



Rail Accident Investigation Branch

Rail Accident Report



Trains overspeeding between Laurencekirk and Portlethen, Aberdeenshire 4 December 2020

Report 08/2021
November 2021

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC
- the Railways and Transport Safety Act 2003
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Any enquiries about this publication should be sent to:

RAIB	Email: enquiries@raib.gov.uk
The Wharf	Telephone: 01332 253300
Stores Road	Website: www.gov.uk/raib
Derby UK	
DE21 4BA	

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Preface

The purpose of a Rail Accident Investigation Branch (RAIB) investigation is to improve railway safety by preventing future railway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

RAIB's findings are based on its own evaluation of the evidence that was available at the time of the investigation and are intended to explain what happened, and why, in a fair and unbiased manner.

Where RAIB has described a factor as being linked to cause and the term is unqualified, this means that RAIB has satisfied itself that the evidence supports both the presence of the factor and its direct relevance to the causation of the accident or incident that is being investigated. However, where RAIB is less confident about the existence of a factor, or its role in the causation of the accident or incident, RAIB will qualify its findings by use of words such as 'probable' or 'possible', as appropriate. Where there is more than one potential explanation RAIB may describe one factor as being 'more' or 'less' likely than the other.

In some cases factors are described as 'underlying'. Such factors are also relevant to the causation of the accident or incident but are associated with the underlying management arrangements or organisational issues (such as working culture). Where necessary, words such as 'probable' or 'possible' can also be used to qualify 'underlying factor'.

Use of the word 'probable' means that, although it is considered highly likely that the factor applied, some small element of uncertainty remains. Use of the word 'possible' means that, although there is some evidence that supports this factor, there remains a more significant degree of uncertainty.

An 'observation' is a safety issue discovered as part of the investigation that is not considered to be causal or underlying to the accident or incident being investigated, but does deserve scrutiny because of a perceived potential for safety learning.

The above terms are intended to assist readers' interpretation of the report, and to provide suitable explanations where uncertainty remains. The report should therefore be interpreted as the view of RAIB, expressed with the sole purpose of improving railway safety.

Any information about casualties is based on figures provided to RAIB from various sources. Considerations of personal privacy may mean that not all of the actual effects of the event are recorded in the report. RAIB recognises that sudden unexpected events can have both short- and long-term consequences for the physical and/or mental health of people who were involved, both directly and indirectly, in what happened.

RAIB's investigation (including its scope, methods, conclusions and recommendations) is independent of any inquest or fatal accident inquiry, and all other investigations, including those carried out by the safety authority, police or railway industry.

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Trains overspeeding between Laurencekirk and Portlethen, Aberdeenshire, 4 December 2020

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Summary

On 4 December 2020, six trains exceeded a reduced speed limit which was temporarily in force between Laurencekirk and Portlethen, Aberdeenshire. A 40 mph (64 km/h) 'blanket' emergency speed restriction (BESR) had been imposed from the start of service on that day until 09:00 hrs, because of a forecast of heavy rain with the associated risk of an earthwork failure obstructing the line. In some instances, trains travelling through the BESR reached the normal maximum permitted speeds which varied along this length of line up to 100 mph (161 km/h) for the trains involved. In other instances, the reduced permitted speeds were exceeded for only parts of the BESR. The actual amount of rainfall was not sufficient to cause any earthwork failures, and no accident occurred.

The investigation found that some drivers were unaware of the BESR as they approached it, and others were unaware of its exact extent. A notice, displayed in the late notice cases at the locations where the drivers reported for duty, was the only information about the BESR provided to drivers. This notice did not convey information in a way that could be readily understood and remembered when drivers needed to apply it. Lineside signage is not used for BESRs and no other reminder was provided as trains approached the restriction. The BESR notice gave the limits in terms of both mileages and lineside features, but these did not correspond to each other. ScotRail had not recognised that use of the late notice case was an unreliable way to implement BESRs. However, some managers had improved reliability by local additions to the formal system. Although not directly relevant to the incident, RAIB observed that the BESR form contained in Network Rail procedures, and variants used in Scotland and on other routes, had shortcomings compared with good practice in human factors.

RAIB has concluded that the railway industry has more work to do to establish a suitable method for the imposition of speed restrictions, in response to extreme weather that has the potential to endanger infrastructure.

RAIB has made two recommendations and identified two learning points as a result of this investigation. The first recommendation seeks an improvement to the BESR notices provided to drivers and the second seeks a review of the methods used to implement blanket emergency speed restrictions. The learning points cover the importance of drivers being aware of information contained in late notices, and the need for safety critical communications to provide clear and unambiguous information.

Introduction

Definitions

- 1 Metric units are used in this report, except when it is normal railway practice to give speeds and locations in imperial units. Where appropriate the equivalent metric value is also given.
- 2 The report contains abbreviations explained in Appendix A. Sources of evidence used in the investigation are listed in Appendix B.

The incident

Summary of the incident

- 3 On 4 December 2020, six trains exceeded the 40 mph (64 km/h) blanket emergency speed restriction (BESR) which was in place between Laurencekirk and Portlethen, Aberdeenshire (figure 1). The BESR was in place because of a forecast of heavy rain, with the associated risk of an earthwork failure obstructing the line. In some instances, trains travelled through the BESR at normal speeds and reached the maximum permitted speeds which varied along this length of line from 70 mph (113 km/h) to 100 mph (161 km/h). In other instances, the reduced permitted speeds were exceeded for only parts of the BESR. The actual amount of rainfall was not sufficient to cause any landslips and no accident occurred.

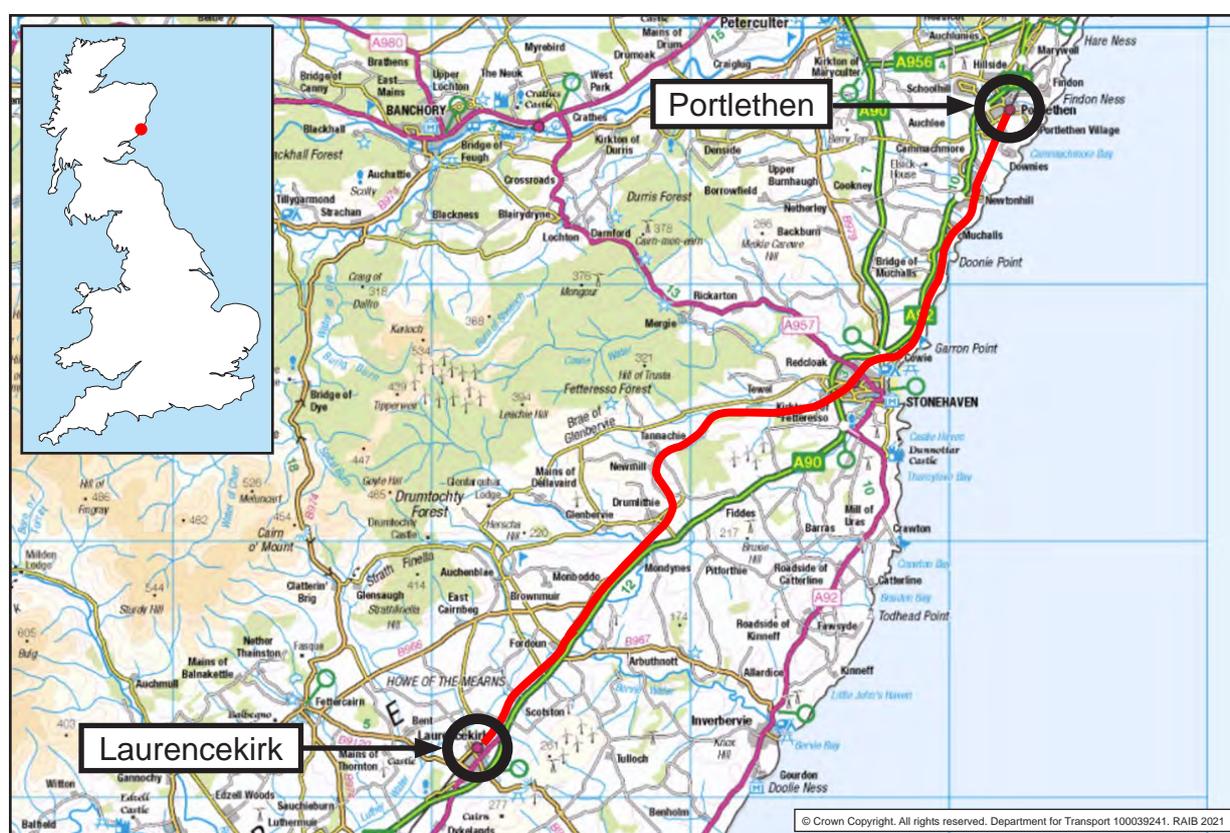


Figure 1: Extract from Ordnance Survey map showing location of incident

Context

Location

- 4 The blanket emergency speed restriction (BESR) applied over about 20 miles (32 km) of both the up (southbound) and down (northbound) lines of the railway between Dundee and Aberdeen (engineer's line reference ECN5). The line is part of Network Rail's Scotland Route.

- 5 The intended limits of the BESR were 212 miles 546 yds,¹ approximately two miles north of Laurencekirk station, and 232 miles 1420 yds, just south of Portlethen station. Railway earthworks in this area had been assessed by Network Rail as being at risk of movement which could adversely affect railway safety during times of heavy rainfall (figure 2).
- 6 The maximum permitted speed for trains running in both directions between Laurencekirk and Portlethen varies from 70 mph (113 km/h) to 95 mph (153 km/h), with enhanced speeds of up to 100 mph (161 km/h) for some trains, including all those involved in this incident, which are permitted to use them.
- 7 Signalling in the area of the BESR is controlled from signal boxes at Aberdeen, Stonehaven, Carmont and Laurencekirk.
- 8 The area covered by the BESR on 4 December 2020 included the site of the accident at Carmont on 12 August 2020, the subject of a separate [RAIB investigation](#).

