# Recommendations for Railway Wheelset Maintenance

## Issue Record

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<td>Two</td>
<td>February 2010</td>
<td>Replaces issue one Small scale change amendment – in GM/RT2466 reflected in 2.7 and 3.2, addition of new recommendation RC163a.</td>
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Amended or additional parts of revised pages have been marked by a vertical black line in the adjacent margin.

## Superseded documents

The following Railway Group documents are superseded, either in whole or in part as indicated:

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<td>GM/RT2496 issue one August 2008 Recommendations for Railway Wheelset Maintenance</td>
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## Supply

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## Recommendations for Railway Wheelset Maintenance

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Part 1  Introduction

1.1 Purpose and structure of this document

This document has been published by Rail Safety and Standards Board (RSSB) to give details of a recommended method which, if followed, would meet the requirements of Railway Group Standard GM/RT2466.

Should an infrastructure manager or railway undertaking choose not to follow the recommended method of meeting the requirements of GM/RT2466 laid out in this document, it should assure itself that the method it is following is as effective, and no less safe, than the method that is recommended here.

Relevant requirements in GM/RT2466 are reproduced in the sections that follow. Recommendations are provided as a series of sequentially numbered clauses prefixed ‘RC’.

Specific responsibilities and compliance requirements are laid down in the Railway Group Standard itself.

This document contains recommendations that are amended under the Railway Group Standards Code (Issue Three) as a small scale change. Reference to the amended recommendations is made in the ‘Issue Record’. All other parts of the document are unchanged from the previous issue.

1.2 Copyright

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1.3 Approval and authorisation of this document

The scope of this document was approved by:

Rolling Stock Standards Committee on 09 October 2009.

This document will authorised by RSSB on 10 December 2009.
Part 2 Recommendations for Railway Wheelset Maintenance

2.1 Requirements for maintenance

GM/RT2466 Railway Wheelsets

4.1 Maintenance plan

4.1.1 All wheelsets shall remain compliant with the requirements, including limits, set out in this document. This shall be achieved through examinations in accordance with a wheelset maintenance plan.

4.1.2 The maintenance plan shall identify all specifications, procedures and processes, including examination, inspection and testing, for wheelset maintenance, which shall be applied at a frequency adequate to ensure that the wheelset is at all times in compliant condition.

4.1.3 GM/RC2496 provides recommendations for wheelset maintenance, in particular requirement for applications in the UK.

2.1.1 Compliance with limits of wear

RC001 Railway undertakings should define as part of its safety management system the means by which the wheelsets are maintained within the specified limits in the maintenance plan.

RC002 The procedures used for the repair / overhaul of wheelsets should be independently assessed and referenced in the maintenance plan for the vehicle. Changes should be reviewed by a technically competent authority and assessed to ensure there is no increase in risk to the original wheelset design.

RC003 Regular monitoring and recording of wheel wear can enable the prediction of maintenance attention and permit economic re-profiling to be undertaken. Such a monitoring method could allow the identification of abnormal wear conditions within a vehicle or fleet of vehicles.

RC004 Alternatively railway undertakings can establish dimensional limits for each wheelset / vehicle combination to ensure that mandatory safety limits of wear, as set out in GM/RT2466, are not infringed between examinations during service operation. Railway undertakings should ensure that the limits are defined in a wheelset database and form part of the relevant maintenance plan.

RC005 The wheelset gauging requirements of Part 4 of GM/RT2466 can be met by the application of systems identified in GM/GN2497.

RC006 All gauges and measuring equipment should be calibrated. When surface texture is specified a stylus type instrument is preferred for measurement, but comparative gauges are permitted as necessary.

2.1.2 Assessment of tread condition

RC007 The most basic method of assessing tread profile condition is to use the flange height and thickness limit gauge. This only identifies when the tread has reached the permitted limits and remedial action is then immediately necessary to restore the tread to an acceptable condition within the permitted limits. Adoption of this method offers very limited planning of wheel remedial attention.

RC008 Railway undertakings should ensure that tread profiles remain within the specified limits for the appropriate profile by regular inspection / measurement of flange height and thickness, as defined in the maintenance plan.

RC009 Appropriate gauges should be used when determining acceptability of the profile. Flange height and flange thickness should be measured as set out in Appendix A of GM/RT2466. Wheel profiles should be rectified before the profile limits are infringed, including the limits for tread roll-over, rim distortion or false flange (see GM/RT2466 Figures 7, 8 and 9).
Recommendations for Railway Wheelset Maintenance

RC010 When inspecting wheel tread condition the wheel diameters should also be checked to ensure that it is maintained within their limits at all times. Checks should be made for unusual wear such as uneven wear across the wheelset and local areas of uneven wear circumferentially around the wheel tread. Tread damage should be assessed in accordance with guidance provided in GM/RC2497 or equivalent document.

2.1.3 Periodic review of maintenance plans

RC011 Maintenance plans should be periodically reviewed to ensure that examination frequencies remain appropriate, particularly if changing conditions in operation occur. The maintenance plan should include a review process that monitors changes in performance of key components to ensure that changes in condition are being addressed by the examination frequencies.

2.1.4 Assessment of other wheelset components

RC012 The wheelset definitions are restricted solely to the axle and wheels in the context of GM/RT2466; however, a wheelset incorporates bearings and possibly axleboxes, brake discs, drive systems and associated bearings, dependent upon the type of wheelset.

RC013 When visually examining the wheelset, other components attached to the wheelset should be examined at the same time; axleboxes, bearings, brake discs, drive systems and associated bearings, suspension tubes, etc.

RC014 These components can have a significant effect on the integrity of wheelsets when in operation. Therefore wheelset examinations should include examination of these components for any unusual conditions that could affect the performance of the wheelset:

<table>
<thead>
<tr>
<th>Component</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axleboxes and bearings</td>
<td>Check for evidence of overheating and discoloured paint.</td>
</tr>
<tr>
<td></td>
<td>Security of bearing retaining rings (as it can damage the wheelset to journal transition).</td>
</tr>
<tr>
<td></td>
<td>Security of attachment to the bogie.</td>
</tr>
<tr>
<td></td>
<td>Evidence of water contamination, particularly when removing the end cover for ultrasonic axle testing (UAT) inspection.</td>
</tr>
<tr>
<td></td>
<td>Loss of bearing lubricant, leaking from seals.</td>
</tr>
<tr>
<td></td>
<td>Noise and vibration emitted from the bearing when rotated.</td>
</tr>
<tr>
<td>Brake discs</td>
<td>Check for cracks.</td>
</tr>
<tr>
<td></td>
<td>Check that the attachment fasteners and mechanism is secure.</td>
</tr>
<tr>
<td></td>
<td>Uneven or excessive braking surface wear</td>
</tr>
<tr>
<td></td>
<td>Deformation of the braking surface.</td>
</tr>
<tr>
<td></td>
<td>Discoloration indicating the disc had overheated caused by brake malfunction.</td>
</tr>
<tr>
<td></td>
<td>Corrosion of braking surface indicating malfunction of brake.</td>
</tr>
<tr>
<td>Integral braked wheels</td>
<td>Cracks in the braking surface.</td>
</tr>
<tr>
<td></td>
<td>Discoloured braking surface.</td>
</tr>
<tr>
<td></td>
<td>Distortion of the wheel due to thermal inputs.</td>
</tr>
<tr>
<td></td>
<td>Wear of the braking surface.</td>
</tr>
<tr>
<td>Drive system, for example final drives, suspension tubes, etc</td>
<td>Bearings rotate freely and smoothly. Drive system is able to rotate freely on the axle bearings (use of train borne or line side monitoring equipment).</td>
</tr>
</tbody>
</table>

Table 1 Component examination
2.1.5 Corrosion protection

RC015 The responsibility for maintaining the integrity and quality of the wheelsets’ corrosion protection system remains with railway undertakings.

RC016 Railway undertakings should ensure the maintenance plan includes examinations to identify damaged coatings and that they are rectified. For example, the maintenance requirement for the protective coatings applied to certain axles is rigorous and requires the wheelset to be removed in the event of damage to the surface coating. This ensures that corrosion of the axle surface does not occur.

