Report arising from the Office of Rail Regulation investigation of a public complaint about the reliability of Bunchrew Level Crossing near Inverness

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Summary

1. This report has been prepared to assist the Procurator Fiscal in consideration of legal proceedings arising from a collision at Bunchrew level crossing, Inverness-shire in May 2008. It arises from the Office of Rail Regulation (ORR) investigation of a complaint made in August 2008 by a number of members of the public about the reliability of the crossing. The complaint alleged that safety at the crossing was being compromised as a consequence of repeated malfunctioning of the crossing equipment over a considerable period and cited the collision as one incident that has occurred.

2. ORR's investigation has confirmed that a relatively high number of incidents have occurred at the crossing. It identified two main types of incident, both related to track circuit operation: spurious activation of the crossing and failure to detect an approaching train. Risk from these types of failures is addressed by the principles of design and operation for automatic open crossings as, in the event of either, the crossing assumes a safe condition closed to either road or rail traffic.

3. Nevertheless the requirement remains for the crossing operator to manage the infrastructure such that the likelihood of any failure is as low as reasonably practicable. This is particularly important as simultaneous failures, of different types, can lead to a train driver being given insufficient warning to stop their train before passing over the crossing. Although the likelihood of the precise combination of circumstances is very low, one such incident took place in August 2008 as a car was about to drive onto the crossing.

4. In response to the incidents and this investigation Network Rail have taken further steps to reduce the likelihood of track circuit failures. We believe the action taken is reasonable and should be sufficient to restore a suitable level of reliable operation. We note however that elimination of track circuit failure is unlikely and confirm the continuing need to ensure the crossing to conforms to design and adopts a safe mode in such circumstances.

5. Our investigation of this complaint has found no evidence to suggest that the crossing failed to operate correctly at the time of a collision between a car and train on 17 May 2008. The findings of the original ORR report into that incident, provided to the Procurator Fiscal on 17 July 2008, are unchanged and not repeated here.

Background

Operation of Automatic Open Level Crossings

6. The level crossing at Bunchrew is of the Automatic Open Crossing – Locally Monitored (AOCL) type. Crossing operation is automatic and independent of the general railway signalling system in the area. To close the road, the road traffic signals and audible warnings are triggered by approaching trains. On each railway approach there is a train driver's red and white light (DRWL) railway signal that indicates to the train driver the status of the crossing, as determined by monitoring equipment built in to the crossing infrastructure.

7. The normal status for an AOCL is for it to be open to road traffic. In this condition the road traffic signals are not illuminated and there is no audible warning for pedestrians. The DRWLs display an intermittent red light.

8. When a train closely approaches the crossing it 'strikes-in' by occupying a particular track circuit. In doing this the train's wheels and axles complete a low voltage electrical circuit between the running rails and the flow of electrical current is detected by the crossing equipment. This causes the cycle to close the crossing to road traffic to begin.

9. First the amber lights in the road traffic signals illuminate and an audible warning for pedestrians begins to sound. After three seconds the amber lights extinguish and the intermittent red lights in each road traffic signal immediately begin to flash.

10. Once the red lights are operating and successful operation of critical components is proved by self-monitoring circuitry at the crossing, the DRWL changes to display an intermittent white light. The white light indicates to the train driver that the protective equipment at the crossing is functioning correctly and the crossing is closed to road traffic.

11. As the train nears the crossing it passes a crossing special speed restriction board. At this point the train driver must check whether a white light is displayed by the DRWL and that the crossing is clear of obstructions. In the event that the crossing is clear and the white light is displayed the train may be driven over the crossing at a speed no greater than that shown on the board.

12. If the white light is not displayed or the crossing is obstructed as the special speed restriction board is reached, the train driver must stop the train short of the crossing. The distance between the special speed restriction board and the crossing

is set such that any train travelling at the maximum permitted speed would be able to stop short.

13. At least 27 seconds should elapse between the start of the amber light phase and the arrival of a train at the crossing.

14. As soon as the train has passed over the crossing it operates a railway treadle mounted adjacent to one of the running rails and 'strikes out'. This extinguishes the road traffic lights and stops the audible warning thereby immediately opening the crossing and minimising delay to road traffic.

Track circuits

15. Track circuits are widely used in railway signalling systems to detect the presence of trains and certain other obstructions on the line. They bring many benefits, but are recognised to be vulnerable to spurious operation in certain conditions. For that reason the design and operation of systems which use track circuits have built-in protection to detect and mitigate the consequences of track circuit failures.

