aggregated data inputs and alerting drivers when near a bridge they cannot safely pass.

Cross-referenced data includes:

- **Ordnance Survey data:** Authoritative bridge locations and dimensional attributes, updated quarterly.
- **Vehicle-level height and width dimensions:** Logged within the Ticketer Portal - Ticketer’s real-time information and fleet management platform used by operators.
- **Real-time vehicle location:** Ticketer ETMs continuously utilise GPS/GNSS technology to feed each vehicle’s precise position to the Ticketer Portal.
- **Pre-defined restriction geofences:** Virtual electronic boundaries created within the Ticketer Portal and applied around known road restrictions, with each restriction assigned a geofence and distributed to ETMs.

Using these inputs, when a vehicle approaches a low bridge, the Ticketer ETM assesses the restriction against the specific vehicle's dimensions and, where appropriate, triggers an alert to the driver.

By factoring in vehicle-specific dimensions, alerts are generated only when a restriction is relevant to the bus being driven. E.g. a single-decker would not receive a height alert where sufficient clearance exists, whereas a double-decker would.

When triggered, the ETM delivers clear visual and audible alerts, displaying the road name and a height-restriction icon on screen, alongside a distinctive audio tone – unique to other ETM notifications to ensure driver recognition and responsiveness.



Ticketer acknowledges the associated challenges whereby alerts may trigger when a low bridge is near a vehicle, but not on the route being taken. High volumes of false alerts can lead to driver complacency; however, Ticketer notes the importance of accounting for deviations from the planned route, for example, due to roadworks or an accident. In such cases, advance warning of a potential hazard on a nearby road before entering it would be critical.

Additionally, Road Restriction Alerts are triggered without the need to logion to the ETM, supporting driving activities such as engineer testing and moving vehicles from one location to another outside of normal Service operations, such as trips and dead runs, when the driver is signed into the ETM

Beyond in-cab driver alerts, all events are recorded within the Ticketer Portal, providing operators with comprehensive back-office visibility and a full audit trail to support incident investigation.

The system enables operators to adjust geofences in real time and configure custom or time-bound restrictions - such as temporary roadworks - through the back-office interface, supporting ongoing accuracy and continuous safety improvement. Geofences can be remotely modified at any time; for example, if a driver reports an unnecessary alert, the restriction can be immediately refined and republished across the fleet. While the pre-supplied dataset provides a comprehensive starting point, fine-tuning using local knowledge is essential to minimise false alerts and ensure warnings remain accurate, relevant, and trusted by drivers.

First Bus Commercial Director, Simon Pearson, has praised the system's ease of implementation and impact on driver confidence: "Ticketer's enhanced driver alert functionality improves our drivers' access to critical information. The seamless implementation ... will allow us to introduce the update at pace and with ease, right across our UK-wide fleet."

Smaller and mid-sized operators have also reported significant benefits. Reliance Motor Services in York adopted Ticketer's Road Restriction Alerts to address the challenges posed by historic archways and narrow routes. Chris Thompson, Operations Manager, highlighted the flexibility of the system: "We needed a Road Restriction Alerts system that was easy to tailor to our needs due to the archways and architecture in York. We haven't seen anything as flexible as this system on the market for operators."

<https://www.ticketer.com/customer-success-stories/reliance-motor-services-switch-to-ticketer-road-restriction-alerts/>

Reliance Director, Gay Newby, also noted a reduction in 'alert fatigue' attributed to Ticketer's distinctive audible signals and accurate geofencing: "The alerts are designed in a way that makes them clearly different from other ETM sounds. Drivers used to experience alert fatigue, which meant they did not always listen."

Operators have full visibility of all restricted locations and the ability to fine-tune geofences to maximise alert accuracy and safety relevance. Where a bridge poses no risk to buses – e.g. where it is located on a railway line - the geofence radius can be reduced to prevent unnecessary alerts on the bus route. Heading tolerances can be applied to ensure alerts are only triggered when the vehicle is travelling in a direction that could reasonably lead to the hazard, reducing false alerts and supporting appropriate driver response. Multiple geofences may be configured for a single structure to cover all valid approach points, ensuring comprehensive hazard coverage.

The introduction of polygon geofences further enhances accuracy by allowing operators to define restriction areas more precisely and better reflect the actual road layout, reducing the likelihood of false alerts. Any configuration changes are applied instantly across all ETMs in the operator's fleet, ensuring consistent and up-to-date safety protection.

Once procured, Road Restriction Alerts can be deployed across an entire ETM estate and benefits from ongoing enhancements delivered via over the air, scheduled software releases. This enables continual improvements to functionality - often informed by customer feedback - without requiring manual intervention or ETM downtime.