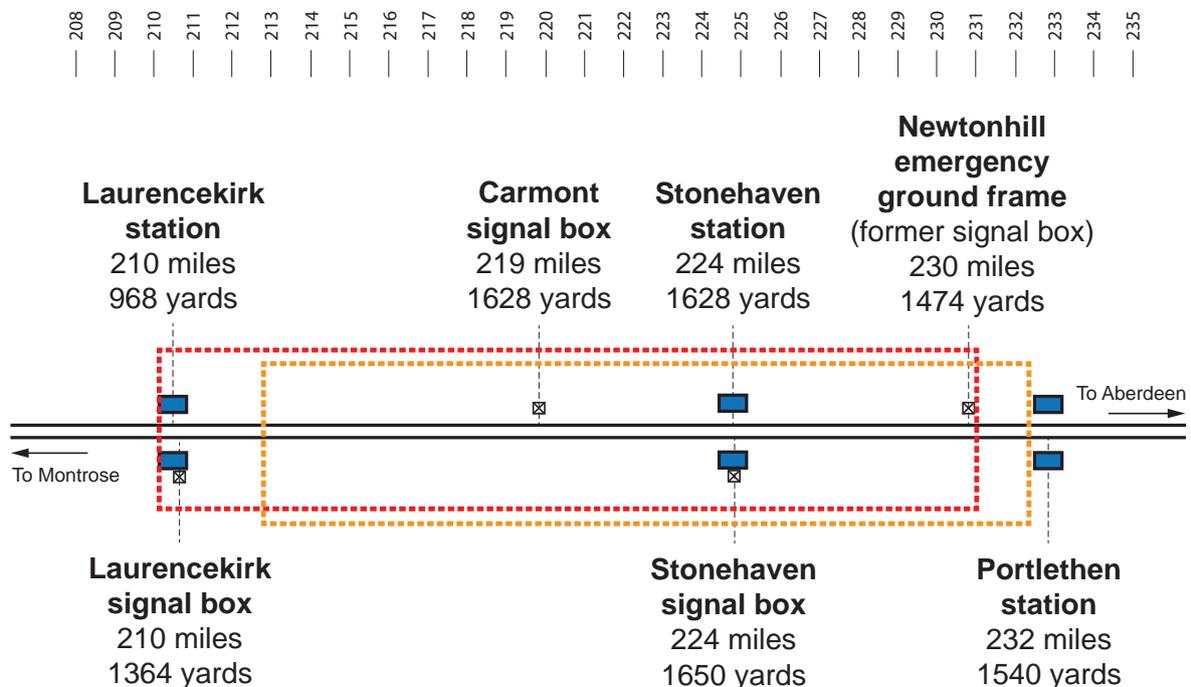


Figure 2: The BESR limits between Laurencekirk and Portlethen. The red box indicates the area defined by the locations on the form in the late notice case, the orange box the area defined by the mileages and intended by the asset managers (see paragraph 66).

Organisations involved

- 9 Network Rail is the owner and maintainer of the infrastructure. It also employs the geotechnical asset management team and route control staff.
- 10 Abellio ScotRail Ltd (ScotRail) was the operator of all the trains involved and the employer of their drivers.
- 11 Network Rail and ScotRail freely co-operated with the investigation.

¹ Distances on this section of railway are measured from Carlisle, via Perth and a now closed route via Forfar.

Trains involved

- 12 Of the 16 train services which passed through the area while the BESR was in force, six were overspeeding for some or all of the distance. These were, in the order they reached the speed restricted area:
- train 1T04,² the 05:36 hrs Aberdeen to Glasgow Queen Street service, a diesel-electric, high speed train (HST) set consisting of a leading power car, four mark-3 passenger coaches and a trailing power car (2+4 HST)
 - train 1B07, the 05:47 hrs Aberdeen to Edinburgh service, a 2+4 HST set
 - train 1H25, the 05:39 hrs Dundee to Inverness service, a two-coach class 158 diesel multiple unit (DMU)
 - train 1B14, the 04:56 hrs Inverness to Edinburgh service, a three-coach class 170 DMU
 - train 1A41, the 05:30 hrs Edinburgh to Aberdeen service, a 2+4 HST set
 - train 1T10, the 07:38 hrs Aberdeen to Glasgow Queen Street service, a 2+4 HST set.

Staff involved

- 13 The Network Rail geotechnical asset management staff were led by the route geotechnical asset manager. The asset managers have duties which include identifying and, when necessary, informing route control staff that mitigation measures, such as speed restrictions, are required. A speed restriction could be required if there is a significant risk to railway safety due to heavy rain triggering landslips, washouts or similar events in cuttings and embankments.
- 14 Scotland Route control staff are based in Glasgow with responsibilities including disseminating information about any mitigating actions required to manage risk associated with cuttings and embankments.
- 15 The ScotRail drivers involved in the incident were based at Dundee and Aberdeen. Their experience of train driving varied from 5 months to 17 years.
- 16 Network Rail employed the signallers involved in the incident, who were located at Aberdeen, Laurencekirk, Carmont and Stonehaven.

External circumstances

- 17 The overspeeding incidents occurred between 05:47 hrs and 08:26 hrs, in the period leading to sunrise at 08:27 hrs. Rain fell in the area for most of that time, with the Scottish Environment Protection Agency (SEPA) reporting 17 mm rainfall on 4 December 2020, measured at a weather station near Stonehaven.

² An alphanumeric code, known as the 'train reporting number', is allocated to every train operating on Network Rail infrastructure.

The sequence of events

Events preceding the incident

- 18 A weather forecast issued during the morning of 3 December 2020 predicted very heavy rainfall on the following day in some coastal parts of eastern Scotland. After reviewing this forecast, staff in the geotechnical asset manager's team requested implementation of BESRs on 4 December for parts of the Dundee to Aberdeen and Inverness to Wick lines, due to the risk of earthwork instability triggered by heavy rain. This request was agreed at a 12:00 hrs meeting chaired by route control staff on 3 December.
- 19 A notice containing details of the BESRs, including details of the BESR between Laurencekirk and Portlethen, was emailed by route control staff to ScotRail depots and affected signal boxes at around 17:00 hrs on 3 December. The notice stated that the BESRs took effect at the start of service on 4 December and continued until 09:00 hrs. ScotRail staff placed a copy of this notice in the late notice cases at Dundee and Aberdeen depots at around 17:20 hrs. The late notice cases comprise a notice board in a glass fronted cupboard located near the places where drivers book on duty (figure 3).
- 20 All the drivers involved in the incident booked on duty the following morning, with drivers of the northbound services booking on at Dundee and drivers of the southbound services booking on at Aberdeen. All these drivers stated that they looked at the late notice case when booking on. The overspeeding occurred during the first trip of their respective shifts.

Events during the incident

- 21 At 07:44 hrs, shortly after the passage of train 1B14, the signaller at Laurencekirk signal box contacted route control staff to inform them that the train had passed through the section between Carmont and Laurencekirk in the time normally taken, rather than losing around six minutes as would be expected if it had been travelling at 40 mph (64 km/h) in accordance with the BESR. Route control staff informed ScotRail so the matter could be investigated.
- 22 At around 07:51 hrs the Carmont signaller observed train 1A41 pass the signal box at around the maximum speed normally permitted, rather than at the reduced speed required by the BESR. The signaller used the GSM-R³ (railway radio system) to request that the train driver contact a signaller as soon as it was safe to do so. The driver contacted the signaller at 07:55 hrs, by which time the train was in Stonehaven station, so the call was connected to the Stonehaven signaller. This signaller was unaware of why the request had been made but, after speaking with the Carmont signaller, provided details of the BESR after finding that the train driver was unaware of it.
- 23 At 08:00 hrs, the Carmont signaller contacted route control staff to inform them that train 1A41 had passed the signal box at the maximum speed normally permitted, but that the driver had then been told about the BESR by the Stonehaven signaller.

³ Global System for Mobile Communications – Railway.

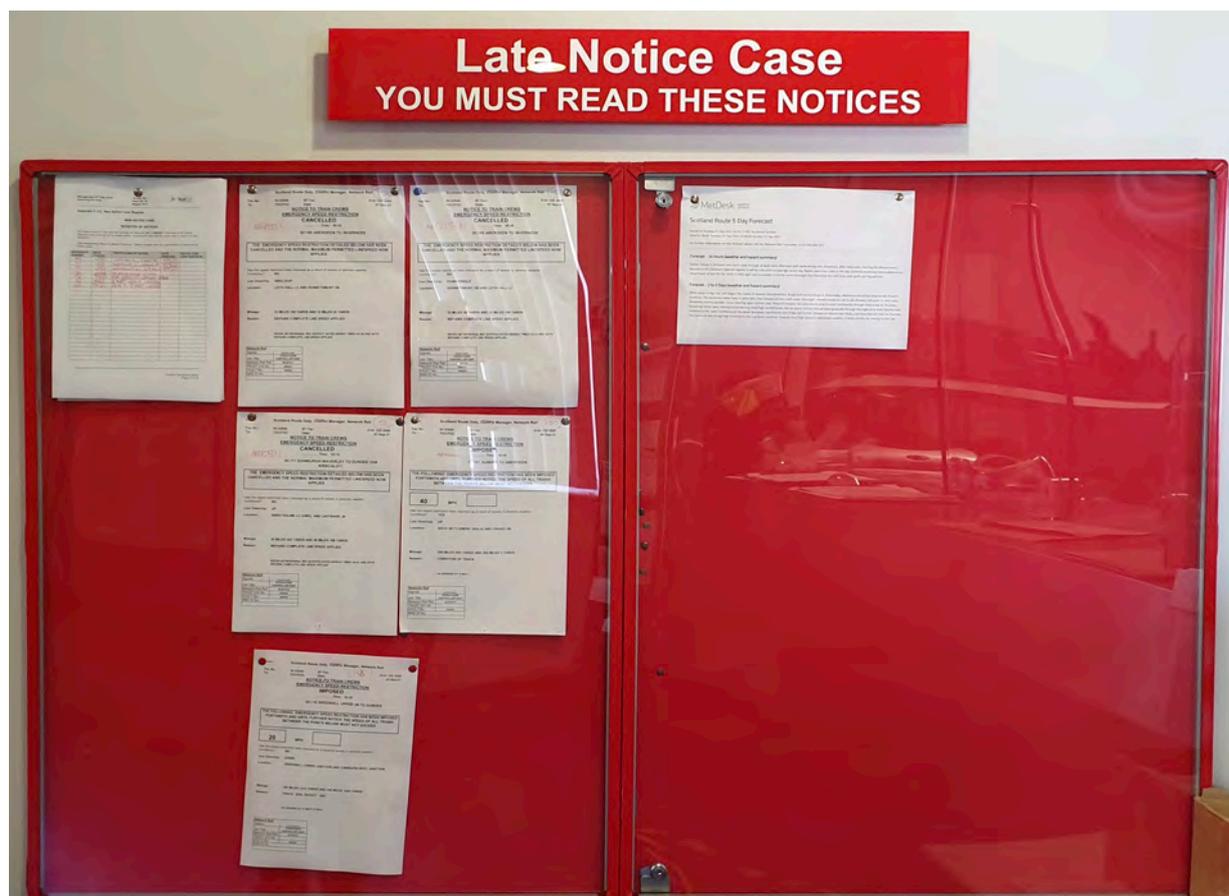


Figure 3: Late notice case at Aberdeen

- 24 At 08:09 hrs, having been stopped by a red signal, as a result of catching up with the preceding service, the driver of train 1T10 contacted the Carmont signaller to enquire about the cause of the delay. The signaller explained it was due to the BESR. The driver's reply indicated that he was unaware of the BESR and so the signaller then provided details of the restriction.
- 25 Immediately after speaking to that driver, the Carmont Signaller contacted route control again to report that a further driver was unaware of the BESR and to request that all trains be stopped at a red signal and cautioned (reminded of the BESR) before entering the area. The route control staff agreed and contacted staff at Aberdeen signal box so they could caution drivers approaching from the north. The Carmont signaller asked the Laurencekirk signaller to caution trains approaching from the south.