16. At an AOCL the consequences of track circuit failure can be either that the crossing protection does not operate when it should, or that it operates when not intended. The former occurs when for some reason the track circuit does not detect a train either because something is preventing the track circuit from being electrically made or there is a power supply problem; the latter occurs when the circuit is made by something other than a train such as a metal object placed or falling on the track or simply due to electrical contact between the rails via wet sleepers and ballast.

17. The design and operating rules for AOCLs take the likelihood of such failures into account as follows:

- If an approaching train is not detected the crossing will not activate and the DRWL will continue to display an intermittent red light. The train must then stop short of the crossing. It may however then be taken over the crossing at low speed without the road traffic signals and audible warnings operating, once the driver has checked it is safe to proceed. Train drivers are required to report such incidents to the signaller.
- If spurious detection occurs the crossing will activate to close the road. As such operation unnecessarily delays road traffic, AOCLs are designed to auto-reset and reopen the road after a few minutes, as long as no train approaches the crossing. Spurious activation is also undesirable as it may lead to regular users of the crossing being more likely to assume any activation is spurious and jump the lights.

18. Network Rail keeps a record of all reported incidents at its level crossings. It is likely that these records correctly reflect the number of incidents where the crossing has not activated, because these must be reported to the signaller by the train driver. But it is likely that only a proportion of the incidents involving spurious activation of the crossing will be recorded because these need a third party to witness them before auto-reset occurs and then to report them to Network Rail.

The complaint

19. On 12 August 2008 the Office of Rail Regulation received a letter raising concerns about the general reliability of Bunchrew level crossing and identifying four specific instances where the crossing had not operated normally. The letter was written on behalf of a large proportion of the residents of the Bunchrew, Englishton Muir and Kirkton Muir areas.

20. The 4 events identified were:

- 30 August 2007 – a train passing over the crossing without stopping when the road traffic signals were not operating and just as two persons were about to cross in a car.
- October 2007 – road traffic signals at the crossing flashing ceaselessly when no train was approaching.
- 17 May 2008 – a collision between a train and car.
- 2 August 2008 – a failure of the crossing lights and trains passing over the crossing with the road traffic signals not operating.

21. ORR has investigated this complaint by:

- Carrying out an inspection and technical review of the crossing
- Meeting with the complainants to identify as precisely as possible the time and nature of witnessed incidents.
- Reviewing Network Rail's records of the incident history at the crossing and the company's response to fault reports.
- Reviewing the way in which risk at the crossing has been managed in the past and is now being managed.

Findings

General

22. The number of recorded incidents for Bunchrew level crossing is relatively high.

23. The recorded incidents are a mix of public misuse, failure of the crossing to detect and activate as trains approached and spurious activations. They include all the incidents specifically identified by the complainants in the letter and subsequent discussions.

24. The misuse incidents have not been followed up in this investigation. The other incidents were almost all associated with track circuit issues and, with the notable exception of one confirmed incident, risk was successfully controlled by the crossing infrastructure adopting a safe condition in response to each.

Failures to detect

25. The failures to detect an approaching train were caused by loss of the primary battery cell power supply to the strike in track circuits. In August 2007, and again in August 2008 these batteries expired more quickly than expected, and approximately one month before the date at which they were due to be changed. In September 2007 a set of batteries failed just two weeks after installation. Shortly before this Network Rail had changed the supplier of the batteries used at Bunchrew and it is believed that the September 2007 failure was the result of the battery that was installed in August being faulty.

26. The service life for a battery is determined by its rating and the electrical load placed upon it. In normal operation significant load is imposed only when a train is occupying the track circuit – which in practice is less than 30 minutes per day. In conditions where there is electrical leakage, such as from wet weather, poorly maintained track insulation or drainage, there is an additional and perhaps constant load, albeit at a low level and less than needed to trigger operation of the crossing. Any additional load will reduce the service life.

27. Network Rail's battery management regime at Bunchrew assumed a typical AOCL battery drain rate adjusted to take into account known additional problems at Bunchrew that arise from track circuits operating spuriously in wet autumn and winter weather. The regime included three battery changes each year with a longer, six month, interval between changes in summer. This regime proved to be insufficient in Summer 2007 and 2008.

Spurious activations

28. Spurious activations are related to unintended completion of a track circuit which the crossing 'interprets' as a train striking in. It is usually difficult to identify the cause of a specific spurious activation. Causes are often transient and lost as the crossing auto-resets. In such instances the technician records a 'no fault found' entry

and returns the crossing to full service once a successful functional check has been carried out. The response to most of the spurious activations at Bunchrew follow this pattern, although one was traced to a cable fault.

29. The crossing is known to suffer from spurious detection problems as a result of the prevailing weather conditions, the particular nature of the track circuits and ballast conditions. In some cases this can cause intermittent and repeated activation of track circuits, termed 'bobbing'. When bobbing occurs the crossing may remain active for a longer period as the auto reset in effect goes through several cycles.