Initially launched with low-bridge alert capabilities, Ticketer’s Road Restriction Alerts (RRA) feature has received significant investment since 2021, with additional functionality rolled out free of charge to existing RRA customers. In addition to the introduction of polygon geofences, the solution is now highly extensible and enables operators to configure navigational restriction alerts, e.g. no left-turn or no right-turn restrictions, as well as fully customisable temporary or time-bound hazard alerts, e.g. low-hanging branches or flooded roads.

<https://www.youtube.com/watch?v=liV0AdzmcBU>

https://www.youtube.com/watch?v=1sO_kDtymdU

<https://www.ticketer.com/article/access-all-areas-road-restriction-alerts-enhancements-with-jason-mann/>

These enhancements further increase the value of RRA by providing operators with the flexibility required to manage bespoke restrictions dynamically, ensuring drivers receive accurate, timely, and relevant information.

11.4 GreenRoad Safety System

Stagecoach works with GreenRoad to prevent bridge strikes - January 14, 2021

<https://www.route-ongreee.net/news/stagecoach-works-with-greenroad-to-prevent-bridge-strikes/>

In 2021 Stagecoach commenced a national rollout of GreenRoad’s low bridge alert system on all double deck vehicles across the fleet. This system is an enhancement of the group’s existing relationship with GreenRoad, whose core telematics system is already fitted to those vehicles.

The system uses GPS location data and mapping to alert the driver to nearby low bridges. If it determines that the bus is heading towards one, it will sound an in-cab alert.

Network Rail (NR) has repeatedly engaged in campaigns to highlight the financial and safety impacts of bridge strikes. It estimates that between 40 and 50 such incidents annually involve buses. In November 2020, a Stagecoach double-decker in Cambridge was involved in a bridge strike that saw its roof removed.

Traffic Commissioners (TCs) have more recently taken a growing interest in bridge strikes. TC Kevin Rooney told a Confederation of Passenger Transport event in December 2020 that operators “have a big part to play” in preventing them.

An updated statutory document released in September 2020 by then- Senior TC Richard Turfitt detailed that the starting point for action against a driver that causes a bridge strike through carelessness or negligence is revocation of their vocational licence and disqualification from holding such an entitlement for six months.

The existing GreenRoad telematics system uses a simple traffic light LED display to notify drivers of driving events, giving them instant feedback about their driving manoeuvres, encouraging smoother, safer, more fuel-efficient driving. The low bridge alert system requires an in-cab audio speaker which will sound a voice alert if the system detects a low bridge ahead.

Data from Network Rail shows that there were 1714 railway bridge strikes across the country in the 2019-20 financial year. Most of these incidents involve heavy goods vehicles (HGVs), with between 40 and 50 a year related to buses. As well as the potential for serious injuries, bridge strikes have significant financial and other costs for the country. On average, a single bridge strike costs more than £6,000 and in 2019-20 these incidents resulted in more than 7,800 hours of delays for rail passengers

In Scotland, over 6,000 delay minutes were caused in total and the incidents cost £460,000 (mainly in compensation for operators). The Carlisle Road bridge in Cleland is the most struck in Scotland - being hit 13 times in the 2019/20 financial year.

The intelligent GreenRoad system uses GPS vehicle location data and mapping services to alert the driver to nearby low bridges. If the technology determines that the bus is heading towards a low bridge, it will sound an in-cab alert, allowing a safe exit route that avoids the bridge.

The initiative has been welcomed by Network Rail, which works with the Driver and Vehicle Standards Agency (DVSA), highways bodies, and road transport providers to help prevent bridge strikes.

Network Rail's Chair, Sir Peter Hendy CBE, said: "Bridge strikes are an unnecessary burden on our railway. They pose serious safety risks, cause hours of delays for rail passengers and road users and swallow up public funds which should be used on upgrading and improving our network. I commend Stagecoach on taking the initiative with the roll-out of this technology and I hope to see other operators take a similar proactive approach to tackling the issue in the near future."

Information provided through liaison with senior representatives of GreenRoad facilitated by Stagecoach:

The GreenRoad (GR) safety system is not linked to ETM functionality but is a complete solution for safety in and of itself. The technology has been employed in Stagecoach vehicles for over 14 years – providing the company's telematics platform. The in-vehicle

device monitors the way the vehicle is being driven and primarily seeks to coach the driver with ongoing tuition – looking for example, at eradicating sharp cornering and harsh breaking. It incorporates an award scheme where the driver can receive badges and other accolades according to how he/she has driven.