RC017 Railway undertakings should have in place procedures detailing the actions necessary to rectify damaged corrosion protection on the axle body.

2.1.6 Change of duty (use)

RC018 When a wheelset is to be subject to a change in duty a documented review of the implications of the proposed changes should be undertaken. The review should assess the risks to the wheelset, track and the interface between the two. Any change of use should not increase the risk of operating that wheelset.

RC019 Before a change of duty is implemented, including where the wheelset is under the same vehicle, all wheelsets fitted to the vehicle should comply with the specified non-destructive testing (NDT) interval in accordance with the applicable NDT procedure for that vehicle.

RC020 The review of the change of duty should include any alterations to the operation or utilisation of the wheelset that would increase the risk or reduce the design life of that wheelset. The change could include, but not limited to, the following:

a) Axle load
b) Route change / mileage
c) Up-rated speed
d) Duty cycle
e) Track forces
f) Change of gearing / tractive effort
g) Transporting of corrosive commodities.

2.1.7 Design or material change

RC021 Where the wheelset design or specification of a wheelset has changed since the original manufacture, the wheelset can be used for the remainder of its life. Wheelsets to a revised design or specifications can be introduced by suppliers of new or repaired wheelsets or via overhaul. A documented review of the proposed changes, including the design, repair, inspection and maintenance should be undertaken to ensure safe operation of the wheelset and vehicle onto which it is fitted, and, as far as reasonably practicable, meet the requirements of GM/RT2466.

RC022 Railway undertakings should establish the standard or specification to be used for the manufacture of replacement wheelsets or components.

2.1.8 Corrosive applications

RC023 Wheelsets that regularly come into contact with materials that contaminate or cause corrosion of the axle should be subject to NDT inspection at a frequency to ensure that defective wheelsets are withdrawn from service. This NDT regime should be maintained, even after change of use to a less corrosive cargo, until the axle is overhauled, stripped of protective coating and subject to magnetic particle inspection (MPI) or similarly sensitive NDT technique.
2.1.9 Old axles

RC024 Old wheelsets were manufactured to earlier standards using materials and processes that produced materials that were not as consistent and reliable as those produced today. These wheelsets will have accumulated a considerable fatigue history during their service lives. Additional inspections should be applied to ensure safety of these wheelsets and minimise risks of continued service operation.

RC025 Wheelsets over 40 years old are permitted only to continue in use subject to continuing to meet the required tests and examinations. The maintenance plan should ensure that the axle is:

a) Subject to NDT at a periodicity half that of similar axles less than 40 years old
b) The axle is identified with an ‘X’ stamped in front of the manufacturing / assembling contractors code
c) The wheelset database is updated to recognise the increased frequency of NDT.

2.1.10 Replacement wheelsets

RC026 Replacement wheelsets should be within the tolerance limits specified for the particular unit / vehicle, compatible with the other wheelsets on the vehicle and to satisfy the requirements of the sub-systems fitted to the vehicle. For example, some diesel multiple unit (DMU) powered bogies, with mechanically linked driven wheelsets across a bogie require a minimal diameter difference between the wheelsets to prevent damage to the drive train. Also, the minimum wheel diameter to be fitted to a vehicle following repair or overhaul is normally specified in the contractual arrangements.

RC027 Replacement wheelsets should have valid NDT certification.

RC028 The NDT certificate validity period of replacement wheelsets should be compatible with the other wheelsets on the vehicle to avoid premature withdrawal from service for NDT inspection.

RC029 Wheelset records should be updated before the wheelset is despatched for overhaul.

2.1.11 NDT

a) NDT inspection

RC030 Wheelsets should be subject to regular NDT as defined by GM/RC2494, recommendations for wheelset design. The NDT periodicity should be specific to the vehicle type, wheelset type and duty.

RC031 NDT of axles should be in accordance with the wheelset maintenance plan.

b) NDT periodicity

RC032 The wheelset NDT periodicity should be recorded in the maintenance plan and wheelset database.

RC033 The NDT periodicity may be either time or distance based but should not be greater than eight years.

RC034 A maximum period between NDT inspections has been identified to ensure that wheelsets with long periodicities between NDT inspections do not develop cracks from corrosion pitting. It is of concern that a vehicle with low utilization can remain in service for a long period of time without NDT examination of the axles, where corrosion is a significant contribution to the initiation of a fatigue fracture.
Recommendations for Railway Wheelset Maintenance

c) Change of NDT periodicity

RC035 Before the NDT periodicity is changed a documented technical review should be undertaken to ensure the risk has been addressed. Such NDT periodicity amendments should be incorporated into the maintenance plan.

RC036 The technical review should consider factors that affect the fatigue life, including, but not limited to, the following:

- Loadings
- Duty cycle
- Axle material properties
- Suspension design
- NDT inspection period
- Fracture propagation prediction
- Defect size
- Probability of detection (NDT method used and flaw detection capabilities).

2.1.12 Examination

a) Examination regimes

RC037 Wheelsets should be examined whenever a vehicle is presented for:

- Wheelset maintenance, as set out in the vehicle maintenance plan
- General vehicle condition examination
- Vehicle repair that affects either the wheelsets, bogies or suspensions.

RC038 Additionally, wheelsets should be examined whenever required by the following:

- Receipt of an incident report, for example rough riding, striking an object, unusual noise, wheel flats, etc
- Report of a wheel load impact detector exceedance
- Activation of a hot box detector
- Brake drag
- Identification of other deficiencies associated with wheelsets, for example identified by High Risk Defect Reports (see GE/RT0250).

RC039 A safety examination should be undertaken for the following reasons:

- Where a defective or damaged vehicle has been identified or reported owing to the potential to affect the safety of its wheelsets
- The vehicle has been stored for a period of time.

RC040 Railway undertakings should have processes for responding to reported wheelset defects, this could include using opportunities to observe and listen for wheelset damage as the vehicle is moved, in addition to visual examinations.

RC041 It is permissible for the scope of an examination to be vehicle or wheelset specific. The examination content should include those elements listed in the examination.
Recommendations for Railway Wheelset Maintenance

Recommendations RC048 to RC057 inclusive of this document that are applicable to the scope of the specific examination being undertaken and all observations recorded.

**RC042**
To undertake safety examinations and in particular wheelset examinations, adequate access to the wheelsets is required. Service points generally have insufficient access to undertake safety examinations, so the vehicle should be moved to a suitable location.

**RC043**
The levels at which actions are taken should be defined with the appropriate action in the wheelset maintenance plan.

**RC044**
When the vehicle has been involved in an incident likely to have caused severe tread damage, the brake equipment and wheel tread should be examined for damage and appropriate action taken to rectify the damage, in accordance with the maintenance specification.

**RC045**
Defects identified in the bogies and suspensions could have resulted in damage to the wheelset or, conversely, resulted from a defect on the wheelset. It is essential that not only is the defect rectified, but also that associated components and equipment should be examined for consequential damage. Table 2 identifies possible defects and consequences.

