| | RSD Internal Guidance | RIG-2013-03 |
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**Braking requirements for type 9B (High ride) Road Rail Vehicles (RRVs).**

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**Keywords**

Road rail vehicle, RRV, type 9B, high ride, braking, runaway, failure to stop.

**Summary**

There have been several serious incidents on Britain's railways involving type 9B (high ride) Road Rail Vehicles where the machines have either runaway during the on/off tracking process or failed to stop on command when operating in rail mode. The incidents have typically involved machines operating on gradients and/or in low adhesion conditions.

These incidents pose a serious risk to workers on the railway who could be hit by runaway machines, causing injuries or fatalities. There is also a risk that these machines could run out of the possession in which they are working and pose a risk to trains operating on open lines.

Type 9B RRVs in standard form when in rail mode rely on the interface between the machine's road wheels and rail wheels to apply traction and braking forces. This design has significant limitations and has been the major factor in the incidents.

The purpose of this RGD is to set out:

a) The risks from type 9B RRVs that has led to the development of the ORR position on braking requirements.

b) The current position and controls across the railway sector.

c) The agreed ORR position on the braking requirements for type 9B (high ride) Road Rail Vehicles (RRVs)

d) The action required by Network Rail Division, Rail Operators Division and ORR inspectors.

**Original consultation**

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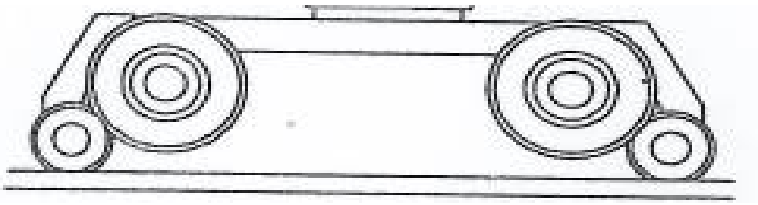
## BACKGROUND

1. In recent years (i.e. since 2004) there have been at least 14 serious incidents involving type 9B RRVs where the machines have either runaway during the on/off tracking process or failed to stop on command when operating in rail mode. The incidents have typically involved machines operating on gradients and/or in low adhesion conditions.
2. These incidents pose a serious risk to workers on the railway who could be hit by runaway machines, and in a worse case scenario could result in fatalities. There is also a risk that these machines could runaway far enough to leave the possession in which they are working and pose a risk to trains operating on open lines, as was the case in the Raigmore runaway incident in July 2010[1].
3. Type 9B RRVs (commonly known as high ride RRVs) in standard form when in rail mode (see diagram & picture below) rely on the interface between the machine's road wheels and rail wheels to apply traction and braking forces.



4. This arrangement in its standard form has two significant limitations:
    a. During on and off tracking if the machine operator doesn't on/off track in the correct sequence (see paras 15 - 19 ) the operator can put the machine into a freewheel state with potential for a runaway incident. i.e. **runaway risk**.
    b. When operating in rail mode the RRV braking performance provided by the road wheel/rail wheel interface is significantly reduced when on steep gradients and/or in wet/low adhesion conditions; and/or when the amount of squash between road and rail wheel is reduced due to tyre wear, tyre pressure, incorrect alignment or incorrect deployment. i.e. **risk of failure to stop.**
5. The type 9B design is used across a range of rail plant e.g. 360$^{O}$ excavator, dumpers, MEWPs dump trucks etc. and all have the same traction and braking limitations.