Events following the incident

- 26 The BESR was lifted at 09:00 hrs and services resumed operation at normal speeds.
- 27 The involvement of trains other than 1B14, 1A41 and 1T10 was not identified at the time, but by later analysis of signalling records and information from on-train data recorders (OTDR).

Consequences

- 28 Two services, the 09:51 hrs Edinburgh to Glenrothes and the 10:52 hrs Glenrothes to Edinburgh, were cancelled because one of the drivers involved in the incident had been relieved of duty.
- 29 Despite some heavy rainfall, there were no landslips in the area covered by the BESR, so the landslip risk did not materialise on this occasion.
- 30 The actions of the signallers at Carmont and Laurencekirk when they identified that trains were overspeeding, could, in other circumstances, have avoided an accident.

Analysis

Background Information

- 31 In general, Emergency Speed Restriction (ESRs) are used when problems on the railway, such as track faults, require trains to operate at lower speeds than usual. They are implemented by signallers cautioning trains until lineside signs are in place, with written notifications in late notices for drivers who sign on after the ESR is in place.
- 32 New procedures implemented by Network Rail in September 2020, as a result of the accident at Carmont (paragraph 8), introduced the use of BESRs as a means of mitigating risk due to heavy rain causing earthwork failures at locations not previously identified as being at particularly high risk of failure. These procedures had resulted in application of the BESR in which the overspeeding occurred on 4 December 2020.
- 33 Before these new procedures were introduced, blanket ESRs had been included in Network Rail National Operating Procedures for at least 18 years, and in the Rule Book since 1996, to be imposed in affected areas when high rail temperatures, high winds, low railhead adhesion or snow were forecast. Risk due to extreme or heavy rainfall causing instability of cuttings and embankments had normally been managed for many years by imposing speed restrictions (or other mitigation) at specific locations considered to be at relatively high risk of instability.
- 34 Following the derailment at Carmont on 12 August 2020 (paragraph 8), an emergency change to Network Rail's National Operating Procedure NR/L3/OPS/045/3.17 issue 3 (NOP 3.17) was published on 14 September 2020. This included a means for providing BESRs in areas where heavy rainfall was considered a significant risk to all (or a significant proportion of) cuttings and earthworks. Key requirements relevant to the overspeeding incident are that:
- geotechnical asset managers should identify areas where BESRs would be required when heavy or extreme rainfall meant there was a significant risk to railway safety due to cutting and embankment instability
 - the railway should be divided into relatively small lengths, known as operational route sections (ORS), which would be used by geotechnical asset managers to inform route control staff when and where they should implement BESRs.
- 35 BESRs differ from other ESRs which are provided with lineside warning signs as soon as is reasonably practicable, and train drivers are cautioned by signallers as they approach the ESR until these are provided. BESRs are not marked with lineside warning signs and, depending on circumstances, drivers approaching a BESR are not necessarily warned by signallers.

Identification of the immediate cause

36 Some drivers did not reduce speed as required by the blanket emergency speed restriction because they were unaware of the restriction or unaware of its exact limits.

37 Witness evidence and recordings of conversations between signallers and drivers show that some drivers were unaware of the BESR as they approached it, and others were unaware of its exact limits (table 1). BESR details (figures 4 and 5) were displayed at Aberdeen and Dundee depots as confirmed by ScotRail and evidenced by other drivers complying with them.

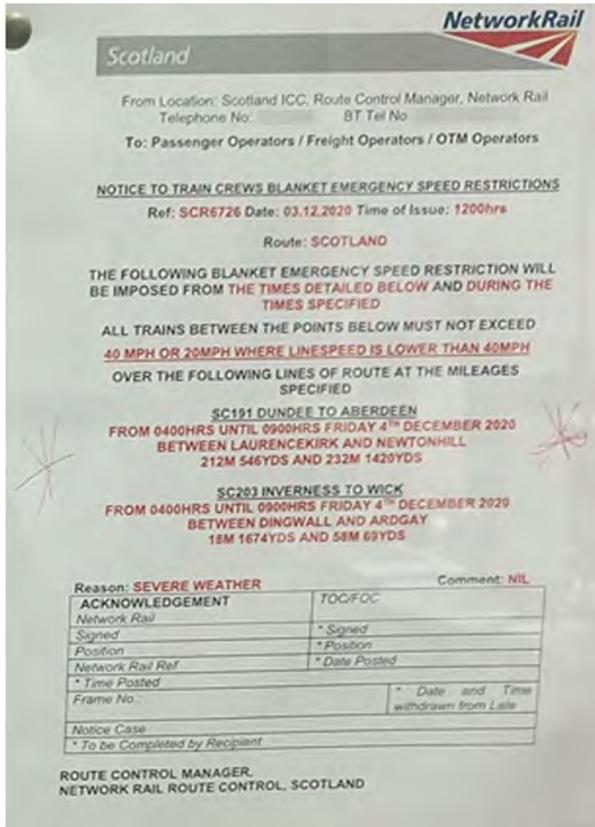


Figure 4: Late notice displayed at Aberdeen

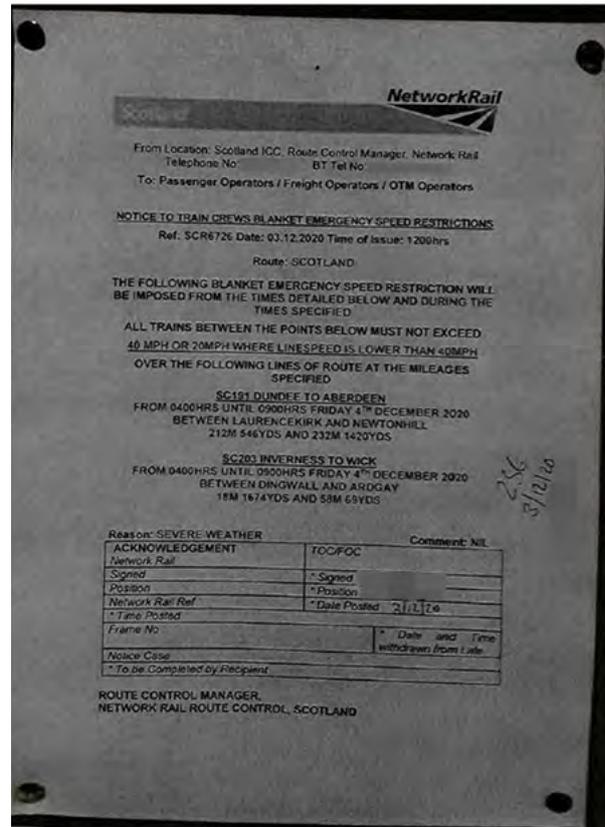


Figure 5: Late notice displayed at Dundee

Train (direction) Driver's experience at time of incident	Driver's stated understanding	Train speed
1T04 (southbound) 5 months driving experience	Knew about the BESR, but misled by geographical information on the BESR notice which was inconsistent with the mileages shown on the notice	Drove at speeds up to the maximum normally permitted, and mainly in excess of BESR requirements, from north end of BESR to Newtonhill. Complied with BESR requirements south of Newtonhill

<i>Train (direction) Driver's experience at time of incident</i>	<i>Driver's stated understanding</i>	<i>Train speed</i>
1B07 (southbound) 1 year driving experience	Knew about the BESR, but was unsure of exact start	Drove more slowly than trains running normally, but in excess of BESR speeds, from north end of BESR to Stonehaven. Complied with BESR requirements south of Stonehaven
1H25 (northbound) 11 years driving experience	Unaware of BESR	Drove at speeds up to the maximum normally permitted, and in excess of BESR speeds throughout the BESR
1B14 (southbound) 2 years driving experience	Unaware of BESR	Drove at speeds up to the maximum normally permitted, and in excess of BESR speeds, throughout the BESR
1A41 (northbound) 17 years driving experience and a driver instructor since 2008	Unaware of BESR until advised by signaller at Stonehaven	Drove at speeds up to the maximum normally permitted, and mainly in excess of BESR requirements, from south end of BESR to Stonehaven. Then complied with BESR requirements
1T10 (southbound) 1 year driving experience	Unaware of BESR until advised by signaller at Carmont	Drove at speeds up to the maximum normally permitted, and mainly in excess of BESR requirements, from north end of BESR to Carmont. Then complied with BESR requirements

Table 1: Trains involved in the overspeeding incident and the varying levels of experience of their drivers

Identification of causal factors

- 38 The overspeeding incidents occurred due to a combination of the following causal factors:
- a. The BESR notice did not convey information in a way that could be readily understood and remembered when drivers needed to apply it (paragraph 39)
 - b. Drivers were not reminded of the BESR after booking on (paragraph 51)
 - c. Geographical locations given on the BESR notice were inconsistent with the mileages over which the restriction was intended to apply (paragraph 66)

Each of these factors is now considered in turn.

39 The BESR notice did not convey information in a way that could be readily understood and remembered when drivers needed to apply it.