<table>
<thead>
<tr>
<th>Defect</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tread damage, ovality, flats</td>
<td>Suspension damage, springs, dampers, pivot bushes, axlebox structural damage, bearings, wheel slide protection installations, drive mechanisms, gearcases and suspension tubes. Seized traction motor / final drive gearbox.</td>
</tr>
<tr>
<td>Loose / broken safety straps or component that can fall onto the wheelset</td>
<td>Damage and scoring of the axle or other component.</td>
</tr>
<tr>
<td>Loss of motor bogie axle protective cover</td>
<td>Scoring of the axle by debris being retained in space between axle and motor</td>
</tr>
<tr>
<td>Loose / defective bearing retaining rings</td>
<td>Damage and scoring of the wheelset to journal transition and contamination of the journal bearing.</td>
</tr>
<tr>
<td>Defective current return brush</td>
<td>Scoring and damage to brush track.</td>
</tr>
<tr>
<td>Defective equipotential bonding and traction return connection</td>
<td>Bearing damage, overheating and potential failure.</td>
</tr>
<tr>
<td>Seized brake mechanism</td>
<td>Overheated brake disc or brake drag, moved wheel / tyre.</td>
</tr>
<tr>
<td>Defective primary damper</td>
<td>Rough riding.</td>
</tr>
<tr>
<td>Defective suspension location</td>
<td>Unusual wear pattern on the wheel tread, high flange wear.</td>
</tr>
<tr>
<td>Loose balance weights</td>
<td>Damage to the wheel, cracks in the wheel.</td>
</tr>
<tr>
<td>Loose bearing end caps</td>
<td>Bearings become loose, subsequently overheat and fail in short period.</td>
</tr>
</tbody>
</table>

**Table 2** Defects and consequential damage

**RC046**
Where a tyred wheel has been subject to a dragging brake or the tyre is believed to have moved, the wheel should be examined as set out in IB/TP0001. The white lines across the tyre / wheel centre interface are used to identify whether the tyre has moved on the wheel centre. If the line is displaced circumferentially across the interface, then the tyre has moved. Railway undertakings should have in place a procedure for dealing with moved / shifted tyres, defining the actions that are to be taken following identification.
Recommendations for Railway Wheelset Maintenance

Failure to address the defect can result in loss of the tyre and derailment of the vehicle. Examination of defective components should consider other attached and associated components and the effect that the observed defect could have on their condition and future performance.

RC047 Wheelsets observed with cracks, damage, overheating, thermal crazing, wear, movement of an interference fit or other deficiency should be assessed by measurement or gauging, as set out below, to determine whether the limits specified in GM/RT2466 have been infringed.

b) Wheelset examination key tasks

RC048 The following is a list of examinations and inspections that should be undertaken on the wheelset as required for continued safe operation. These tasks are to be undertaken with the wheelset in its assembled state. Disassembly of the wheelset is not necessary, other than where removal of the axle end cover is required.

RC049 The list includes a range of inspections to be undertaken in the assessment of wheelset condition and conformance with the limits specified in GM/RT2466.

c) General examination requirements

RC050 The wheelset should be examined for integrity, including but not limited to:

a) Corrosion anywhere on the axle, wheel (other than the tread) or wheel centre.

b) Damage anywhere on the axle, wheel or wheel centre. This can be in the form of scoring, burrs, raised edges, sharp indentations, impact marks or fretting.

c) Tread damage and flats.

d) Any signs of overheating anywhere on the wheelset.

e) Cracks in the axle, wheel or wheel centre. Thermal crazing and rolling contact fatigue cracks in the centre of the tread surface should not exceed the requirements of the appropriate maintenance specification. Tread conditions in excess of the criteria will be rectified by re-profiling.

f) Any sign of movement at interference fit interfaces.

g) Where there is reason to suspect that dimensions are at variance with requirements, check that relevant dimensions are within limits:

i) Back-to-back dimension, measured at axle height and at three equi-spaced locations around the wheelset

ii) Wheel tread diameters

iii) Wheel tread diameter difference.

RC051 Checks for damage to, or missing, oil injection hole plug.

d) Axle examination

RC052 The axles should be examined for, but not limited to, the following:

a) Flame cutting damage, weld spatter or electric arc damage

b) Integrity of the axle surface coating

c) Damage to axle end threaded holes, when the holes are exposed for reasons other than the visual inspection
d) Raised edges to axle end faces, indentations, depression, poor surface texture or grooves that may hinder UAT. This examination need only be carried out when the axle end face is exposed for reasons other than the visual inspection and when the NDT policy includes UAT.

RC053 Where the examination identifies deficiencies in the axle condition, then measurements should be undertaken to confirm the extent of defects, such as axle body run-out, surface texture, back-to-back, etc.

e) Tread examination

RC054 Where the visual inspection of the tread profile suggests that it is worn or damaged, railway undertakings should:

a) Examine for, and measure, tread damage, flats and cavities
b) Measure or gauge tyre / rim thickness
c) Measure or gauge flange thickness and flange height
d) Measure or gauge flange toe radius and examine for sharp flange features
e) Measure or gauge flange angle or flange angle dimension (European system of measurement)
f) Examine the profile for grooving, false flange, flange step etc to ensure they are within allowable limits.

f) Tyred wheel examination

RC055 The tyres should be examined for security and integrity, including:

a) Checks for evidence of movement between the tyre and wheel centre, (disturbed or cracked rust / dirt / paint between wheel centre / retaining ring / tyre, polishing at the interface, slivers of metal close to the interface)
b) Checks for cracks in the tyre
c) Checks for damage to the retaining ring
d) Where there is reason to suspect that the tyre has moved, checks with a feeler gauge that the clearance between the tyre snip and the wheel centre rim is within limits
e) Checking the clearances between the inside vertical face of the tyre and the retaining ring and between the retaining ring and wheel centre to ensure that they are within limits*
f) Checking that the retaining ring ends are not separated by more than the allowable gap and that there is no make-up piece in the retaining ring*.
g) Check integrity of electrical continuity bonding (resilient wheels)

RC056 The items marked with * in RC055 e) and f) should usually only be applied at repair or overhaul when the wheelset is dismantled.

g) Other components

RC057 Examine other components attached to the wheelset (for example axleboxes, gearboxes, final drives, suspension tubes, brake discs etc) for damage, cracks, oil leakage and other problems.
2.2 Wheelsets off vehicle

GM/RT2466 Railway Wheelsets

4.2 Handling and care of wheelsets

4.2.1 The requirements for handling and care of wheelsets are set out in 3.8 of this document.

(3.8.1 Wheelsets which are not in service under vehicles and wheelset components prior to assembly shall be protected, stored, handled and transported in a manner which is not detrimental to the wheelset / component life. Guidance is set out in GM/GN2498.)

2.2.1 Handling and care of wheelsets

RC058 The handling and storage of wheelsets is crucial to their subsequent safe operation in service. Industry best practice is published in GM/GN2498. A railway undertaking’s safety management system should include reference to how the requirements are to be implemented.

RC059 When a wheelset has been assembled or when an overhaul or repair has been completed a durable label should be attached to the wheelset. The method of attachment should be secure and avoid damaging the wheelset or its protective coatings.

RC060 The label(s) should clearly show the following information:

a) Contractor’s identification
b) Wheelset catalogue number, where applicable
c) Wheelset serial number (axle unique number)
d) Overhaul / repair date
e) UAT date or other NDT date
f) UAT / NDT operator(s) name(s)
g) Warranty expiry date if applicable
h) Axle bearing manufacture date *
i) Axle bearing overhaul date *
j) Axle bearing fitting date *
k) Axle bearing serial number *

(* NOTE: for both bearings on the axle).

(1) NOTE: not applicable where only new bearings fitted).

RC061 Wheelsets with defects that have been removed from service should be placed in quarantine, labelled with the details of the failure and identify whether further action is necessary: investigation, repair, overhaul or scrap. The means of identification should include labelling and a red band around a NDT failed axle. The method should be documented and understood by all involved in managing wheelsets. The label should clearly show the following information:
Recommendations for Railway Wheelset Maintenance

a) Catalogue or part number
b) Wheelset serial number
c) Reason for removal from vehicle
d) Requirements for particular tests or examinations
e) Estimate of miles run since the last NDT examination.

RC062 Where railway undertakings requires a specific response this should be clearly stated on
the attached label. If a special investigation is requested the requirements should be
stated on the label.

2.2.2 Wheelset condition assessment

RC063 Where a railway undertaking requires a specific wheelset examination the wheelset should
be placed into quarantine and clearly labelled to ensure there is no risk of being returned to
service or scrapped prior to investigation. The quarantine storage should provide sufficient
protection from the elements to prevent further deterioration of defective and damaged
components that would prejudice the investigation. All associated parts relevant to the
investigation should be kept together prior to examination. Wheelsets in quarantine should
not be cleaned until:

a) A visual inspection has been carried out
b) The repair / overhaul procedure has been agreed by the railway undertaking.