Their dedicated software system is called Central - which brings together all the data around a driver's performance and facilitates the transmission of it back to the control room, where a manager can access it to look at an individual driver's behaviour. The drivers have the Central app on their phones which gives them the data on their own driving behaviour. The system's prior deployment in Stagecoach buses only had visual alerts (although an audible option was available). The big change for the operator with this new roll-out is the addition of an audible alert in respect of low bridge warnings.

There was no low bridge alert facility built into the GreenRoad system before the 2021 roll-out. For them, the problem has become more prominent in recent years. Fundamentally, the aim of the enhancement is, as far as possible, to reduce the possibility of the vehicle hitting the low bridge.

Each potentially hazardous bridge has an amber low bridge (LB) zone, which covers all access roads in its vicinity including parallel roads. Access points (APs) – essentially geofences which create virtual landmarks around the bridge, are located within the low bridge zones. The use of the low bridge zones as well as the access points provides a hybrid solution. They are all embedded into the system hardware device – Edge, which through GPS, then identifies proximity to the hazard and activates the alerts. A key design imperative was not to rely on connectivity and to create an alert in real time, so as well as all the data being embedded, all the processing is done – within the Edge unit.

The use of GPS is further enhanced by the addition of GNSS which gives even better coverage. Greenroad developed this capability because of some of the work they have done in Asia, where they found that canyoning was a problem in cities and other built-up urban areas – meaning that the standard GPS system is not sufficient to give accurate locations in such areas.

They see both visual and audible alerts as key. The visible alert consists of three LED lights which sit in the driver's peripheral vision and activate when the bus approaches/enters the low bridge zone and then the Access point zone. The lights appear as a flashing wave effect all the time that the bus is in the risk area. The audible signal is in two parts: an initial voice alert warning of the low bridge ahead, followed by a stronger voice warning instructing the driver to stop if they have continued into the actual bridge geofence zone.

GreenRoad are also aware of the oft-mentioned concern around false positives – which can lead to driver complacency. The system's use of Access points provides the flexibility to place them only in roads that have direct access to the bridge. For example, where a

bus could only approach a low bridge zone from the north side, then an Access Point can be located at the point. An Access Point would not, however, be required on the south side approach.

Until now, Greenroad has seen no need to embed vehicle dimensions in the technical solution, however, in the 4 years since deployment, it has become apparent that this would drastically enhance its efficacy. Stagecoach see a need to be able to tailor any technical solution to the variable heights across the fleet, so that buses can pass under low bridges safely, where they are of an appropriate height, with an alert sounding when there is a genuine risk of a bridge strike.

11.5 Transmach

Often, double-deckers may be allocated to routes that have may have low bridges or allocated to duties to meet the same demand that would normally be allocated a single decked vehicle. This is often done when pressure is on or lack of local knowledge. Transmach has adopted road restriction alerts based on GPS, National Bridge Database and Ordnance Survey and these are imported into the Transmach back-office. This driver alert feature on the Electronic Ticketing Machine, ETMs, allows operators to change vehicles to minimise or even remove the risk of a bridge strike.

Changing routes due to road closures, rail replacement services and new drivers on the route, this could be unfamiliar and with restricted access. Transmach have built in the ability to populate the back office with width and height details of all fleet vehicles to allow the driver to be warned of possible areas of concern. This functionality also delivers alerts without the requirement of logging into the ETM, provided power is there, the system will provide full alert functionality during engineering road test, vehicle movements between depots etc.

The TM700 ETM comes with a “**Driver Route Guidance**” function that allows drivers to use on service in general but will also link to temporary routes changes by uploading a TXC file. This will then change the route, identify any hazards and alert the driver as they log into the service. This will ensure that the vehicle will not start the service as it alerts before departure. **The drivers will also be alerted if they're off route.**

Minesh Vandra, Director of Transmach said, “The TM700 ETM delivers this functionality as part of the system and does not require additional hardware upgrades and is a standard feature of the TM700 ETM.

As well as the uploading of national database, Transmach’s back-office has the function for operators to add to the database by creating their own hazard. This allows them to add height, width and location and then geofence the hazard with various shapes and

down to very fine margins so this will not overlap with a route that is unaffected by the hazard, this reduces the chance of a false alert to the driver. All of Transmach's software is populated with full vehicle details and dimensions that powers the alerts. Knowing the height, width and length of a vehicle makes the data much more reliable and gives confidence to those using it.

All changes to the back-office can be published at any point, there is no requirement to wait to a set time. ETMs will be updated automatically during the house keeping process overnight. Drivers can also update ETM in a matter of seconds using the manual update function after receiving a message on the ETM from the supervisors or managers.