- 40 All the drivers involved in the incident reported that they had seen the BESR notice. The four drivers who were unaware of the BESR until told by a signaller or a driver manager stated that they did not recall the content of the notice.
- 41 The notice displayed in the late notice cases to advise drivers of the BESR was based on a template that Scotland route control had been using since 2008.
- 42 The drivers of the trains involved in the incident stated that they were not familiar with the layout of this notice. The form differed from that frequently encountered by drivers and describing other types of other emergency speed restrictions. Although all were aware of blanket speed restrictions from their training, most stated that they had never encountered one during their driving careers. The driver with most experience reported seeing no more than three in 17 years of driving. Prior to the procedure change in September 2020, BESRs were rarely used in north-east Scotland as there is no overhead line electrification to be affected by high winds, and BESRs to mitigate the effect of high temperatures on track alignment are unusual. Other hazards were generally dealt with by imposing multiple local emergency speed restrictions.
- 43 The BESR form used by Scotland route control had not been reviewed, other than changing some text from black to red, between 2008 and the time of the incident. This form differed from the sample BESR form included in Network Rail NOP 3.19 (June 2018) and discussed at paragraph 83.
- 44 The Scotland Route control BESR notice, as displayed at both Aberdeen and Dundee depots in December 2020, did not meet current best practice for human factors applicable to documentation and displays. Research suggests that *'The display must be able to be seen clearly and the design should help the viewer to correctly perceive the meaning of the display'*.⁴ To achieve this, the notice should be visible, legible and readable. The notice used in Scotland was visible but contained shortcomings in both legibility and readability. These shortcomings are described below using research relating to written instructions, and, where the same principles are applicable, research relating to the presentation of information.
- 45 **Visibility:** the forms were displayed in the late notice cases, and drivers are trained to look at these. All drivers understood that viewing and noting the content of the late notice case was an important part of their signing-on routine, and each driver stated that they had seen the notice and could recall where it was in the case.

⁴ Sanders, M. & McCormick, E. (1992) Human factors in engineering and design.

- 46 **Readability:** the form had no hierarchy of information, with all text printed in the same size. The form displayed in Aberdeen contained some red text but, as there was no colour printer at Dundee, the form there used only black text. The critical information that the driver needed, such as the restricted speed and the locations where this applied, did not stand out. There was no text stating that, unlike other types of emergency speed restrictions, lineside reminders were not being provided. The form was unnecessarily cluttered with around half of the sheet taken up with headers and acknowledgments, which were not relevant to the driver and contained material which could have been communicated without detracting from the important information needed by drivers.
- 47 There was an absence of visual cues, such as maps or diagrams, which may increase the effectiveness of the notice. Research has shown that the effective use of visual cues can decrease learning time, improve comprehension, enhance retrieval, and increase retention of information.⁵ Visual information will also support recognition, allowing the rapid extraction of relevant information.
- 48 **Legibility:** although the size, font and spacing of alphanumeric characters is generally appropriate, nearly all the text is in capitals. If using full sentences, it is preferable to use lower case as *'during reading of upper-case words, perception occurs in a character-by-character order, thereby reducing the speed of reading and readability of the entire word'*.⁶ A study found that *'words set in capital letters are less legible than in lower case when reading text, searching for newspaper headlines, or finding a name on a map. The difference is usually attributed to the distinctive shape of lower case words, but lower case setting also emphasises capital letters at the start of sentences and for proper names'*.⁷
- 49 Red text was used on both the Scotland route template and the notice displayed at Aberdeen, to attract attention and to highlight parts of the notice. However, its use was not limited to the most important information and this detracted from its potential value as a useful visual cue. Use of colour should also be limited to critical information which the driver needs to memorise as: *'[colour] has a high potential for distraction, so overuse of color [sic] can increase the appearance of visual clutter and reduce display legibility'*.⁸ The potential for colour to act as a visual cue was not available at Dundee where the notice was printed in black and white.
- 50 The quality of the printing of the notice posted in Dundee was poor which adversely affected legibility and readability because: *'the print should be clear and the boundaries strokes and spaces should be sharp and distinguishable'*.⁹

⁵ Kouyoumdjian, H. (2012) Learning Through Visuals <https://www.psychologytoday.com/gb/blog/get-psyched/201207/learning-through-visuals>.

⁶ On The Typography Of Flight Deck Documentation- Degani, A. (1992) San Jose State University Foundation for NASA.

⁷ Poulton, E. C. (1967). Searching for newspaper headlines printed in capitals or lower-case letters. *Journal of Applied Psychology*, 51(5, Pt.1), 417–425.

⁸ Human Factors Considerations In The Design And Evaluation Of Flight Deck Displays And Controls, v2.0, Yeh, M., Swider C., Jin Jo, Y., and Donovan, C. 2016, Federal Aviation Administration.

⁹ Degani, A. (1992).

51 Drivers were not reminded of the BESR after booking on.

52 Unlike other type of emergency and temporary speed restriction, there were no warnings, reminders or visual cues available to train drivers relating to this BESR, other than the late notice case. This meant that drivers' memory was a potential single point of failure for compliance with a safety-related speed restriction.

53 This causal factor arose due to a combination of the following:

- a. there were no further copies of the BESR notice for drivers to refer to (paragraph 54)
- b. there was no reminder provided to drivers at or near the limits of the BESR (paragraph 59)

Each of these factors is now considered in turn.

54 There were no further copies of the BESR notice for drivers to refer to.

55 Viewing the information in the late notice case at Aberdeen or Dundee depots was the only opportunity for the drivers involved in the incident to familiarise themselves with the BESR. The potential for this to be insufficient had been recognised at some other ScotRail depots where an additional copy of the notice was placed at the signing-on point to help draw drivers' attention to BESRs.

56 When ScotRail managers regarded a BESR notice as complex, for example when several areas on a driver's route were affected, they arranged for a copy of the notice to be attached to the driver's diagram, a document carried by drivers in the cab and giving details of the services they were operating. This allowed drivers to remind themselves of the limits. This was not done on the day of the incident as only one area of BESR affected each driver.

57 ScotRail drivers are provided with electronic tablets, but these are not used to disseminate urgent safety critical information as the drivers are not required to check them when they sign-on for duty. It was also not ScotRail's practice to email copies of notices to the drivers for reference purposes, as it did not wish to overload drivers with information that was not relevant to them.

58 RAIB asked a sample of other train and freight operating companies (TOCs and FOCs) for details of their processes for notifying drivers of emergency speed restriction and BESR notices. Each company reported a different process with significant variations including:

- whether drivers were required to acknowledge (by signature or electronically) receipt of the notices
- whether drivers were provided with a copy of the notice (or the key information from it) to use as an aide-memoire during their shift.

59 There was no reminder provided to drivers at or near the limits of the BESR.

60 For the BESR on 4 December 2020 there was no reminder for the drivers approaching the start points. For other types of emergency speed restriction, drivers are warned by temporary lineside signs when they are required to consider braking, and by magnets placed between the rails to trigger the automatic warning system (AWS) in the drivers' cab. Further signs mark the beginning and end of the restriction. If these warnings are not in place, signallers stop each train as it approaches to advise the driver of the restriction (paragraph 30).

- 61 The railway Rule Book¹⁰ does not require warning signs or magnets for a BESR, stating that ‘*emergency indicators and other track equipment are not provided*’.
- 62 Network Rail expects route control staff to use NOPs, rather than the Rule Book used by train drivers and some other railway staff. The NOPs include NR/L3/OPS/045/3.19 issue 2, 2 June 2018 (NOP 3.19) which contains the following:
- ‘10.2.1 *If the Route decides to impose a blanket speed restriction, details shall be published on the Late Notice Case at Traincrew Booking on Points. The time when this notice is published shall dictate whether further reactive advice to drivers and signallers is required.*
 - 10.2.2 *Train drivers shall be advised of the imposition of [B]ESRs by:*
 - GSM-R.
 - *Stopping of trains at signals to advise of the action required.*
 - 10.2.3 *Route Operations Control shall confirm signal boxes are advised if such restrictions are imposed.*
 - 10.2.4 *Any trains entering the blanket speed restriction area shall also be advised, stopping especially if necessary. Cross route trains and boundaries shall be taken into account when imposing speed restrictions.*
 - 10.2.5 *If there is a conflict between different requirements, the most restrictive requirement shall be applied.’*
- 63 Network Rail’s route control staff did not ask signallers to set up a GSM-R broadcast or stop and advise train drivers because they understood NOP 3.19 did not require this if all drivers had had the opportunity to see the published notice. This understanding was consistent with the final sentence of paragraph 10.2.1 of NOP 3.19, but inconsistent with the more restrictive requirement of paragraph 10.2.2 and the paragraph 10.2.5 requirement to use the most restrictive requirement.
- 64 The requirements of NOP 3.19 are unclear. The final sentence of paragraph 10.2.1 indicates that the need for signallers to advise drivers depends on when the BESR is published (effectively when the notice is taken to have been seen by drivers). These words would never apply if warnings are always required as indicated by paragraphs 10.2.2. and 10.2.5.
- 65 The stopping of trains (to advise drivers of BESRs) can only be applied by signallers, and they also have facilities allowing them to give warnings by GSM-R. Paragraph 10.2.2 of NOP 3.19 therefore suggests that signallers would warn individual drivers. However, until the signallers observed overspeeding by trains, they did not do this. Signallers are expected to comply with the Rule Book, which does not require them to give these warnings unless asked to do so by route control staff. Signallers are not expected to be familiar with the content of the NOP and were not asked to give warnings by route control staff on the day of the incident.

¹⁰ GE/RT8000/SP issue 5 05/12/2015.

66 Geographical locations given on the BESR notice were inconsistent with the mileages over which the restriction was intended to apply.