RC064 Railway undertakings should ensure that the contractor has the correct information to use
for the overhaul / repair of the wheelset, including relevant specifications and drawings,
before any work commences. If there are differences between the wheelset and the
relevant drawing, then railway undertakings should require the repairer or overhauler to
ensure that there is no safety degradation as a consequence. A technically competent
authority should be consulted if there is any doubt. Communications can be through a third
party in the supply chain for wheelset repair / overhaul. Where a difference has been
identified between the wheelset and drawing, railway undertakings should ensure there is
no reduction in the level of safety and, where necessary, confirmation obtained from a
technically competent authority.

RC065 Railway undertakings should label the wheelset and advise the repairer / overhauler of the
requirements for special investigations, before work commences. It is important that
feedback is provided to railway undertakings and the maintenance staff to confirm or
otherwise the presence of a defect. The presence of defects should be recorded on the
appropriate system or database, including defective axles.

RC066 The visual examinations as listed in 2.1.12 of this document can be used as a guide but
should be adjusted with experience of particular fleets and vehicles.

RC067 Prior to repair or overhaul wheelsets should be visually examined before cleaning or
dismantling. This examination should include all of the aspects listed in 2.1.12 of this
document. Where there is any sign of movement of interference fits, any cracks are found
or the examination indicates that other factors are outside the limits set out in GM/RT2466,
then the wheelset should be subject to overhaul.

RC068 The objective of the examination is to confirm, or otherwise, that the wheelset is safe to be
used in service.

2.2.3 Cleaning

RC069 Before overhaul, and where required for repair, the wheelset should be cleaned by a
method which is not detrimental to the wheelset or attached components and which does
not hinder any tests which may be required. To prevent damage from cleaning materials,
bearings and other wheelset components should be protected and apertures sealed.
Washing sprays should not be directed at the axlebox / bearing assemblies or seals.
Where it is believed that contamination has occurred, then appropriate remedial action should be applied to the components.

RC070 Damaged protective surface coatings on the axle body should be rectified. Where the axle and wheelset component protective coating has suffered significant damage then consideration should be given to removing the whole surface coating. Otherwise the surface coating may only be removed where required by the proposed testing procedure.

RC071 Damaged protective surface coatings can produce localised pitting corrosion and also allow corrosion to propagate beneath the coating. Axle fatigue fractures can initiate from surface corrosion; therefore, to minimise this risk the whole of the damaged surface coating should be removed for examination and any damage rectified.

2.2.4 Tread measurement

RC072 Flange height and flange thickness should be measured, as shown in Appendix A of GM/RT2466. Where there is any false flange, tread roll-over or rim distortion (see Figures 7, 8 and 9 in GM/RT2466) remedial action should be taken as set out in this document and in accordance with a validated procedure. Wheelsets with damage and wear that exceeds the limits set out in GM/RT2466 will require remedial action in accordance with the requirements set out in this document.

RC073 The wheel tread should be inspected to assess damage, wear, flange height and thickness measured using appropriate gauges. Defective or worn treads should be re-profiled provided adequate material remains in the turned wheel. The minimum wheel diameter to be fitted to a vehicle following repair or overhaul is normally specified in the contractual arrangements.

2.2.5 Prohibited processes

RC074 The application of certain processes is prohibited on wheelsets. Where there is evidence that any of these has been applied to a wheelset, then that wheelset should be removed from service and sent for overhaul, identifying on the wheelset the cause of rejection. The following processes should be prohibited at all times:

a) The use of power tools on an axle or component or any part of the wheelset which is 'ready for assembly' or at any time other than as part of an approved process

b) Welding, brazing or other thermal process, except where it is set out in a validated procedure

c) Action which would cause flame cutting debris or weld spatter to fall on a wheelset or component

d) Attachment of an electrical connection or current return, not allowed for by the wheelset design, other than those needed to carry out MPI or welding using a validated procedure or electrical resistance testing

e) Use of any tool which could cause notches, other than in accordance with a validated procedure, pits or other markings on the axle or wheelset components

f) The application of grease to axle and suspension tube bearings to any extent prior to testing for smooth rotation

g) Any action which could have an adverse effect on the safety of the wheelset

h) Hand grinding to remove sharp flanges except to facilitate recovery of the vehicle.

RC075 Repairs undertaken on a vehicle can have detrimental effects on the wheelsets. Where damage is identified, the wheelset should be removed from the vehicle and sent for repair / overhaul. The following identifies some of the processes and types of damage that can occur:
Recommendations for Railway Wheelset Maintenance

a) Welding or grinding splatter and sparks can damage the surface of the wheelset causing localised imperfections on the material surface that could subsequently develop into a fracture.

b) Processes accidentally or inappropriately applied to the wheelset that would mechanically or thermally affect the wheelset should be prohibited in the vicinity of wheelsets unless adequate protection can be provided to prevent damage.

c) Any electrical welding of a railway vehicle should have adequate electrical return current bonding to prevent electrical current passing through the wheelset and bearings. Electrical current can damage the bearing surfaces that could subsequently fail in service. The return current from electrical welding in adjacent vehicles can pass through the coupling and inter-vehicle jumper arrangements to earth, so damaging the bearings of attached vehicles.

2.2.6 Traceability

RC076 The wheelset and its components should be traceable throughout the repair / overhaul. Systems are to be in place to ensure the correct processes are applied and demonstrate the work has been correctly and competently undertaken. Completed wheelsets should be suitably labelled.

RC077 The label(s), including its method of attachment, should not damage the wheelset or the surface coating. Consideration should be given to the properties of any material that is fitted between the label and the axle body. Moisture can become trapped at the interface or absorbed by the material and lead to corrosion at imperfections or damage in the corrosion protection system.

2.3 Repair / overhaul requirements

2.3.1 Inspection of axle when stripped of components

a) Axle seat damage

RC078 Axle seats should be free of all scores, burrs, sheared metal or excessive depth which could act as a crack initiator, cause loss of oil injection pressure or cause suspect defect on ultrasonic examination. It is permissible to machine imperfections out of the axle where it can still meet relevant dimensional limits. Rectification of such defects should be in accordance with an appropriate procedure.

b) Axle damage

RC079 Damage to the axle surface can lead to the initiation of fatigue fractures. The axle should be free of surface damage and imperfections resulting from the following:

a) Weld spatter – causing small imperfections in the surface that cause irregularities and stress concentrations.

b) Electric arc damage – can result in local high thermal gradients sufficient to transform a small area of the surface to martensite, a hard, brittle phase of steel that can form cracks during cooling and subsequent operation that can develop into fatigue fractures.

c) Sharp indentations – that can form a stress concentration at the axle surface and initiate fatigue fracture.

d) Circumferential damage – scoring around the axle.

e) Copper penetration – caused by overheated plain bearing where the copper from the bearing has migrated into the steel micro structure during elevated temperature, will probably require metallurgical examination to confirm.
c) Axle corrosion

RC080 In assessing axle corrosion the extent and depth shall be taken into account. All corroded areas shall be subject to a special inspection by MPI, or equivalent technique, and where cracks are indicated the axle shall be dealt with by an appropriate procedure or scrapped.

RC081 For axles which are to be protected by a surface coating, even where MPI or an equivalent technique shows that the axle is clear, the corrosion shall still be unacceptable where it:

a) Is located in any transition area
b) Is concentrated at a particular point, that is a corrosion pit, particularly where it has a ring of red/brown staining
c) Is greater than 1 mm deep or longer than 30 mm circumferentially or 50 mm axially
d) Cannot be removed by polishing up to 1 mm deep

d) Axle dimensions

RC082 The axle should meet all dimensional requirements given in the applicable specification, including convex corner radii on seats.

e) Axle run-out

RC083 The axle body run-out, see Figure 1, should not exceed the maximum value for new wheelsets set out in the respective standard; BS 5892, Part 1 or BS EN 13261 or AAR wheelsets shall be checked in accordance with rules 1A12 and 1C2 of AAR Manual of Standards and Recommended Practices Section G – Part II. Where the limits are exceeded the axle should be scrapped or recovered.