[1] Details of the Raigmore incident are available in the RAIB report at http://www.raib.gov.uk/publications/investigation_reports/reports_2011/report102011.cfm

Type 9B Excavator

Type 9B Dumper

Type 9B MEWP

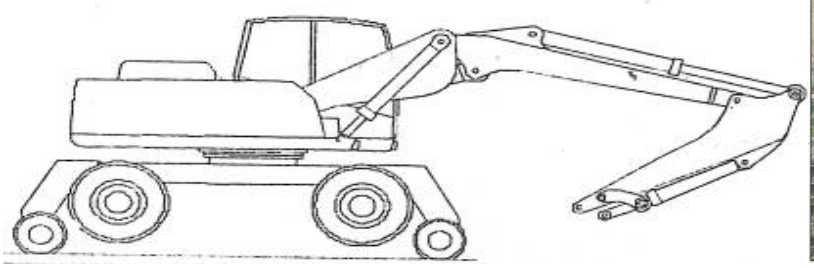
6. There is a variant of the type9B arrangement where an extended hub on the rail wheels provides a much larger and increased friction contact area for the road wheels, these machines have better braking performance when in rail mode but still have the same on/off tracking runaway risk.

Type 9B extended hub drive machines

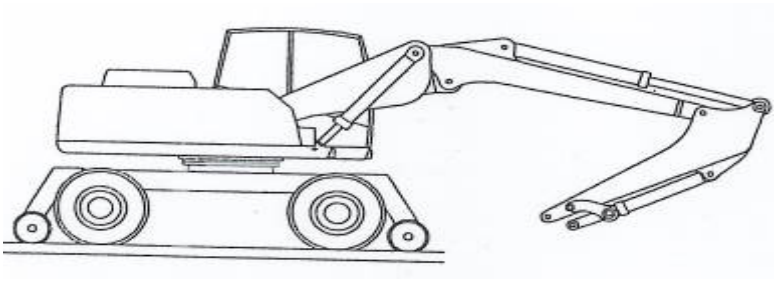
7. The type 9B RRVs are the most common type of RRV in use, however there are other types of RRVs that don't have the same inherent braking issues. These are:

    a. Type 9A (Direct drive) machines which have directly driven rail wheels that provide the traction and braking for the machine.

    b. Type C machines (Low ride) machines where the traction and braking is provided through the vehicles road wheels directly on to the rail head.



Type 9A (Direct drive) Machine



Type 9C (Low ride) Machine

8. It is estimated that there are over 800 machines within the fleet of RRVs available to the rail industry. The vast majority of the machines work primarily on Network Rail infrastructure although a significant number also work on TFL infrastructure. A smaller number operate on light rail/trams systems and heritage railways. Irrespective of where the machines are used, the risks and potential consequences are the same.

9. The current fleet of type 9B machines operating on Network Rail infrastructure consists of approx.

    a. c460 Excavators

    b. c120 MEWPS

    c. c 52 Dumpers

    d. c 6 others e.g. tractors, Unimogs, telehandlers etc.
    Plant hire companies own the majority of these machines who in turn hire them to infrastructure managers and their contractors. Very few are owned by infrastructure managers.

**CURRENT RISK CONTROL POSITION IN THE INDUSTRY**

10. Following the high profile incidents with these machines, ORR has taken action on Network Rail requiring them to put in place a planned programme of work to address the safety issues that are inherent with the standard machine design. The key elements in this work are set out below.

11. The braking issues with the type 9B RRVs have been raised with TFL, light rail, and heritage sectors. These sectors are becoming more aware of the issues and we are encouraging them to control the safety risks in a similar way to machines used on the mainline railway.

12. ORR enforcement action has been a key driver to secure improvements, indicating that the industry has not yet taken full ownership of this risk.

**On/Off tracking runaway risk**

13. To ensure RRVs do not get into an un-braked state during on/off-tracking they need, at all times, to have at least one axle (either road or rail axle) with brakes applied (or