- 67 The start and end points for the BESR on the notice posted in the late notice case were described in terms of mileage and geographical locations in a spreadsheet containing the ORS for Scotland, as required by the emergency change to the NOP (paragraph 32). The guidance in this emergency change stated that *'Operational Route Sections shall start and finish at clearly distinguishable points for Signallers and Drivers (e.g. Junction to Junction, Line of Route, station to station etc).'*
- 68 The ORS used in Scotland were based on areas which were already defined in the Fault Management System (FMS), a database of Network Rail's assets used for managing maintenance operations. Where required, these areas were adjusted to give ORS boundaries more appropriate to the NOP's requirements. However, in most plain line¹¹ areas, such as between Laurencekirk and Portlethen, the ORS boundaries were the mileages and places names used in the FMS areas.
- 69 The place names in the FMS database were chosen to suit maintenance activities, so they tended to relate to how equipment was operated, rather than its strict geographical location. For example, the area immediately to the south of Portlethen station was referred to as *'Newtonhill North'* as, before signalling control in this area was moved to Aberdeen, this had been the northern extremity of Newtonhill signal box's control area.
- 70 From September 2020, when the geotechnical asset management team began using the ORS areas to request BESRs, they copied all of the details from the relevant lines of the spreadsheet into the request. Accordingly, the limits of the BESR on 4 December 2020 would have been shown as:
- 'ECN5-B – 212.0546 (Laurneckirk [sic](N) > Carmont (S)) to 220.1472 (Carmont (S) > Carmont (N))*
- ECN5-C – 220.1472 (Carmont (N) > Stonehaven (S)) to 226.0689 (Stonehaven (S) > Stonehaven (N))*
- ECN5-D – 226.0689 (Stonehaven (N) > Newtonhill (S)) to 232.142 (Newtonhill (S) > Newtonhill (N))'*
- 71 After some requests were made in the format above, route control staff asked that the asset management team provide only the locations and mileages of the extremities of a BESR area to make the request easier to understand and apply. As a result, the location information for the BESR requested on 3 December 2020 was curtailed by the asset management team to:
- 'ECN5-B – 212.0546 (Laurencekirk) to ECN5-D – 232.1420 (Newtonhill)'*

¹¹ A section of railway without points or junctions.

- 72 The asset management team stated that they believed that the route control staff would modify the place names provided, so that the issued BESR would contain named locations which were easily identifiable by drivers, but the route control staff were not aware of this expectation, or that the ORS sections were not named such that drivers could easily and reliably interpret them. Neither the asset engineer nor the control room staff were aware that the way the names were listed on the spreadsheet, had resulted in a discrepancy between the place name on the notice and the actual place referred to by the mileage (figure 2).
- 73 The BESR notices were issued with the same mileage information and geographical descriptions as on the request from the asset managers, which meant that, although the mileages correctly defined the required extent of the restriction, the named locations did not convey the same information to drivers. Standards¹² require that train drivers are familiar with the names and sequence of railway and lineside features, and the visual cues seen as they approach these. However, drivers are not required to know the mileage of each feature. Witness evidence shows that:
- Some drivers believed that the northern end of the BESR was at the old Newtonhill signal box when it was actually around two miles further north, at the southern end of Porthlethen station, where the railway enters a cutting. This meant the intended BESR extended beyond the limit understood by these drivers.
 - Some drivers believed that the southern end of the BESR was at Laurencekirk when the mileage and the actual requirement corresponded approximately to the beginning of cuttings around two miles north of this location. As a result, OTDR data from the day of the incident shows that some drivers reduced the speed of their trains for this extra distance.

Identification of underlying factors

74 ScotRail had not identified that the formal late notice case process had the potential to be not fully effective for BESRs.

75 ScotRail, as the current franchise holder, inherited the formal process for using late notice cases to notify drivers of emergency speed restrictions from previous franchise holders, who, in turn had inherited it from British Rail. The process is mandated in procedure SOM104¹³ and had been reviewed by ScotRail when taking over the franchise, and in the light of previous RAIB recommendations (see paragraph 102). The review concluded that there were no better means of advising drivers. Ongoing use of the process was considered justified because there were no recorded overspeeding incidents by ScotRail trains in the five years prior to 2020. However, ScotRail also supported efforts within the rail industry, led by RSSB,¹⁴ to review the emergency speed restriction process.

¹² RIS-3702-TOM Management of route knowledge, issue 3, March 2020.

¹³ ScotRail Operational Procedure S.O.M. 104, Management of Train Crew /Train Dispatchers / Station Shunters Reporting For Duty, issue 16, May 2018.

¹⁴ A not-for-profit body whose members are the companies making up the railway industry. The company is registered as Rail Safety and Standards Board Ltd, but trades as RSSB.

76 Staff at Aberdeen and Dundee ScotRail depots posted BESR forms in their late notice cases in the format issued by Network Rail route control. The ScotRail formal process did not require any additional measures to notify drivers and none were implemented at these locations. The additional measures taken at some ScotRail depots (paragraph 55) were local customs and were not reflected in ScotRail's formal procedures. There is no evidence that ScotRail had assessed the BESR form to determine whether it was the best way to convey information about BESRs to its drivers.

77 The railway industry had yet to establish a suitable method for the imposition of speed restrictions in response to extreme weather that has the potential to endanger infrastructure.

78 The Rule Book and Network Rail's NOPs provide the framework within which the TOCs and FOCs disseminate information about speed restrictions using a variety of methods. The framework includes NOP 3.19, which provides ambiguous requirements about when and how drivers would be advised of blanket speed restrictions (paragraphs 62 to 64). In addition to causing inconsistent actions by Network Rail staff, it is also possible that differing interpretations influenced the way in which TOCs and FOCs provided information to their drivers.

79 The various TOCs and FOCs advised drivers of blanket speed restrictions using methods which depend on driver memory to varying extents. In some instances, these relied on drivers seeing a notice at the beginning of their shift and then recalling the information at the relevant parts of their journey. In other instances they provided additional reminders, and some operators provided drivers with documents to carry in train cabs. Although some of these differences reflect differing operational requirements, this does not explain the wide variation in the extent to which organisations relied on driver understanding, memory and recall.

80 The use of late notice cases to provide drivers with information goes back many decades, long before modern technology provided electronic communication, including GSM-R and mobile data. These provide an opportunity to securely and rapidly disseminate information to all relevant stakeholders. The extent to which different TOCs and FOCs have utilised modern technologies, and the way they have done so, varies significantly in ways which do not necessarily relate to differences in operating environments (paragraph 58). The underlying system provided by Network Rail is still based on paper notices, albeit distributed by email.

81 In the future, the rollout and implementation of digital railway systems, such as ETCS,¹⁵ may allow late notice speed restrictions to be communicated directly to the driving interface in train driving cabs, and enforced automatically. However, since it may be decades before ETCS is rolled out to all parts of the network, improved management of weather-related speed restrictions should not await its installation. A recommendation made by RAIB following investigation of an overspeeding event at Sandy ([RAIB report 10/2019](#), see paragraph 96) relates to advising drivers of emergency speed restrictions, and rail industry actions already in hand may also be relevant to blanket speed restrictions (see paragraph 108).

¹⁵ European train control system is the signalling and control component of the European Rail Traffic Management System (ERTMS) which uses trackside equipment to give indications to the driver on a display in the cab.

82 The Intergovernmental Panel on Climate Change has reported¹⁶ that climate change is intensifying the water cycle. This brings more intense rainfall and associated flooding, as well as more intense drought in many regions. In high latitude areas, such as the United Kingdom, precipitation is likely to increase throughout the 21st century. This is likely to lead to an increase in the number of short notice speed restrictions required to keep the railway safe. This reinforces the need to develop reliable methods to implement these. The more frequent intense rainfall is difficult to forecast with accuracy, and coupling of modern communication technology with modern weather forecasting provides a means of implementing speed restrictions only in areas actually (or very likely to be) affected by heavy rain. This would maximise the safety benefit without unnecessary performance impacts.

Observations

83 The example emergency speed restriction form provided in the National Operating Procedure (NOP) and some speed restriction forms developed by routes had shortcomings compared to best practice.

84 RAIB reviewed the following forms, with those applicable to routes outside Scotland being provided in response to an RAIB request for the forms used when implementing a BESR:

- Forms specific to BESRs and relevant to the incident as displayed at Aberdeen and Dundee (shown in figures 4 and 5).
- Forms developed by Scotland Route after the overspeeding incident in December 2020 (shown in Appendix C).
- Forms specific to BESRs as developed for East Midlands, North West, and Western routes (Appendix C).
- Generic emergency speed restriction forms as used in North East route (Appendix C).
- The NOP 3.19 generic emergency speed restriction form - the NOP does not contain a form specifically intended for BESRs (Appendix C).

85 All forms were reviewed by RAIB in the context of their use for BESRs. None fully met human factors best practice (paragraphs 44 to 50) for reasons summarised in Appendix D. To varying extents, all of the forms presented safety critical information in a way which made it difficult for drivers to quickly distinguish this among less important text.

86 Network Rail had not revised the BESR form in NOP 3.19 because it had not identified the form's shortcomings, and was not aware that route control centres had developed their own BESR forms. Guidance from human factors specialists had not been used in the development of the BESR form in the NOP, nor in those developed by the route control centres.

¹⁶ IPCC Working Group I report, 'Climate Change 2021: The Physical Science Basis' 9 August 2021.

Subsequent occurrences of a similar character

Law Junction to Carstairs, 24 February 2021

- 87 A 40 mph (64 km/h) BESR was imposed between Carstairs South Junction and Law Junction from 10:00 hrs on 23 February 2021 to 10:00 hrs on 24 February 2021. This was required because of forecast heavy rainfall in the area and was shown in late notice cases (figure 6). Signallers set up a GSM-R message intended to be broadcast to specific trains when they reached a designated location (the broadcast was intended to be triggered by signalling equipment). There was no requirement for this to be acknowledged by train drivers.
- 88 The broadcasts did not always operate correctly, and, on these occasions, signallers received a 'broadcast failed' message. In response to these, the signallers initially contacted the trains involved and, after the extent of the problem was recognised, stopped and spoke with each driver by radio as their train approached the restriction.
- 89 Three drivers contacted by signallers in response to the 'broadcast failed' message were unaware of the BESR. Examination of OTDR data relating to the speed of these trains within the BESR showed that two reached speeds of up to 50 mph (80 km/h) on falling gradients and the third reached a maximum speed of 78 mph (125 km/h).

Oxenholme to Penrith, 29 March 2021

- 90 A 40 mph (64 km/h) BESR was imposed between Oxenholme and Penrith from 01:00 hrs to 09:00 hrs on 29 March 2021 following a forecast of heavy rainfall. The 04:48 hrs Glasgow Central to London Euston service was identified as having passed through the speed restricted section, which was around 32 miles (51 km) long, without losing any time. If the train had obeyed the speed restriction it is likely that it would have incurred around 25 minutes of delay. Subsequent examination of the train's OTDR showed that the train had passed through the area at maximum permitted speeds varying between 90 mph (144 km/h) and 125 mph (200 km/h).
- 91 The driver had signed-on at Polmadie depot in Glasgow at 03:25 hrs and had been issued with two pages of late notices by their employer; these included the BESR between Oxenholme and Penrith (figure 7). Although the driver signed the receipt on the bottom of the second page, the driver stated that they were unaware of the BESR when met, shortly after the incident, by a driver manager at Preston.
- 92 No GSM-R broadcasts were being used to advise drivers of this BESR. This was normal practice for this part of Network Rail infrastructure at the time of the incident.