RC084 The datum for the run-out is the bearing journal surface. Where the limits are exceeded the axle should be scrapped or recovered by means of approved processes.

2.3.2 Axle end flatness

RC085 The axle end flatness and surface condition can have an influence on the reliability of UAT. Therefore, it is important that the axle end faces are flat with no burrs, free of indentations, sharp edges or grooves in the surface, other than permitted identification. The axle end is to be normal to the axle centre line. It is permitted to use oilstone to remove burrs and sharp edges.

RC086 The surface condition of axle ends has typically been manufactured and maintained to the following:

a) Surface texture of the end face less than 3.2 \( \mu \)m
b) Flatness / run-out of end face less than 0.08 mm

and where the end face is re-machined to accommodate an axial thrust pad the surface texture has typically been reduced to a value less than 0.8 \( \mu \)m and the complete geometry of the axle end should be reinstated.

2.3.3 NDT of partially stripped axles

RC087 At overhaul all solid axles that have been partially dismantled should be subject to MPI or equivalent technique, as set out in 4.22 of GM/RT2466. Where an axle is partially stripped for overhaul, there could be occasions where components remain in positions that cause difficulty in the application of suitable NDT techniques. Consideration should be given to the benefits that can be gained by completely stripping the wheelset to achieve MPI of the complete axle.

RC088 The earth return track of partially stripped axles should be examined. Refer also to 2.4.2 of this document.
Recommendations for Railway Wheelset Maintenance

2.3.4 Management of defective axles

RC089 Where cracks, damage or corrosion infringe the limits as set out in GM/RT2466 3.3.1.5, and recommendations in 2.3.1 and 2.10.1 of this document and the appropriate specification, the wheelset should be repaired, overhauled or scrapped. Wheelsets with defects exceeding the permitted criteria should be clearly labelled and retained in quarantine until remedial action is taken. When an axle is to be scrapped it should be dealt with in accordance with 2.3.5 of this document and the journal surface should be mutilated so that it cannot be used, reclaimed or repaired.

2.3.5 NDT of defective axles

RC090 Before a defective axle is to be mutilated and scrapped it should be subject to NDT. The objective is to determine the proportion of the axle population being scrapped for fractures, the fracture origin and whether there are any trends in the failure rate or detection methods. Where the defect is greater than a specified size the axle should be subject to further metallurgical examination. This requirement has been included as a recommendation of the Rickerscote enquiry.

2.3.6 Minimum attention

RC091 The minimum attention for any wheelset should be:

a) Visual examination, as set out in 2.1.12 of this document
b) Wheelset dimensional check (including tread profile, wheel diameter and back-to-back dimension) as set out in 2.1.12 of this document
c) NDT inspection and results recorded, as set out in 2.10 of this document
d) Remedial attention to any previously recorded defects and those found by a), b) or c) above. In particular, where the wheelset back-to-back dimension falls outside the acceptable range, both wheels or wheel centres should be changed unless one wheel is clearly distorted.

RC092 Where the defects found cannot be rectified by an approved repair, the wheelset should be overhauled.

RC093 These recommendations identify the minimum attention that should be given when a wheelset is repaired, excluding re-profiling. The objective is that the wheelset is returned to a condition that will allow it to operate safely for the remainder of its service life.

2.3.7 Recovery of axles

RC094 Where allowed by the design, it is permissible to skim an axle to remove shallow surface damage, corrosion and cracks. The axle should be subject to MPI, or equivalent technique, after machining to determine that there are no residual defects.

RC095 The rectification of longitudinal defect is permissible in accordance with the respective standard: BS 5892, Part 1, sections B3 and B4 or or BS EN 13261 or AAR standard. Rectification should be undertaken in accordance with a procedure approved by a technically competent authority. After rectification, the axle should be subject to MPI or equivalent technique to demonstrate it is free of defects. Axles having unacceptable longitudinal defect should be scrapped.

RC096 Rectification of axle defects should be limited such that there is no adverse effect on the axle design life.

2.4 Examination of wheelset components

2.4.1 Examinations

RC097 The condition of other components attached to the wheelset, such as axleboxes, brake discs, suspension tubes, etc, should be assessed when the wheelset is being examined, where there is an effect on the wheelset performance.
Recommendations for Railway Wheelset Maintenance

**2.4.2 Bearing examination**

**RC099** Where the axlebox is not being removed during repair the bearing should be examined for freedom of rotation, excessive end-float, unusual noise and integrity of seals, etc by personnel competent to assess the condition of axle journal bearings whilst in situ on the axle. Where a defect is identified, the axlebox and bearing is to be removed and the assembly overhauled to a validated procedure. Defective bearings should be investigated to ascertain the nature of the defect, recording the results.

**RC100** Plain bearings reported as having run hot should be examined to ascertain whether there has been copper penetration into the journal. If copper penetration is suspected then the axle should be scrapped.

Copper penetration occurs along the grain boundary where the copper molecules can relatively easily migrate. The propagation of copper into the axle steel is comparatively quick at the elevated temperatures that would be experienced with an overheated bearing; it has been predicted that copper could theoretically propagate through a journal section in about 30 minutes. This rate of penetration could see a significant depth of copper propagation in a short period. At normal operating temperatures, copper does not penetrate into the journal material. As the copper penetrates along the grain boundaries the visible area on the material surface is very small and would require etching to be sure of identification, such a process would not normally be available in a workshop environment. The copper forms a disruption along the grain boundary that weakens the material and can lead to subsequent failure. An American report of an investigation of axles with copper penetration indicated that approximately 70% of axles failed when returned to service. Since the identification of copper penetration is difficult and the depth of penetration could be significant, axles with copper penetration should be scrapped.

**RC102** Copper can be beneficially used to form the track for earth return brushes. In normal operating conditions the copper track does not increase the risk of copper penetration because there is insufficient thermal energy in the material to cause migration of copper molecules into the axle steel.

**2.4.3 Component security check**

**RC103** Where components, such as brake discs, gearwheels and suspension tubes, etc. are not to be removed as part of the repair or overhaul procedure, they should be checked for security, integrity, damage and defects. Fasteners normally remaining in position may have samples removed to assess corrosion that would otherwise be hidden. Any problems should be dealt with using an applicable procedure.

**2.4.4 Check for cracks in wheels**

**RC104** When accessible, the wheel web and wheel web holes should be inspected for corrosion, cracks and damage, in particular those wheels that are known to be susceptible to fatigue fractures of the web. These can frequently be initiated from features such as holes in the web and the point of initiation can be damage or an imperfection in the surface. Fractures in the web can run circumferentially around the wheel web.

**2.4.5 Wheelset tread profile requirements**

**RC105** When a wheelset is re-profiled the limits for re-profiling should be specified by railway undertakings but they are not to exceed the limits set out in GM/RT2466, including tread run-out, wheel wobble, diameter difference between wheels on the same axle, etc.

**RC106** The condition of tread profiles can seriously affect the wheelset and vehicle performance. Diameter differences across a wheelset cause the wheelset to operate offset on the track and in severe cases this can cause the wheelset to yaw within the bogie and result in excessive flange wear of one wheel. This effect can also be experienced if the tread profile is not correctly aligned on the wheel.

**RC107** When re-profiling, sufficient material should be removed consistent with the removal of all cracks, cavities and hard spots and the creation of the profile designated for use on the
wheelset / vehicle combination. It is permitted to leave up to 1 mm of wear on the flange back.

RC108 If defects remain in the wheel tread it is probable that they could develop whilst in service and require further attention. A crack remaining in the tread may propagate rapidly in the appropriate conditions resulting in wheel failure.

RC109 Witness marks may be left on the wheel tread when re-profiling where it is appropriate, providing that a consistent band remains around the tread. However, witness marks being work hardened will have a greater resistance to wear than the adjacent turned surface and may result in irregular tread surface. Also, where only a small amount of material has been turned off the tread sub-surface defects may remain undetected which can result in tread defects shortly after returning to service.