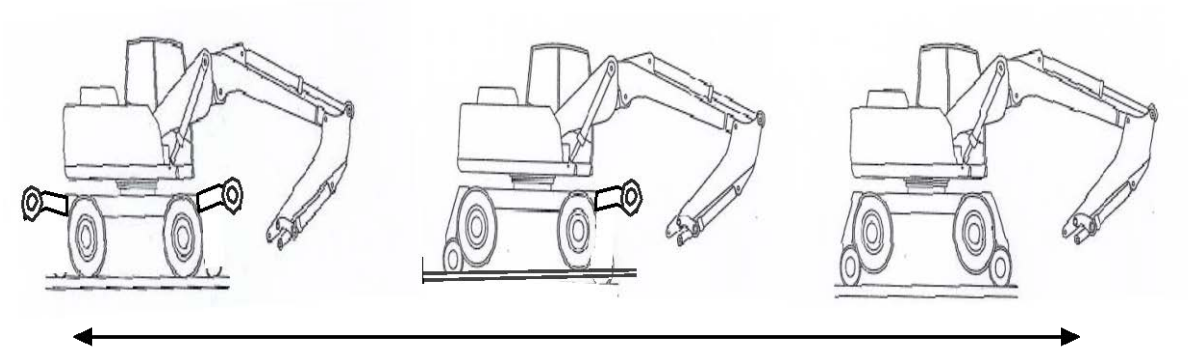
being capable of being applied) in contact with the ground or rail. The braking must be sufficient to hold the vehicle on the steepest gradient on which it can be on/off tracked.

14. The operator must follow a specified procedure to ensure an unbraked state is not created during on/off tracking. The operator must:

    a. fully lower one rail axle (which lifts the respective road wheels off the ground) to ensure rail wheels are in contact with the road wheels and providing braking. During this operation the other pair of road wheels remain on the ground and provide braking.

    b. then fully lower the second rail axle (lifting the second set of road wheels off the ground) ensuring the rail wheels are fully in contact with the road wheels. During this operation, the previously lowered rail wheels that are in full contact with their respective road wheels provide braking.

15. Off-tracking requires the reverse of this.



Correct on/off-tracking procedure

16. To remove reliance on the operator maintaining braking during on/off-tracking, type 9B RRVs should be engineered to ensure a continuous means of braking. This is currently achieved when the machine is manufactured or converted by interlocking the rail axles to ensure one axle is fully lowered and engaged/locked before the other rail axle can be lowered. (Or vice versa for off-tracking). This ensures that at least one braked axle is always in contact with the ground or rail. Typically interlocking is achieved by either electronic controls such as proximity/limit switches or modifications to the hydraulic system.

***Position on Network Rail managed infrastructure.***

17. Rail axle interlocks are currently fitted to all type 9B MEWPs, all type 9B excavators with external emergency stop controls (i.e. those that are also certificated for use on LUL infrastructure), and any type 9B RRV with a RIS 1530[2] engineering acceptance

[2]Railway Industry Standard (RIS) 1530 is the engineering acceptance standard mandated by Network Rail that all Possession Only Rail Vehicles (e.g. RRVs etc) to be used on Network Rail infrastructure have to comply with.

certificate issued after October 2008. Consequently, the population of non-interlocked type 9B machines in use on Network Rail Infrastructure is diminishing as the recertification cycle progresses, but small numbers of non-interlocked machines may still be in use.

18. Alternatively machines may have braking on the rail wheels to ensure that at least one braked axle is always in contact with the ground or rail during on/off tracking.

***Position on other infrastructure***

19. As the risks on LUL are largely the same as the mainline network, and as LUL use largely the same plant supply base as Network Rail we expect that the axle interlocking position will be similar to that of Network Rail.

20. The position with the Light Rail/Trams infrastructure managers is less clear, it is likely that the RRV suppliers will largely be the same as for Network Rail and LUL. We understand that this sector owns a small number of machines. The axle interlocking position with these machines is unknown, but it is likely that risks are controlled by operator competence and operational procedures.

21. Small but increasing numbers of 9B RRVs are being introduced into the heritage sector. Typically Heritage Railways purchase older machines that the mainline railway no longer use; typically these machines are not fitted with axle interlocking systems and risk control will rely solely on operator competence and procedural controls.