NATIONAL OPERATING PROCEDURES

Form: F3.19A
Issue: Scotland
Date: 02/06/18



NOTICE TO TRAIN CREWS – EMERGENCY RESTRICTION OF SPEED

Emergency Blanket Speed Restriction Form:			F3.19A - Scotland	
Route Control	Glasgow	Telephone (Internal)	[REDACTED]	
		Telephone (External)	[REDACTED]	
Speed Reference:	SC6848	Time:	2100	

Line of Route:	SC001	Gretna Jn	Glasgow Central (Via Beattock)
THE FOLLOWING BLANKET EMERGENCY SPEED RESTRICTION HAS BEEN IMPOSED FORTHWITH AND UNTIL FURTHER NOTICE THE SPEED OF ALL TRAINS BETWEEN THE POINTS BELOW MUST NOT EXCEED			

40
 MPH or 20
 Where line speed is lower than 40MPH

Line(s):	ALL								
Location(s):	Carstairs South Jn			to	Law Jn				
Mileage:	73	Miles	303	Yards	to	84	Miles	385	Yards
Reason:	EARTHWORKS RISK SITE								
Duration:	Time:	10:00	Date:	23/02/2021	to	Time:	10:00	Date:	24/02/2021

NETWORK RAIL Acknowledgement:			
Name:	[REDACTED]	Signature:	[REDACTED]
Position:	Ops Controller	Reference time sent:	20:45
<i>Information below to be completed by Recipient</i>			
TOC / FOC / OTM Operator / Stakeholder			
Signature:		Position:	
Date Posted:		Time Posted:	

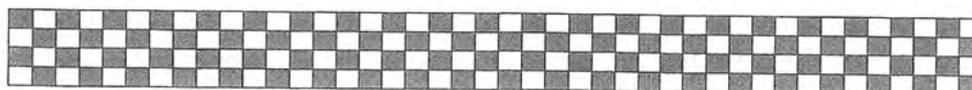


Figure 6: Late notice displayed on 23 and 24 February 2021

LATE NOTICES



AVANTI
WEST COAST

Printed: Monday 29 March, 2021 02:00

CANCELLED SECTION A ITEMS

LNW(N) 51

ITEM 156621 MACCLESFIELD AND CONGLETON

EROS & TSR's

LOCATION	LINES AFFECTED	MILEAGE AT OR BETWEEN		SPEED M.P.H	REMARKS
		M.Ch	M.Ch		
<u>LN3340 ASTON NORTH JUNCTION TO WICHNOR JN</u>					
FINE LANE	UP MAIN	20.67	20.65	<u>30</u>	CYCLIC TOP
<u>MD101 EUSTON TO ARMITAGE JN (EXCL)</u>					
HILLMORTON OHNS AND HILLMORTON JUNCTION	DOWN MAIN	81.03	81.11	<u>50</u>	CONDITION OF EMBANKMENT
HILLMORTON JUNCTION AND HILLMORTON OHNS	UP MAIN	81.11	81.03	<u>70</u>	CONDITION OF EMBANKMENT
<u>NW1001 ARMITAGE JN (INCL) TO PRESTON (FYLDE JN)</u>					
WHITMORE AND HEAMIES BRIDGE	DOWN FAST	142.07	142.11	<u>20</u>	CONDITION OF BRIDGE.
WHITMORE AND HEAMIES BRIDGE	UP FAST	142.11	142.07	<u>20</u>	CONDITION OF BRIDGE.
<u>NW3001 CREWE NORTH JN TO HOLYHEAD</u>					
ROCKLIFFE HALL TUNNEL AND SHOTTON (LOW LEVEL)	UP HOLYHEAD	188.24	188.21	<u>30</u> <u>90</u>	CYLIC TOP.
<u>NW3003 CHESTER EAST JN TO ACTON GRANGE JN</u>					
FRODSHAM JN AND HALTON JN	FRODSHAM SINGLE	1.20	1.13	<u>30</u> <u>40</u>	TRACK DEFECT
<u>NW4001 PRESTON (RIBBLE JN) TO COVE L.C. (INC GOODS LINE UPPERBY)</u>					
QUINTINSHILL TO LOOP JN	UP MAIN	9.78	9.72	<u>50</u>	TRACK DEFECT.
OXENHOLME TO PENRITH	ALL LINES	19.11	51.20	<u>40</u>	BESR - 0001 MONDAY 29/03/21 & 0900 MONDAY 29/03/21 - EMERGENCY INDICATOR AND ASSOCIATED BOARDS WILL NOT BE PROVIDED
<u>NW5009 COLWICH JN TO CHEADLE HULME</u>					
MACCLESFIELD AND CONGLETON	UP STOKE	3.24	4.04	<u>90</u>	CONDITION OF TRACK.
MACCLESFIELD AND CONGLETON	UP MAIN	4.18	5.05	<u>90</u>	TRACK RENEWALS FROM 05:30 TUE 23/03/21. EMERGENCY INDICATORS IN USE.
<u>SC001 GRETNA JN TO GLASGOW CENTRAL (VIA BEATTOCK)</u>					

Version: 5690 (29/03/2021 02:00)

Page 1 of 1

Printed: Monday 29 March, 2021 02:00

Figure 7: Late notice issued to driver on 29 March 2021

Somerton Tunnel to Heywood Road Junction, 5 June 2021

- 93 A 30/60 mph¹⁷ (48/97 km/h) BESR was imposed on parts of the railway between Reading and Cogload Junction from 11:00 hrs to 18:00 hrs on 5 June 2021 due to the possibility of track buckling in high temperatures. A member of staff at Network Rail's route control room noticed that train 1A86, the 11:12 hrs service from Penzance to London Paddington, had not incurred the delay of 25 minutes which would be expected due to the speed restriction. When met shortly after the incident by a driver manager at Reading station, the driver reported that they were not aware of the BESR.
- 94 Great Western Railway issued its drivers with a personal copy of late notices which, on 5 June 2021, covered six sides of paper, printed double sided. When the driver of train 1A86 collected these notices, they had been taken off the printer and placed on an adjacent windowsill. Examination after the incident found that the second sheet, which contained all the information about the BESR between Reading and Cogload Junction, was missing. The driver had not noticed that the sheet was missing when collecting and signing for the notices.
- 95 No GSM-R broadcasts were being used to advise drivers of this BESR. This was normal practice for this part of Network Rail infrastructure at the time of the incident.

Previous occurrences

- 96 RAIB has not previously investigated any incidents involving BESRs, but factors overlapping with those in this report were found in the following investigations which led to recommendations which are presented in paragraphs 102 to 111:
- [RAIB Report 19/2016](#): Overspeed at Queen's Park due to a driver misunderstanding an emergency speed restriction notice and so believing that the restriction applied to a different line from the one on which he was travelling.
 - [RAIB Report 10/2019](#): Overspeed at Sandy South Junction, Bedfordshire, due to a train not slowing for an emergency speed restriction because the train operating company did not provide its drivers with late notices for emergency speed restrictions, and the driver involved in the incident became distracted as he approached the lineside signs.

¹⁷ Where a speed restriction has two values, the second (higher) number is the maximum speed permitted for passenger trains, postal services and light locomotives and the first (lower) number applies to all other trains. The maximum permitted speed for train 1A86 was 60 mph (97 km/h).

Summary of conclusions

Immediate cause

- 97 Some drivers did not reduce train speeds as required by the blanket emergency speed restriction because they were unaware of the restriction or unaware of its exact limits (paragraph 36).

Causal factors

- 98 The causal factors were:
- a. The BESR notice did not convey information in a way that could be readily understood and remembered when drivers needed to apply it (paragraph 39).
 - b. Drivers were not reminded of the BESR after booking-on (paragraph 51). This causal factor arose due to a combination of the following:
 - i. There were no further copies of the BESR notice for drivers to refer to (paragraph 54, action already taken, see paragraph 114)
 - ii. There was no reminder provided to drivers at or near the limits of the BESR (paragraph 59, action already taken, see paragraph 115)
 - c. Geographical locations given on the BESR notice were inconsistent with the mileages over which the restriction was intended to apply (paragraph 66, action already taken, see paragraph 116).

Underlying factors

- 99 ScotRail had not identified that the formal late notice case process had the potential to not be fully effective for BESRs (paragraph 74, action already taken, see paragraph 114).
- 100 The railway industry had yet to establish a suitable method for the imposition of speed restrictions in response to extreme weather that has the potential to endanger infrastructure (paragraph 77, **Recommendation 2**).

Additional observations

- 101 Although not linked to the incident on 4 December 2020, RAIB observes that the example emergency speed restriction form provided in the National Operating Procedure and emergency speed restriction forms developed by some routes had shortcomings compared to best practice (paragraph 83, **Recommendations 1 and 2**).

Previous RAIB recommendations relevant to this investigation

102 The following recommendations, which were made by RAIB as a result of its previous investigations, have relevance to this investigation.

Previous recommendation that had the potential to address one or more factors identified in this report

[Overspeed at Queen's Park, RAIB report 19/2016, Recommendation 2](#)

103 It is possible that implementation of this recommendation by ScotRail would have improved the clarity of the information displayed on the BESR notice and so avoided at least some of the overspeeding on 4 December 2020.

104 This recommendation read as follows:

Recommendation 2

London Midland should review and improve the communication of safety critical information transmitted to its drivers using traditional methods (eg late notice cases) and any transmitted electronically.

The review should include:

- ensuring essential safety information is prominently displayed;*
- ensuring subsidiary information is differentiated from safety critical content;*
- ensuring non-essential information is omitted;*
- considering the use of differing fonts, differing font sizes and colours;*
- considering use of maps or plans; and*
- considering the introduction of a requirement for staff to acknowledge the receipt and understanding of such communications.*

This recommendation may also apply to other train operators.

105 On 6 October 2017, the Office of Rail and Road (ORR) informed RAIB that the recommendation had been implemented. Supporting documentation stated that London Midland had reviewed its processes and made changes to the way safety critical information was displayed. The response does not record whether this presentation included BESR notices.

106 ORR did not report on whether other train operators made any changes to their systems in response to this recommendation.

Recommendations that are currently being implemented

[Overspeed at Sandy South Junction, RAIB Report 10/2019, Recommendations 1 and 2](#)

107 These recommendations, reproduced below, partially address the way in which information about emergency speed restrictions is conveyed to drivers. It is envisaged that the work being undertaken to address these recommendations could assist implementation of recommendation 2 in this report.