RC110 When re-profiling the wheel treads, the bearings and other components shall be protected. It is important to protect bearings and other components from contamination and damage by swarf or other debris produced during the re-profiling process. Such material can damage bearing seals with a risk of subsequent contamination and failure of the bearing.

2.5 Wheel centre geometry

GM/RT2466 Railway Wheelsets

4.20 Wheel centre to tyre integrity

4.20.1 The wheel centre to tyre interface shall be maintained to ensure integrity throughout its service life, with particular attention to the inspection and rectification of wheel centre interface surfaces.

RC111 All wheel centres should meet the criteria identified below, otherwise the requirements of BS 5892 Part 2 apply. Typically the criteria deemed acceptable are:

a) Outside diameter not be less than nominal diameter minus 5 mm (nominal diameter is recorded in the wheelset database)

b) Centre rim run-out less than 0.6 mm

c) Surface texture of all surfaces of the rim less than 3.2 µm

d) Width of rim not less than nominal minus 2.5 mm

e) Machined rim profile to comply with the relevant drawing

f) No corrosion, after any shallow corrosion up to 0.2 mm deep has been removed by an approved process

g) No indentations greater than 2.5 mm across

h) No raised edges or burrs. Material standing proud of the surface shall be removed using an approved process. Material below the surface shall not be removed.

RC112 To achieve the above criteria, machining with a minimum depth of cut is permitted providing that minimum dimensions, as shown on the relevant drawing, are not transgressed. Welding, using a validated procedure, is permitted in the wheel centre bore.

2.6 Prohibited components

RC113 The following components should not be re-used once removed from a wheelset:

a) Tyres once removed from a wheel centre

b) Gibson rings

c) Brake disc security bolts

d) Balance weight bolt
e) Un-overhauled axle bearings
f) Axle end cap-locking plates
g) Except for seals designed for re-use that have been examined and found serviceable, any gaskets or rubbing seals fitted to the axle end, axle box end or any axle end equipment. It is important that in re-using such seals their integrity is maintained, as water ingress is a major contributor to bearing failures.

RC114 Consideration should be given to the inherent risk before re-using any component which may have a limited life.

2.7 Assembly of wheelsets
2.7.1 Wheelset assembly facilities

RC115 To facilitate re-assembly of wheel and wheel centres, oil injection facilities should be incorporated where they are not already present, in accordance with the relevant drawing.

GM/RT2466 Railway Wheelsets
4.16 Back-to-back dimension
4.16.1 The back-to-back dimension shall be within the range set out in Table 5.

<table>
<thead>
<tr>
<th>Wheelset type</th>
<th>Dimension range</th>
</tr>
</thead>
<tbody>
<tr>
<td>All new, re-wheeled or re-tyred wheelsets with outside</td>
<td>1360 to 1362 mm</td>
</tr>
<tr>
<td>bearings</td>
<td></td>
</tr>
<tr>
<td>Re-profiled and in-service wheelsets with outside</td>
<td>1360 to 1363.3 mm</td>
</tr>
<tr>
<td>bearings</td>
<td></td>
</tr>
<tr>
<td>Any wheelset with inside bearings</td>
<td>1358 to 1360 mm</td>
</tr>
<tr>
<td>Class 373 (Eurostar)</td>
<td>1357 to 1363 mm</td>
</tr>
<tr>
<td>Steam locomotive</td>
<td>1360 to 1362 mm</td>
</tr>
</tbody>
</table>

Table 5 Wheelset back-to-back dimensions

RC116 The measurement of wheelset back-to-back, when installed under a vehicle, is to be taken at axle height above rail level. Measurements should be taken at 3 equally spaced locations around the wheel circumference, necessitating moving the vehicle to ensure all measurements are taken at axle level.

2.7.2 Wheelset dimensions

RC117 The re-profiled and in-service wheelset back-to-back dimension refers to wheelsets that were manufactured to previous standards and are gradually being withdrawn from service.

GM/RT2466 Railway Wheelsets
4.17 Diameter difference between wheels on the same axle
4.17.1 The maximum variation between wheel diameters following profiling for wheels on the same axle shall be in accordance with the requirements of BS 5892, Part 6, Table 2 or BS EN 13260, Table 3. Figures 1 and 2 L – L1 indicates the measurement position.

RC118 Once assembled, the wheel diameters should be within the requirements for diameter difference and back-to-back, as set out in GM/RT2466 or a railway undertaking’s wheelset database.

GM/RT2466 Railway Wheelsets
4.18 Limits for tread run-out and wheel wobble
4.18.1 When new, or following re-wheeling or re-tyring, the tread run-out and the wheel wobble (see Figure 2, dimension H, and Figure 2, dimension G, respectively) shall not exceed the values set out in Table 6.
# Recommendations for Railway Wheelset Maintenance

<table>
<thead>
<tr>
<th></th>
<th>Maximum tread run-out (mm)</th>
<th>Maximum wheel wobble (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All vehicles permitted to operate at speeds greater than 125 mile/h and up to and including 140 mile/h</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Locomotives and coaching stock operating at speeds up to and including 125 mile/h</td>
<td>0.25</td>
<td>0.40</td>
</tr>
<tr>
<td>Freight vehicles operating at speeds greater than 75 mile/h and up to and including 100 mile/h</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>Freight vehicles operating at speeds between 60 and 75 mile/h</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>Freight vehicles operating at speeds up to and including 60 mile/h</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>All other vehicles</td>
<td>As BS 5892, Part 6</td>
<td></td>
</tr>
<tr>
<td>AAR wheelsets</td>
<td>New AAR wheelsets shall comply with the requirements in rules 1E12 &amp; 1F4 of AAR Manual of Standards and Recommended Practices Section G – Part II.</td>
<td></td>
</tr>
</tbody>
</table>

**Table 7**    Tread run-out and wheel wobble limits

4.18.1a When a wheelset is re-profiled, the maximum tread run-out shall be as set out in Table 6. The maximum allowable wheel wobble shall not exceed 0.75 mm for all vehicles.

4.18.2 Resilient wheels when new, re-wheeled or re-tyred shall have a maximum wheel wobble of 0.75 mm for all vehicles.

4.18.3 Resilient wheels shall have a maximum wobble of 1 mm following re-profiling.

**GM/RT2466 Railway Wheelsets**

4.19 Wheel tread profile alignment and symmetry

4.19.1 When newly turned, the wheel tread profiles on each wheel shall be aligned with the wheelset axis.

4.19.2 Wheel tread profile shall be within a geometric tolerance of ± 0.25 mm of the nominal.

4.19.3 On new or overhauled wheelsets the outside face of the rim of the wheel or tyre shall be flat to within ± 0.25 mm.
RC119 The profile alignment on the wheels of a wheelset can have a significant effect on the performance of the vehicle and life of the wheelset. The correct tread profile alignment may be checked using a sliding gauge, as set out in GM/GN2497.

2.8 Wheelset balancing requirements

GM/RT2466 Railway Wheelsets
4.23 Balancing

4.23.1 Wheelsets shall be dynamically balanced to the design requirements when re-tyred, repaired or overhauled, when this is reasonably practicable.

2.8.1 Balancing

RC120 After overhaul wheelsets should be balanced, repaired wheelsets having replacement brake discs should also be balanced, where required by the relevant specification. The balancing requirements should be the same as those for new wheelsets.

RC121 Where balance weights are being refitted they should be secured in the original position to ensure correct balance is maintained.

RC122 When dynamic balancing is not physically possible, it is permissible for the equivalent out of balance to be demonstrated to be within the specified tolerance by calculation. Typical examples of when it is not feasible to balance wheelsets are when they remain in situ in the vehicle or when limited dismantling takes place, where significant axle mounted equipment remains in place, re-profiling or when no other components are removed.

RC123 Where dynamic balancing is not practical, specific attention should be given to minimising tread run-out.

RC124 Wheels and other components attached to the wheelset that are liable to affect the wheelset balance should be statically balanced prior to assembly. The wheelset components, including brake discs, where fitted, should be assembled so as to minimise the overall imbalance of the assembled unit.