**Risk of failure to stop**

22. The industry approach to controlling the risk of failing to stop from type 9B RRVs includes a number of controls as set out below. These have been adopted in differing degrees by infrastructure managers/sectors. Note that whilst risk control was primarily procedure-based, and this remains important, tighter specifications and machinery improvements mean that engineering measures should now provide the primary risk control – see below.

23. Controls in use include:

a. Operator competence

   i. Raising awareness of the risk via information provision through briefings, posters etc.

   ii. Improvements in operator and machine/crane controller training.

b. Procedural controls

   i. Including risk of failure to stop in safe systems of work (SSOW) planning

   ii. Restricting the gradients type 9B RRVs are allowed to operate on. Network Rail has assessed the risks and typically restricts operation on gradients of 1:75 or steeper. (NB this 1:75 cut off includes a factor of safety to help

account for wet conditions).

iii. In conjunction with gradient controls some infrastructure managers have also introduced requirements not to operate type 9B machines in wet weather/low adhesion conditions. These tend to be in the heritage sector where there is more flexibility in track access time.

iv. Use of service braked trailers to provide additional braking.

v. Using of 9A or 9C machines instead of 9Bs.

c. Engineering controls

i. Fitting direct rail wheel brakes (DRWB). Typically these are disc brakes (see photos below) that act directly on the rail wheels and are linked into the machines service brakes so they work as an integrated part of the machines braking system. Currently the majority of DRWB systems are fitted to type 9B excavators. This significantly improves the operational braking performance, and addresses the on/off tracking runaway risk, removing the need for axle interlocks to ensure continuous braking during on / off tracking.

ii. Note Issue 5 of the RSSB Rail Industry Standard for Engineering Acceptance of On-Track Plant and Associated Equipment (RIS-1530-PLT), published in June 2014. This publication provides useful benchmark standards for robust braking performance both at the on/off tracking stages and in service – see:

http://www.rssb.co.uk/rgs/standards/RIS-1530-PLT%20Iss%205.pdf

***Position on Network Rail managed infrastructure.***

24. Following an ORR improvement notice served in March 2011 Network Rail has taken the lead in managing the risk of failure to stop. Network Rail manages the risk using a combination of, operator competence, procedural and engineering controls. They have taken a hierarchy of control approach and are working towards a full engineering control solution. The main current controls in place are:

a. Operator competence –control of on/off tracking runaway risk and failure to stop risks are an integral part of operator and machine/crane controller competence and training process.

b. Machine selection - planners should specify type 9A, 9C and DRWB 9B machines in preference to equivalent standard type 9B machines.

c. Prohibition of all type 9B RRVs on gradients of 1:75 or steeper unless fitted with DRWB or are of the extended hub drive type.

d. Irrespective of gradient only type 9B excavator RRVs fitted with DRWB or of the extended hub drive type are permitted to be used on Network Rail Infrastructure. Network Rail has achieved this position by funding an industry DRWB upgrade programme for 9B excavators.

25. Network Rail is now putting in place arrangements to move to DRWB for all type 9B machines operating on their infrastructure.

***Position on other infrastructure***

26. ORR has been raising awareness in the sectors other than Network Rail of the risks runaway and failure to stop with type 9B machines these sectors are beginning to put controls in place with LUL closely following Network Rail's approach and timescales.

27. LUL have followed a similar route as Network Rail regarding gradient restrictions and DRWB systems. As of 2nd July 2013 LU have confirmed they do not use type 9B RRV without DRWB on the LU infrastructure and have issued an internal prohibition notice banning to that effect.

28. Other TFL dutyholders (DLR and Rail for London) have confirmed that they do not use type 9B RRVs on their infrastructure. (NB The Rail for London East London line is maintained by Network Rail and will be under Network Rail arrangements)

29. The position with the light rail/trams infrastructure managers is less clear but it is likely that the RRVs suppliers will be those that supply to Network Rail and TFL; there may be some machines fitted with DRWB; but on other machines the risk of failure to stop is managed through operator competence and procedural controls. As the gradients on tramways can often be significantly more sever that on railways (up to 12% in Sheffield), the use of RRVs must be carefully planned and risk assessed.