Recommendation 1

Train Operating Companies and Freight Operating Companies should review their practice in relation to drivers' prior awareness of emergency speed restrictions. This review should be based on a suitable and sufficient risk assessment, and consider any necessary measures to minimise the likelihood that a driver encountering an emergency speed restriction may not respond correctly to the trackside signs. Any necessary actions should be implemented.

Recommendation 2

Rail Delivery Group, in consultation with Network Rail, should consider and review options for a safe and suitable means of providing drivers with warning of emergency speed restrictions on the route ahead through the use of available technologies.

108 On 31 July 2020, ORR reported to RAIB that train operating companies and freight operating companies have taken Recommendation 1 into consideration and have either implemented it, or are taking action to do so.

109 Following discussions after publication of the RAIB report, it was agreed by appropriate organisations, including RAIB and ORR, that RSSB was the appropriate owner for Recommendation 2. On 31 July 2020, ORR reported to RAIB that RSSB had taken the recommendation into consideration and is taking action to implement it, but a time-bound plan [for implementation] is not yet in place. The status of the recommendation was formally reported by ORR as 'progressing'.

110 In response to the recommendation, RSSB established a programme of work to review the hazards, risks and controls of overspeeding. This work is being undertaken in conjunction with the Train Accident Risk Group (TARG) and RSSB stated that the work comprises two phases. The first phase is to increase industry's understanding of the hazards, risk and controls through the whole process of overspeed management. The second phase is a research project to review what short term technologies could be implemented to help better manage these risks, looking to systems such as radio based limited supervision (RBLs) and ETCS as the medium to longer term controls. The outputs of both phases will support wider work by the rail industry to produce an industry-wide strategy to improve the management of overspeeding by trains.

111 The Sandy recommendation is targeted at locations where lineside signage is normally provided as soon as reasonably practicable, and additional actions are taken to advise drivers about the restriction until these signs are in place. Learning from implementation of this recommendation is likely to assist the new recommendation relating to weather-related blanket speed restrictions, for which lineside signage is not provided and safety depends on advice by other means.

Actions reported as already taken or in progress relevant to this report

Actions reported that address factors which otherwise would have resulted in a RAIB recommendation

- 112 Scotland Route control, in co-operation with representatives from ScotRail driving and control staff, created a new format for BESR notices based on the form in NOP 3.19. This was introduced in late January 2021 and was in use when overspeeding occurred between Law Junction and Carstairs (paragraph 85 and Appendix C).
- 113 An amendment to Section M3¹⁸ of the Rule Book, produced after the accident at Carmont (paragraph 8) and published in December 2020 introduced a section detailing the actions required from signallers when they received reports of extreme weather from control. A further amendment to this section applied from June 2021 and added that these actions could include the use of GSM-R broadcasts which do not have to be acknowledged by drivers.
- 114 As a short-term solution to make its drivers more aware of BESRs, ScotRail has introduced a notice to be displayed at booking-on points when a BESR is in place (figure 8). This is intended to remind drivers that they should have made themselves fully familiar with the content of a BESR notice.



Figure 8: ScotRail BESR booking-on point reminder introduced after the incident

¹⁸ GERT8000-M3 issue 4, Managing incidents, floods and snow, issued 6 March 2021, in force 5 June 2021.

- 115 Network Rail has agreed a process with all of its route control centres for advising drivers of BESRs in which reminders will be provided to drivers by GSM-R broadcasts triggered by the signalling system, a general GSM-R broadcast, or signallers speaking to drivers when they collect the token for authority to enter a single track section of railway. In Scotland, drivers will be stopped, and advised of the restriction, by signallers for the first 12 hours after a BESR has been posted in the late notice case.
- 116 Network Rail Scotland route has reviewed and updated the ORS spreadsheet so that the section limits correspond to places that are recognisable to drivers.

Recommendations and learning points

Recommendations

117 The following recommendations are made:¹⁹

- 1 *The intent of this recommendation is to provide a complete and easily understood template to advise drivers and signallers of emergency speed restrictions. The basis of such a document is currently included within NR/L3/OPS/045/3.19 issue 2.*

Network Rail should review and improve the content and layout of the example Emergency and Blanket Emergency Speed Restriction form. This should include consideration of:

- identification of key information for drivers, other information which should be included and existing content which is unnecessary;
- applying human factors best practice relating to the effective communication of critical information displayed in late notice cases; and
- including a simple diagrammatic representation of the restriction to aid comprehension and make it easier to remember.

- 2 *The intent of this recommendation is to develop reliable and easily understood methods of implementing blanket emergency speed restrictions (precautionary speed restrictions that are imposed over a wide area without the installation of speed restriction warning signs). Implementation of this recommendation may be assisted by work currently being undertaken by RSSB and TARG in response to RAIB recommendations relating to the Sandy South Junction investigation.*

RSSB, in consultation with RDG and Network Rail, should review the methods of implementing blanket emergency speed restrictions. This review should include consideration of how safety critical information can be more reliably disseminated to train drivers, how they can best be helped to remember this information when needed and future alternatives to reliance on the driver's memory. Its scope should include:

- a critical evaluation of all methods that are currently used to disseminate safety critical information to train drivers;

¹⁹ Those identified in the recommendations have a general and ongoing obligation to comply with health and safety legislation, and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail and Road (ORR) to enable it to carry out its duties under regulation 12(2) to:

- (a) ensure that recommendations are duly considered and where appropriate acted upon; and
- (b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 200 to 203) can be found on RAIB's website www.gov.uk/raib.

- human factors best practice relating to the effective communication of critical information;
- the capability of existing railway technology (such as GSM-R radio) as an aid to notifying or reminding drivers of blanket emergency speed restrictions systems, and the potential of future technological developments; and
- the longer-term potential of modern digital train control systems, such as the European Train Control System, to provide a reliable means of slowing down trains on a section of route when required.

The findings of this review, and the solutions identified, should then be communicated to train operators and infrastructure managers in the form of published guidance and recommendations for changes to standards and/or technological systems.

Learning points

118 RAIB has identified the following learning points:²⁰

- 1 These instances of overspeeding are a reminder of the importance of drivers ensuring they have read, fully understood and, if necessary, made a written reminder of, information contained in late notices displayed in late notice cases or communicated to them by other means.
- 2 The lack of clarity in notices concerning speed restrictions demonstrates the importance of organisations ensuring that information used to generate safety critical communications is up to date, accurate and understandable by all its users.

²⁰ 'Learning points' are intended to disseminate safety learning that is not covered by a recommendation. They are included in a report when RAIB wishes to reinforce the importance of compliance with existing safety arrangements (where RAIB has not identified management issues that justify a recommendation) and the consequences of failing to do so. They also record good practice and actions already taken by industry bodies that may have a wider application.

Appendices

Appendix A - Glossary of abbreviations and acronyms

BESR	Blanket emergency speed restriction
ESR	Emergency speed restrictions
FOC	Freight operating company
FMS	Fault management system
GSM-R	Global system for mobile communications – railway
HST	High speed train
NOP	National operating procedure
ORR	Office of Rail and Road
ORS	Operational route section
OTDR	On-train data recorder
RSSB	A not-for-profit company owned and funded by major stakeholders in the railway industry, and which provides support and facilitation for a wide range of cross-industry activities. The company is registered as 'Rail Safety and Standards Board', but trades as 'RSSB'.
TOC	Train operating company

Appendix B - Investigation details

RAIB used the following sources of evidence in this investigation:

- information provided by witnesses
- information taken from the trains' on-train data recorders (OTDR)
- information taken from automatic and manually recorded signalling records
- weather reports
- a review of industry reports
- Network Rail, ScotRail and industry standards and procedures
- a review of previous RAIB investigations that had relevance to this incident.

Appendix C - BESR forms not directly relevant to the incident

NATIONAL OPERATING PROCEDURES	Form: F3.19A
NOTICE TO TRAIN CREWS – EMERGENCY RESTRICTION OF SPEED	Issue: 02
	Date: 02/06/18

NOTICE TO TRAIN CREWS
EMERGENCY RESTRICTION OF SPEED

From Network Rail Route Control Location:	
Telephone No:	BT Telephone No:

To: Train Operators / Freight Operators / OTM Operators / Other Stakeholders
Date:/...../.....

Ref:		Time:	
Route:			

THE FOLLOWING EMERGENCY SPEED RESTRICTION HAS BEEN IMPOSED FORTHWITH AND UNTIL FURTHER NOTICE THE SPEED OF ALL TRAINS BETWEEN THE POINTS BELOW MUST NOT EXCEED	
<input type="text"/>	MPH* <input type="text"/> Differential Speed Restriction OR*

* On ERTMS lines ESR in km/h

Line Down / Up:									
At or Between:									
Mileage:	<input type="text"/>	M	<input type="text"/>	CH	to	<input type="text"/>	M	<input type="text"/>	CH
Reason:									
Comment:									

ACKNOWLEDGEMENT

Network Rail			
Signed:	<input type="text"/>	Position:	<input type="text"/>
Reference:	<input type="text"/>	Fault No:	<input type="text"/>
TOC / FOC / OTM Operator / Other Stakeholder			
* Signed:	<input type="text"/>	* Position:	<input type="text"/>
* Date Posted:	<input type="text"/>	* Time Posted:	<input type="text"/>

* To be completed by Recipient

Figure C1: NOP example form

NATIONAL OPERATING PROCEDURES

NOTICE TO TRAIN CREWS – EMERGENCY RESTRICTION OF SPEED

Form: F3.19A
Issue: Scotland
Date: 02/06/18



Emergency Blanket Speed Restriction Form:			F3.19A - Scotland	
Route Control	Glasgow	Telephone (Internal)		
		Telephone (External)		
Speed Reference:	SCRS725	Time:	1200hrs	

Line of Route:	SC191	DUNDEE	ABERDEEN
THE FOLLOWING BLANKET EMERGENCY SPEED RESTRICTION HAS BEEN IMPOSED FORTHWITH AND UNTIL FURTHER NOTICE THE SPEED OF ALL TRAINS BETWEEN THE POINTS BELOW MUST NOT EXCEED			

40
MPH
or
20
Where line speed is lower than 40MPH

Line(s):	All								
Location(s):	Laurencekirk			to	Newtonhill				
Mileage:	212	Miles	544	Yards	to	232	Miles	1429	Yards
Reason:	Heavy Rain								
Duration:	Time:	0400	Date:	04/12/2020	to	Time:	0900	Date:	04/12/2020