Simultaneous incidents

30. When spurious activation occurs the crossing will auto-reset after 3 to 4 minutes as long as no approaching train is detected. If a train is detected the crossing will not reset and users will be protected by the traffic signals and audible warnings continuing to operate. However if spurious activation occurs whilst the capability to detect an approaching train has been lost, there is a possibility that the crossing will reset and open to road traffic as a train approaches.

31. If the train has yet to reach the special speed restriction board, the risk will be controlled by the reset reverting the DRWL to an intermittent red light in response to which the driver must stop short of the crossing. However, if it happens after the train has passed the special speed restriction board the driver will brake, but be unlikely to be able to stop short. Anyone attempting to use the crossing at that time will not then be protected by the crossing equipment.

32. At Bunchrew it takes 16 to 21 seconds, depending on direction of travel, for a train travelling at the 50mph line speed to travel between the special speed restriction board and the crossing.

33. The likelihood of such a combination of events happening in such a short time interval is low, but it does appear to have happened for the 30 August 2007 incident raised in the complaint. This emphasises the importance of good infrastructure management to reduce the likelihood of the contributing events such as the track circuit problems.

Causes of incidents raised in the complaint

34. The circumstances of the specific incidents raised in the letter were as follows:

- On 2 August 2008 the battery power supply to a track circuit failed and the crossing did not detecting approaching trains. Trains stopped short and then passed over the crossing in accordance with the rules.

- On 17 May 2008 a northbound train struck a car travelling north at the crossing. The crossing event recorder indicates that the crossing operated correctly. This incident was the subject of a separate report to the Procurator Fiscal.
- In October 2007 there were at least two spurious activations for which it was not possible to identify a cause. Wider experience suggests that these were probably the result of poor rail or conditions or wet formation/ballast conditions.
- On 30 August 2007 the track circuit battery supply failed at the same time as a spurious activation occurred. As a result a train reached the strike in point while the crossing was operating, but was not detected. The crossing was still operating as the train reached the speed restriction board and the DRWL was displaying a white light. However the crossing auto-reset after the train had passed the speed restriction, but before it had reached the crossing. The reset changed this the DRWL to red and the driver braked, but it was too late for the train to be stopped and a collision with a car was narrowly avoided. Had the train been detected the crossing would not have auto-reset.

Action taken by Network Rail

35. Network Rail technicians responded to each of the recorded incidents. The log records that for the spurious activations in most cases no fault was identified and the crossing was found to operate correctly when tested. This is not unusual for such incidents when the cause may be transient. There was one incident however where a damaged cable was found and repaired.

36. For all recorded failures to detect a train the cause was traced to the battery power supplies and the batteries were changed. In each case the batteries were within their expected life and not beyond the normal replacement interval. Apart from the problem with the probably faulty battery, their action successfully resolved the problem until the next six month replacement interval.

37. Following the incident on 2 August 2008 Network Rail have reviewed the arrangements in place at Bunchrew, with particular reference to management of track circuits and the impact on battery life. They have revised the battery such that the maximum interval between battery changes is 13 weeks. Measurements have been taken of the current draw at Bunchrew and used to demonstrate that this frequency is suitable and well within the capability of the batteries as indicated by the manufacturer.

38. Network Rail have now enhanced their management of the track and lineside to reduce the likelihood of false detection and railhead contamination problems. They are also conducting a design review of technical changes to improve the robustness of the track circuit detection system.

39. Network Rail have improved sight lines for road vehicle drivers approaching the crossing to reduce the risk of a vehicles meeting on the crossing itself as a train approaches. Although such an incident is catered for in the operating rules for AOCLs by the requirement for a train driver to stop short of the crossing if it is obstructed, this action addresses a further concern raised by some complainants.

Conclusions

40. The relatively high number of operational incidents at Bunchrew level crossing has been caused by problems with track circuits associated with battery power supply problems and spurious activations.

41. The crossing responded to the failures as designed and the system adopted a safe condition, closed to either trains or road vehicles.

42. A combination of simultaneous spurious activation, failure to detect an approaching train and auto-resetting after a the train has passed the special speed restriction board could result in the train passing over the crossing with the road signal and audible alarms not operating.

43. Network Rail are taking action to improve the reliability of the crossing through an enhanced battery management regime based on local measurements; improvements to the management of the lineside and railhead contamination; and evaluation of technical improvements to the track circuits.

44. These actions are considered to be suitable for reducing the likelihood of train detection failures and the number of spurious activations. In turn this should ensure that the already low likelihood of a combined failure as seen on 30 August 2007 will be reduced further.