RC125 The recommended method of eliminating residual imbalance of monobloc wheels is by the machining of material from the fillet between the web and the flange back. The thickness of metal removed should not exceed 4 mm. The resultant surface should be carefully blended into adjacent material, avoiding notches and stress raisers. The method of material removal should be approved by a competent person with wheelset expertise. The amount of residual imbalance should not exceed that set out in the relevant standards supporting the wheel design.

RC126 The balance requirements for new monobloc wheel designs should be achieved by eccentric machining the wheel inner rim in accordance with a validated procedure satisfying the requirements of the respective standards: BS 5892 Part 3 or BS EN 13262 or AAR standards.

RC127 Existing wheel designs that have historically been balanced with rim weights may continue to use this method, although the recommended method of balancing wheels is by machining of the wheel inner flange rim, as indicated above.

2.8.2 Wheel web balance weight holes examination

RC128 Balance weight holes in the wheel web can be a source of stress raisers and initiation of fatigue fractures in wheel webs. Thus it is necessary to ensure that the balance weight holes are inspected at repair and overhaul. It is recommended that wheel web balance weight holes are proved crack free by MPI or a process of equivalent level of sensitivity. The number and spacing of balance weight holes should not adversely affect the structural integrity of the wheels.

RC129 Wheels / wheel centres proved to be satisfactory can be re-used. Where cracks are found, the defects should be rectified in accordance with a procedure approved by a technically competent authority or the wheel / wheel centres should be scrapped.
Recommendations for Railway Wheelset Maintenance

RC130 Balance weights should be fitted using new fasteners and tightened in accordance with a validated procedure. Corrosion protection should be repaired in accordance with an applicable repair specification.

2.8.3 Wheel rim balance weights

RC131 Wheel rim balance weights are to be securely attached to the wheel. The number and spacing of tapped holes should not adversely affect the structural integrity of the wheels.

RC132 Wheel rim balance weights should be maintained to ensure security of attachment to the wheel rim. Consideration should be given to removing the balance weights and checking the tapped holes for signs of wear and cracks. Additionally, care should be taken when using tread locking compound on rim balance weight fasteners to prevent hydraulic locking.

RC133 Where cracks are found, or where the holes do not comply with requirements, then the wheelset should be overhauled and the wheel scrapped.

2.9 Changes to processes

RC134 Railway undertakings are permitted to authorise the repairer or overhauler to replace any process with an equivalent process, provided that an engineering review is undertaken to ensure that no additional risks have been introduced prior to implementation and incorporated into the applicable maintenance plan(s). The requirements for maintenance plans are set out in GM/RT2004.

RC135 Railway undertakings should request the repairer or overhauler to make and retain complete records of examinations, measurements, tests, work done and assembly details.

2.10 NDT requirements

2.10.1 NDT techniques and procedures

RC136 The objective of subjecting wheelsets to NDT is to prove they are defect free to a level of confidence consistent with the application. At the design stage the NDT frequency is determined to ensure that defects do not propagate to failure between NDT inspections. These criteria are set to ensure that if a defect in the axle is just below the detectable size then it does not grow to failure before the subsequent inspection.

RC137 The NDT technique and procedure applied to a wheelset should be validated for that wheelset, taking into account the normal level of confidence expected.

RC138 All axles should be free of:

a) Surface breaking transverse cracks or crack like indications

b) Surface breaking longitudinal cracks or crack indications in excess of the limits set out in recommendation RC094

c) Non-surface breaking defects greater than defined in the respective standards: BS 5892 or BS EN 13261 or AAR standards.

d) Any characteristic that causes the axle to be opaque to ultrasound.

RC139 Whatever tests are carried out on wheelsets or wheelset components during repair or overhaul, every wheelset which is subject to a UAT regime should undergo a full UAT in accordance with the appropriate procedure after assembly and before being fitted to a vehicle.

RC140 During overhaul the NDT examinations of the assembled wheelset shall be proven to be as sensitive and reliable at detecting the same size flaws as the in-service NDT regime. Where no other NDT scanning methods are used the wheelset axles shall be tested as a minimum by: Far End, Near End or High Angle Techniques to a validated procedure.

RC141 The internal automated ultrasonic test of a hollow axle should be a complete test of the axle using approved equipment and procedures for the particular design of axle. Care
should be taken to prevent couplant used in NDT examinations, particularly hollow axle ultrasonic testing, entering into bearings. The couplant can adversely affect the function of bearing lubricant, leading to premature bearing failure.

RC142 MPI should not be carried out on axles where bearings are fitted which cannot be demagnetised in situ.

RC143 Journal surfaces, wheelseats, gear wheels, suspension tubes and other interference fit components should be subject to MPI, or equivalent technique, when exposed. Although it is not necessary to remove all components at overhaul, consideration shall be given to exposing the entire surface for testing.

RC144 Axles fitted with suspension tubes that are not removed at overhaul should have the earth return tracks examined using an approved NDT technique.

RC145 Where the axle is subject to a UAT inspection regime the completed, re-assembled wheelset should be subject to UAT using the validated procedure before it is released for service use or storage.

RC146 After MPI the residual magnetism in the axle should be measured and rectified, as appropriate.

2.10.2 NDT records

RC147 The results of all NDT tests should be recorded and reported. Permanent evidence of any defects found and a positive indication of axles tested and found clear should be maintained.

2.10.3 Record updating

RC148 The full records relating to a wheelset should be updated, including entries on computer systems, before the wheelset is despatched from the contractor's works. Records of wheelsets held in store shall be maintained at all times.

2.10.4 Records availability

RC149 Railway undertakings should ensure that suppliers of NDT services keep full records to demonstrate compliance both with this document, the NDT requirements set out in GM/RT2005 and the procedures, in addition to results of individual tests. The records should be available for inspection by railway undertakings and include relevant facility certificates, operator certificates and work experience records, calibration evidence and equipment approval documentation.

GM/RT2466 Railway Wheelsets

4.22 Axe MPI inspection

4.22.1 Except for hollow axles subject to internal NDT inspection. Axles shall be subject to MPI or equivalent process during overhaul.

RC150 All axles should be subject to MPI, or an equivalent technique, at overhaul to ensure they are free of surface breaking defects. This technique is applied when the axles are generally stripped of components to allow access to most surfaces of the axle. In addition to the MPI, axles that are subject to a UAT regime should be examined in accordance with a validated procedure during the overhaul. The requirement for MPI of axles has been introduced following the Rickerscote enquiry.

RC151 Consideration should be given to the benefits of removing components to gain access for NDT of the whole axle surface.

RC152 Motor axles with suspension tubes that remain on the axle throughout overhaul should have their centre earth return track inspected by an approved NDT technique. This recommendation was introduced following the failure of a motor axle that was initiated from electrical arc damage on the axle earth return track.
Recommendations for Railway Wheelset Maintenance

RC153 In order to understand the reasons for failure of axles, railway undertakings should ensure that all axles which are cracked, with cracks measured deeper than 2 mm or longer than 5 mm, are metallurgically and physically examined by a technically competent authority in a timely manner. Consideration should be given to publishing the findings of the investigation as a high risk defect report (GE/RT8250).

2.10.5 Defective wheelsets

RC154 All wheelsets found by NDT to be defective should be referred for overhaul and further investigation as set out in recommendation RC061 of this document. It is permissible to mutilate the axle to prevent inadvertent re-use.

RC155 Wheelsets that have been found to be defective should be subject to NDT examination before being scrapped. This examination should be undertaken prior to the axle being mutilated. Where an axle is found to contain a defect greater than the size specified in RC145 of this document, then further metallurgical and physical investigation should be undertaken to determine the origin and any additional information that can be obtained from the investigation.

RC156 The defect threshold has been introduced to restrict the axle examinations to those defects that provide the best opportunity of gaining information on the origin and propagation of fractures.

2.10.6 Alternative techniques

RC157 The requirement for NDT detailed in GM/RT2466 should be complied with unless an alternative, approved technique is used.