The TM700 will deliver an audible alert and ETM tablet will display all the relevant information for the driver.

There is no need to ask for this as an additional function, Transmach fully understands the need for safety in the industry and this is why it is built for all operators using the TM700 ETM.

11.6 Timespace Technology Bridge Alert System

Bridge Alert is a low bridge driver warning aid, integrated with the Timespace vehicle digital video recorders (DVRs). Audible and visual low bridge warnings are provided via a dash-board mounted device and the driver's CCTV monitor. Using the vehicle's GPS device, and Timespace low-bridge data, Bridge Alert is a simple 'plug and play' installation, with free updates.

UK-made system

Timespace produces market-leading DVRs specifically designed for public transport. All products are developed, manufactured and supported in the UK at Timespace in Huntingdon, ensuring high standards of quality and reliability.

Bridge Alert device

The Bridge Alert system is built around and installed alongside the Timespace DVR. Bridge Alert works by combining the vehicle's GPS position with bridge height data stored within the DVR software. This integration allows the system to accurately detect low bridges and trigger warnings to the driver.

Bridge data

The bridge data is owned, managed and updated by Timespace. The database includes bridges across the UK and Ireland and is maintained through a programme of checks and updates. All bridge data is stored directly within the DVR software, and updates are included as part of periodic DVR software releases.

System operation

Bridge Alert warns drivers using a combination of visual and audible alerts. Flashing LEDs are activated on the dashboard-mounted Bridge Alert device, while a visual alert is also displayed on the driver's monitor. As the vehicle approaches the bridge, the system issues audible warnings. The Bridge Alert device can be temporarily silenced using the mute button, and any use of this function is automatically logged by the DVR.

Installation and configuration

Warning distance thresholds are selected at installation, and the vehicle height is input into the system. No subsequent driver input or configuration is required. Users can select audible beep and/or voice alerts. Available bridge data updates are automatically installed when the DVR software is upgraded.

Summary

The Timespace Bridge Alert works in conjunction with a Timespace DVR. The system is not limited to set routes, and complements other essential business practices such as route planning and driver training. Multiple audible and visual alerts notify the driver when approaching a low bridge. The low bridge data is stored in the Timespace DVR's software, and operation of the Bridge Alert system is logged by the DVR. Many top-tier vehicle fleets across the UK have already adopted the Timespace Bridge Alert as an essential part of their on-board technology.

11.7 Technology Development projects

The recent change is companies / research projects looking at implementing more advanced technologies, particularly through initiatives like the DfT/Innovate UK First of a Kind (FOAK) competition:

- **Centrad CenBridge** has recently completed a successful trial with Bus Link, a small Staffordshire-based school bus operator, where it demonstrated its ability to provide real-time alerts to drivers approaching low bridges via a camera-based system. The solution harnesses AI with improved geolocation technology. Its key innovation is an algorithm trained on a diverse range of UK low bridges, enabling real-time detection from a distance of 50 metres or more. It is designed to detect low bridges without appropriate height limit signage and function reliably during harsh turns or in low light. Similar products include [ACSS](#), which builds on the bridge strike prevention technology with their suite of advanced driver assistance features, such as forward collision warnings and monitoring of safe following distances, aimed more toward the HGV market.

<https://centrad.co.uk/centrad-launches-low-bridge-warning-system-to-help-operators-tackle-bridge-strikes/>
- **Vision-Based Over-height Vehicle Detection** (University of Cambridge): Academic research has validated an innovative Over-height Vehicle Strike (OHVS) prevention system using a single calibrated video camera mounted roadside, replacing the need for transmitters, receivers, and loop detectors. Testing demonstrated a height accuracy of ± 2.875 mm (far exceeding the target of ± 50 mm) and a detection accuracy of 99.9%. Crucially, the system offers comparable accuracy to existing laser beam systems but at an order of magnitude less cost, as it eliminates the need for expensive permanent infrastructure.

<https://www-smartinfrastucture.eng.cam.ac.uk/projects-and-case-studies/2018-case-studies/autonomous-vision-based-bridge-and-tunnel-strike>
- **FOAK 2025 Sensing Innovations** : Government-backed research focuses on scalable, low-cost infrastructure solutions:

(PDF) https://iuk-business-connect.org.uk/wp-content/uploads/2025/09/FOAK_2025_Competition_Winners.pdf
- **BridgeAlert (sponsored by Space Data Centres)**: This solution utilizes Bluetooth Low Energy (BLE) Beacons deployed on bridges to communicate directly with a mobile device app, requiring no reliance on GPS, active internet, grid power, in-cab hardware, or gantry structures.