NETWORK RAIL Acknowledgement:			
Name:		Signature:	
Position:		Reference time sent:	
<i>Information below to be completed by Recipient</i>			
TOC / FOC / OTM Operator / Stakeholder			
Signature:		Position:	
Date Posted:		Time Posted:	

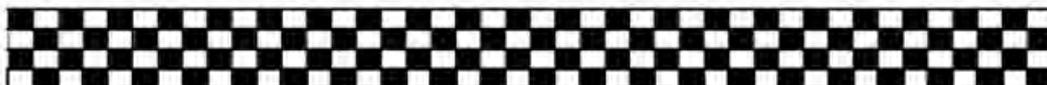


Figure C2: Scotland (post-incident)

From: Route Control Manager
London North East Control

York Rail Operating Centre
Engineers Triangle Leeman Road
York
YO26 4AB



TEST WIRE

18-January-2021 19:01

NOTICE TO TRAIN CREWS EMERGENCY SPEED RESTRICTION IMPOSED

THE FOLLOWING EMERGENCY SPEED RESTRICTION HAS BEEN IMPOSED FORTHWITH, AND UNTIL FURTHER NOTICE THE SPEED OF ALL TRAINS BETWEEN THE POINTS BELOW MUST NOT EXCEED:

40 (FORTY) MPH

Was speed restriction imposed as a result of adverse weather conditions? **Yes**

DETAILS:

Line of Route (LOR): LN854 HALL ROYD JN TO SKELTON JN
 Line: All lines
 Mileage: 37m 47ch and 19m 61ch
 At or Between: Heaton Lodge East Jn and Hall Royd Jn
 Reason: Exceptional Weather Conditions
 Remarks: EMERGENCY INDICATORS WILL NOT BE ERECTED
 APPLIES TO ALL TRACTIONS
 Estimated time of removal 02:00 on the 20 January 2021

Network Rail		TOC/FOC	
Signed:	[Redacted]	*Signed:	
Position:	HOND	*Position:	
Network Rail Ref:	YR21LNE001	*Date Posted:	
TDA No:		*Time Posted:	
FMS No:		*Date and time withdrawn from late notice case:	
CCIL No:			

*To be completed by recipient

END

Figure C3: North East

Network Rail East Midlands Route
EMCC, Derby



To:

NETWORK RAIL LNE & EM SIGNAL BOXES, etc; OTHER NETWORK RAIL ROUTES.
ALL TRAIN OPERATOR USERS OF EM INFRASTRUCTURE.
MAINTENANCE & RENEWAL CONTRACTORS.

**WOULD TRAIN COMPANIES RESPONSIBLE FOR TRAIN CREWS
PLEASE ARRANGE TO DISPLAY THE FOLLOWING IN LATE NOTICE CASE.**

Wire No. 2

**NOTICE TO TRAIN CREWS
BLANKET EMERGENCY SPEED RESTRICTION IMPOSED**

SPC	LN3201 St. Pancras to Tpton Jnc (Via Derby)
------------	---

BESR applies Wednesday 24th June 2020 Between 11:00 & 19:00 hrs

Due to high temperatures affecting the OLE equipment, the following blanket emergency speed restriction will apply to **ELECTRIC TRACTION ONLY** on **ALL lines between the North Portal of Belsize Tunnel and Hendon Station.**

50 (Fifty) mph

Issued at 11:00 on Tuesday 23rd June 2020

THIS NOTICE CAN BE REMOVED AFTER 19:00 HRS on Wednesday 24th June.

END

Figure C4: East Midlands

OFFICIAL

From: **NW&C Region – North West Route – Manchester, Route Control Manager**
 Telephone No [redacted] BT Telephone No [redacted]

To: **All affected operators** Date: **Wednesday 28th October 2020**

NOTICE TO TRAIN CREWS
BLANKET EMERGENCY SPEED RESTRICTION

Depot: Time: **1900 hrs**

Please note some of the lines on route below have a lower maximum permissible speed than 50mph, all boarded TSRs and ESRs lower than 50 mph will supersede this wire

This restriction covers the following routes–

(NW4001 Preston (Ribble Jct) to Cove L.C.)
Between Preston station (0m 0ch) & Shap Harrison's (41m 62ch)

(NW9901 Gargrave to Carlisle South Jct)
Between Settle station (234m 44ch) & Appleby station (277m 22ch)

THE FOLLOWING BLANKET EMERGENCY SPEED RESTRICTION WILL BE IMPOSED BETWEEN THE TIMES AND LOCATIONS DETAILED WITHIN THIS WIRE. THE SPEED OF ALL TRAINS BETWEEN THE POINTS BELOW MUST NOT EXCEED.

50 (Fifty)	MPH OR	[]
-----------------------	-------------------	-----

Has this speed restriction been imposed because of severe or adverse weather conditions? **Yes**

Locations: All lines of route listed above between the locations shown:

Between: **1030hrs Thursday
29th October 2020** **And** **0700hrs Friday
30th October 2020**

Reason: High Risk Earthworks sites - mitigation

Comment: This is a **BESR** & emergency Indicator and associated boards **WILL NOT** be provided

ACKNOWLEDGEMENT

Network Rail	TOC/ FOC
Signed: [redacted]	* Signed: [redacted]
Position: Route Control Manager	* Position:
Network Rail Ref: 0034 BESR	* Date Posted:
TDI:	* Time Posted:
Frame No: N/A	* Date and time withdrawn
CCIL Ref: 2207855	from Late Notice Case:

Figure C5: North West

OFFICIAL



From: Infrastructure Incident Controller, Western Route Control, Swindon



NOTICE TO TRAIN CREWS
BLANKET SPEED RESTRICTION
IMPOSED

Depot* _____ **Issued** Date/Time: 19:30 Friday 4th June 2021

Route(s): **GW500 Reading to Cogload Jn via Westbury and Frome A/LS (only part of route detailed below)**
GW5001 Beechgrove GF (incl) to Westbury South Jn
GW510 Westbury North Jn to Bathampton Jn
GW560 Heywood Road Jn to Fairwood Jn via Westbury

<p>THE FOLLOWING BLANKET SPEED RESTRICTION HAS BEEN IMPOSED ON SATURDAY 5TH JUNE 2021 BETWEEN THE LOCATIONS SHOWN BELOW FOR THE TIME PERIOD 11:00 TO 18:00. DURING THIS PERIOD THE SPEED OF ALL TRAINS MUST NOT EXCEED:-</p> <div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: 80%;"> <p style="font-size: 2em; font-weight: bold; color: red;">30 60</p> <p>MPH OR</p> <p style="font-size: 1.5em; font-weight: bold; color: red;">THIRTY OVER SIXTY</p> </div>

Has this speed been imposed as a result of severe or adverse weather conditions? **Yes**

Lines: **Route GW500 applies between: All Lines Heywood Road Jn and Somerton Tunnel. (95m 45ch to 126m 60ch)**
Route GW5001 applies between: All Lines Westbury South Jn and Beechgrove G.F (110m 07ch to 115m 27ch):
Route GW510 applies between: All Lines Westbury North and Bathampton Jn (109m 49ch to 0m 00ch)
Route GW560 applies between: All Lines Heywood Road Jn to Fairwood Jn via Westbury (94m 45ch to 111m 18ch)

Summary At or between: **ALL LINES BETWEEN BATHAMPTON JN / HEYWOOD ROAD JN / BEECHGROVE AND SOMERTON G.F VIA WESTBURY STATION AND AVOIDING LINES (NOT INCLUDING FROME, WHATLEY & MEREHEAD QUARRY LINES).**

Mileages: **SEE ABOVE**

Reason: **TRACK QUALITY – RAIL TEMPERATURE. DRIVERS ARE REMINDED THAT THEY ARE TO CONTINUE TO REPORT SUSPECTED TRACK DEFECTS IN LINE WITH THE RULEBOOK.**

Comment: **THERE WILL BE NO EMERGENCY EQUIPMENT ERECTED. ALL OTHER MORE RESTRICTIVE SPEED RESTRICTIONS MUST BE OBSERVED.**

Network Rail	TOC/ FOC
Signed _____	* Signed _____

OFFICIAL

Position	Infrastructure Controller	* Position	
Network Rail Ref:	GW491	* Date Posted	
Trust Delay Incident No:	TBC	* Time Posted	
Frame No:	N/A	* Date and time withdrawn from the late notice case	

* To be completed by recipient

Figure C6: Western

Appendix D - Comparison of the content and layout of BESR forms

The following table assesses the readability of the BESR forms intended to be displayed in late notice cases								
	<i>Location at which form is used</i>							
	<i>Incident (Aberdeen) (figure 4)</i>	<i>Incident (Dundee) (figure 5)</i>	<i>NOP (Appendix C)</i>	<i>Scotland (post-incident) (Appendix C)</i>	<i>North East (Appendix C)</i>	<i>East Midlands (Appendix C)</i>	<i>North West (Appendix C)</i>	<i>Western (Appendix C)</i>
<i>B = Special form used for BESRs S = Generic emergency speed restriction form used for BESRs</i>	B	B	S	B	S	B	B	B
<i>Approximate space devoted to information about speed restriction</i>	45%	45%	40%	50%	60%	50%	60%	60%
Shortcomings								
All text same size so critical information does not stand out	✓	✓	✓					✓ a
Colour used (black & white if not ticked)	✓ b	c	d	✓		✓ e	✓	✓ f
Anachronistic language			✓	✓	✓			
Conflicting text					✓ g			
Positive features								
Safety critical information is clear				✓	✓		✓	
Mentions absence of signs on approach to restriction					✓		✓	✓

Notes

- speed is displayed in a large size, but remainder of text is dense and information does not stand out
- red text is mostly the critical information, but excessive use diminishes impact
- printed in black and white at depot
- example content not shown in NOP, some boxes shaded in blue
- text is divided by colour, blue (including yellow highlight) for administrative parts, red and black for safety message, however most of the safety message is red, diminishing impact
- large block of red text detailing affected areas makes it difficult to pick out information
- states restriction 'until further notice' and also includes time restriction ends

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Any enquiries about this publication should be sent to:

RAIB	Email: enquiries@raib.gov.uk
The Wharf	Telephone: 01332 253300
Stores Road	Website: www.gov.uk/raib
Derby UK	
DE21 4BA	