30. Small but increasing numbers of 9B RRVs are being introduced into the heritage sector. Typically heritage railways purchase older machines that the mainline railway no longer use and will not be fitted with DRWB systems. Consequently, risk control in the heritage sector relies solely on operator competence and procedural controls.

**ORR POSITION**

31. To date we have focused on getting improvements with machines used on the Network Rail infrastructure, because Network Rail uses the largest number of these machines. Network Rail is working with RRV manufacturers and machine hirers to develop engineering design solutions to control risk and in the interim has a number of operational and procedural controls in place, including machine selection.

32. We think more can be, and needs to be done by the wider rail industry and suppliers to meet their legal duties regarding self-propelled work equipment. Network Rail through its DRWB programme has demonstrated a reasonably practicable solution for type 9B RRVs and other sectors need to achieve the same level of risk controls for type 9B RRV machines.

33. Specifically

    a. All sectors that use type 9B RRVs must move to a position where braking is fully delivered by engineering means i.e. the provision of a DRWB or similar solution that provides suitable braking during on/off tracking and during operation in rail mode.

    b. Axle interlocking may provide an interim engineering control method (for the runaway risk) but the final position must be the provision of a DRWB or similar solution.

    c. As part of interim controls, we expect infrastructure managers to ensure that there are planning and procedural arrangements in place to reduce the likelihood of a runaway / failure to stop event occurring, and to mitigate the consequences should it occur.

34. Key points:

    a. Braking must be achieved at all times, by effective engineering means (PUWER r28(c));

    b. Reliance on procedural controls to ensure braking must be removed from all sectors over a defined timescale to be determined by sector risk;

    c. DRWB provides an acceptable form of braking; however this does not preclude the use of alternative engineering solutions to deliver a similar level of reliable braking in all conditions.

    d. Engineering control via the axle interlock route may provide part of an adequate interim solution as part of a planned time bound programme to DRWB or similar solutions.

    e. As part of interim arrangements whilst engineering solutions are being

implemented, planning/procedural controls restricting the operation of standard type 9B machines in wet/low adhesion conditions and/or on gradients should be in place.

**ACTION REQUIRED**

**Network Rail Division and Rail Operators Division**

35. Each part of RSD (Network Rail Division & Rail Operators Division) to encourage duty holders to take action bringing them into compliance with the law. In particular:

a. **Network Rail Division** to continue its work with Network Rail to ensure that all type 9B RRVs used on its infrastructure are fitted with DRWB or alternative engineering solutions that deliver a similar level of reliable braking in all foreseeable conditions.

b. **Rail Operators Division**, for each of the sectors it covers (LUL, Light Rail, Trams, & Heritage) to develop and implement plans to a defined timescale that:

i. Achieve the position that all type 9B RRVs used on their respective its infrastructures are fitted with DRWB or alternative engineering solutions that deliver a similar level of reliable braking in all foreseeable conditions.

ii. Have in place appropriate interim controls to manage the risks of runaway and failure to stop from type 9B RRVs whilst engineering solutions are being implemented.

For the Heritage sector two dates have now been set to deliver point (i) above i.e. fitment of DRWB or alternative engineering solution etc. These dates are:

i. From 1 April 2014 no type 9B RRVs new to the Heritage sector shall be brought in to use unless they are fitted with DRWB or alternative engineering solutions that deliver a similar level of reliable braking in all foreseeable conditions.

ii. By the 31 December 2016 all type 9B RRVs being used within the Heritage sector must be fitted with DRWB or alternative engineering solutions that deliver a similar level of reliable braking in all foreseeable conditions.

**Inspectors**

36. Understand the requirements of this RGD and ensure dutyholders they deal with are

taking appropriate action to meet the above ORR requirements through their Divisional arrangements.