- **Bridge Aware** (Dr. Mani Entezami at University of Birmingham Centre for Railway Research & Education): A two-part system incorporating LiDAR and image recognition for real-time prevention (detecting out-of-gauge vehicles) and low-power vibration sensors installed on the structure for rapid post-strike structural assessment.
- **Virtual Reality (VR) Training:** The Immersive Bridge Strike Awareness (IBSA) project is developing a module using immersive VR training to teach commercial drivers behavioural safety techniques, such as G.O.A.L. (Get Out and Look). In this space, Edwards Coaches are also considering simulation-based training to further develop awareness for both new and experienced drivers. Go-Ahead have independently considered using developed driving simulators for driver selection and training, so we'd acknowledge the benefit of this approach.
- **AI for Rapid Response:** The Bridge Strike Guardian system is a solar-powered, AI-driven multi-sensor system designed not just to detect a strike, but to autonomously analyse structural damage in real-time, delivering diagnostic insights to accelerate recovery times and reduce temporary track restrictions. This comes from a team who have done useful work on pantograph electricity supply infrastructure which Go-Ahead incorporated into our operations and infrastructure plan for the Elizabeth line.
- **AEBS (Automated Emergency Braking Systems):** While not currently mandatory for low bridge protection, [early TRL research](#) (PDF) ⁶noted that AEBS systems in production are capable of autonomously mitigating collisions with "rigid fixed objects on the carriageway". Since bridges and their protection beams constitute rigid fixed objects, the underlying technology (CMBS/Collision Avoidance) could present a future opportunity for research. The research concluded that fitment to buses and coaches is highly likely to be a very effective safety measure with a positive benefit-to-cost ratio.

11.7.1 Exeros Technologies:⁷

An AI based trial being undertaken with GO Ahead. Go-Ahead undertook a thorough human factors study in 2025 and elected to undertake a proof-of-concept study using the Exeros Low Bridge Strike technology at the

⁶ <https://www.trl.co.uk/uploads/trl/documents/XPR110---Using-in-vehicle-technologies-for-safe-and-efficient-driving---Full-report.pdf>

⁷ <https://exeros-technologies.com/solutions/low-bridge-recognition/>

Salisbury depot. The Exeros solution combines AI vision, GPS data, and automatic vehicle measurement to eliminate guesswork and reduce false positives.

A vehicle-mounted camera reads low-bridge signs and measures the height of the bridge aperture, and the system cross-checks that information with GPS positioning and known low bridges. The system checks the data against the vehicle's height using RFID sensors and alerts the driver if there is genuine risk. If there's a genuine risk, the system instantly alerts the driver, with the alert taking the form of sound, voice, light, or a subtle vibration (whatever suits your fleet and drivers).

The system also records each event as a short video clip. Fleet managers can then review the footage, handle claims, or use incidents for training. The Go-Ahead trial simply looked at identifying the bridge signage and generating warnings, to fully evaluate the claim of reducing false positives. We also took initial steps to explore the potential for extending of this technology to integrate with bus control systems, which could in future (for example) automatically put the vehicle into limp mode if the driver failed to act in response.

In evaluation, the Salisbury trial performed very well in validating the utility of the AI identification system, producing very few false warnings, across the five buses it was installed on. The next steps will be to look at a wider trial across all Go-Ahead businesses, with a view to a full fleet rollout if successful.

Appendix

1. Network Rail Bridge Strike Protocol: Prevention of strikes on bridges over highways – a protocol for highway managers and bridge owners
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/350114/network-rail-bridge-strike-protocol.pdf
2. Network Rail Wise up size up campaign
<https://www.networkrail.co.uk/communities/safety-in-the-community/railway-safety-campaigns/wise-up-size-up/>
3. View good practice guides on how drivers, transport staff and bridge owners can prevent vehicles from hitting bridges and what to do if a bridge strike happens.
<https://www.gov.uk/government/publications/prevention-of-bridge-strikes-good-practice-guide>
4. Network Rail The risk of bridge strikes – including information on Bridge Strike champions
This also includes a very useful PowerPoint presentation for use in CPC.
<https://www.networkrail.co.uk/running-the-railway/looking-after-the-railway/bridges-tunnels-and-viaducts/the-risk-of-bridge-strikes/>
5. Managing Bridge Strikes from Rail to Road Bridges
A very comprehensive report from the Australian Small Bridges Conference 2019, which includes information from the UK, Australia and New Zealand
https://na.eventscloud.com/file_uploads/c79ec26115cd9aa1f1f8d7a45d2c3775_Coleman-NZ_Transport_ManagingBridgeStrikesfromRailtoRoadBridges.pdf