RC158 An alternative technique will have demonstrated that the probability of detection of the minimum crack size, for the NDT inspection periodicity of the axle, is at least as good as that of the procedure being replaced or MPI, whichever is better. An alternative technique should be accepted by a technically competent authority.

RC159 The alternative techniques should satisfy the requirements set out in GM/RT2005.

2.10.7 Advice of inspections

RC160 NDT failures should be advised to the responsible railway undertaking within seven days of the inspection. Failure reports should be maintained by railway undertakings for five years from the date on which the wheelset or axle is scrapped.

2.11 Electrical testing

GM/RT2466 Railway Wheelsets

4.24 Electrical testing

4.24.1 At overhaul the electrical resistance testing of wheelsets shall be undertaken.

RC161 The requirement for electrical testing should be undertaken in accordance with the respective standard: BS 5892-6:1992 or BS EN 13260:2003. The High-Speed Rolling Stock TSI includes a requirement to ensure that wheelsets operate track circuits by measuring the electrical resistance between each wheel; this requirement has also been included in the Conventional Rail Freight Wagon TSI. The electrical resistance of wheelsets is measured as follows:

a) Tyre-to-tyre
b) In tare condition
c) With a voltage of between 1.8 and 2 V

The resistance should be less than:

i) 0.01 ohm when new
ii) 0.1 ohm after overhaul of the wheelset.
Part 3  Maintenance Parameters for Wheelset Geometry

3.1 Tread profile requirements

4.4 Wheelset tread profile requirements

4.4.1 The tread, when newly profiled, shall be as defined by the design for the wheelset / vehicle combination and selected only from those listed in Appendix A and applied to each wheel of a wheelset.

4.4.2 The tread, when newly profiled, shall comply with the requirements set out in the respective standard, BS 5892, Parts 3 and 6, EN13260 and AAR Manual of Standards and Recommended Practices.

RC162 The tread profiles used on a wheelset can affect the vehicle dynamic performance; it is therefore important to ensure that the correct profile is applied to all wheelsets on a vehicle.

RC163 The inspection criteria when newly profiled, the tread should meet the requirements set out in respective standards and be free of visible defects, cracks and cavities, flats and spalling.

RC163a The tread profiles shown in Appendix A are depicted with tread chamfers of 6 mm x 6 mm. It is permissible for the chamfer to be smaller, having minimum dimensions of 3 mm x 3 mm.

3.1.1 Profiling equipment

RC164 The alignment and surface finish of tread profiles produced on a lathe should be checked regularly. It is recommended that profiles should be checked at least once a day and on the first wheelset machined after changing or change of the lathe settings, for example template, program, etc. The check should be applied to all types of lathe to ensure that acceptable profiles are being achieved on the wheelset.

RC165 Care should be exercised when applying hold down loads to the wheelset to avoid damaging suspension components, axleboxes and bearings.

3.2 Flange requirements

GM/RT2466 Railway Wheelsets

4.9 Flange requirements

4.9.1 Minimum flange radius

4.9.1.1 The flange tip shall not wear to form either a sharp flange or toe radius build-up (see Figures 5 and 6), as gauged in accordance with the requirements set out in GM/GN2497. A wheel flange failing these criteria shall be withdrawn from service within 24 hours of the fault being found.

4.9.2 Flange back

4.9.2.1 No point in the flange back blend shall be closer to the vehicle centre-line than the flange back, refer to Figure 4.

4.9.3 False flange

4.9.3.1 A false flange (see Figure 7) shall not exceed 2.0 mm.

RC166 Wear on the flange toe should not cause the midpoint of a concave arc of 5 mm radius with a chord of 7 mm to touch or interfere with the profile. A wheel profile with a radius less than this value should be removed from service within 24 hours of the fault being found.

RC167 The presence of sharp flange or toe radius build-up should be assessed using the gauging system identified in GM/GN2497. The profile should be considered to fail the criteria if any part of the flange toe makes contact with the concave portion of the gauge.
Recommendations for Railway Wheelset Maintenance

3.3 NDT suspect signal in service

RC168 During NDT inspection any indication should be treated as if it were a crack and subject to detailed investigation. Care should be taken to ensure that spurious indications are avoided.

RC169 An axle with a confirmed transverse crack should be withdrawn from operation.

RC170 Axle NDT results giving longitudinal indications should be assessed. If the indications exceed the limits given in the respective standards: BS 5892-1:1992, section B3 or BS EN 13261:2003, clause 3.7.2.1 or AAR standard, the axle will have failed and should be withdrawn.

RC171 A technically competent authority may classify a spurious NDT result as a ‘suspect signal’ and advise a railway undertaking to authorise continued operation where the spurious NDT signal is proven not to be associated with a crack but caused by a non-hazardous defect. The wheelset should be subject to an increased frequency of NDT examination to monitor the suspect signal for change. The results of the NDT inspection and revised inspection arrangements are to be documented.

3.4 Recording of examination results

RC172 Records of all examinations and inspections of the wheelsets should be retained, including the measurements recorded, NDT results and the defects identified. This information then permits railway undertakings to plan attention to worn or defective wheelsets before mandatory limits are exceeded.

RC173 Railway undertakings should ensure the examination requirements are clearly specified to the repair contractor. A copy of relevant records identifying the cause of removal from service should be attached to the defective wheelset when dispatched for repair of overhaul, this could provide crucial information in subsequent investigations. Where a special investigation is to be undertaken on a defective wheelset, then it should be labelled clearly to identify the need to quarantine and include an indication of the failure or defect and an indication of the inspection to be undertaken.

3.5 Profile limits

GM/RT2466 Railway Wheelsets

4.11 Profile limits

4.11.1 Dimensional limits

4.11.1 Railway undertakings shall establish dimensional limits to ensure that the safety limits set out in Appendix A of this document are not infringed between examinations. The limits shall include the minimum rim and tyre thickness. Railway undertakings shall ensure that the required dimensions and tolerances are specified for each wheelset / vehicle combination and that these dimensions are recorded in the wheelset database.

RC174 The tread and flange surfaces finish should be in accordance with the respective standard: BS 5892 or BS EN 13262 or AAR standards to minimise damage to the track, risk of derailment and damage to the wheel.

3.6 Damaged wheelsets

3.6.1 Advice to the infrastructure manager

GM/RT2466 Railway Wheelsets

4.10 Advice of wheel damage to the infrastructure manager

4.10.1 The railway undertaking shall advise the infrastructure manager of wheelset damage that may have adversely affected the track over which it has been operating. These are to include wheelsets that have been removed from service for:

   a) Wheel flats that exceed criteria for vehicle to be removed from service, as set out in 4.6 of this document.
Recommendations for Railway Wheelset Maintenance

4.10.2 The railway undertaking shall identify the vehicle, the train formation it had been operating within and the routes on which it had been operating prior to being removed from service.

b) Tread run-out that exceed criteria as set out in 4.6 of this document.

c) False flange exceeding the limits defined in 4.9.3.1 of this document.

3.6.2 Overheated wheels

The regular maintenance of wheelsets should include a visual examination of the wheels to ensure they have not overheated. Overheating is evident by loss of dirt, discolouration and flaking of the paint from the wheel rim and web transition on tread braked wheels. Overheating of the wheel can cause the wheel to expand and relieve the interference fit on the axle, similarly overheated tyres can move on the wheel centre. The wheel hub to axle interface should be checked for evidence of movement on the axle, indicated by signs of the paint at the wheel / axle interface being broken, metal particles at the interface and measurement of the wheelset back-to-back. The tyred wheels should be checked for movements, for example in accordance with IB/TP0001.

The discolouration and flaking of paint on the inner surface of the wheel rim can indicate fault conditions that have caused excess temperature of the wheel rim, such as a dragging brake. The use of such observations is only intended as a guide and should not replace routine inspections.

Where a wheel is suspected of having overheated, the cause of the overheating should be investigated. The brake gear should be examined to ensure that it is operating freely and correctly.

3.6.3 Collision and derailment

Wheelsets that have been involved in a collision, struck an object on the track or become derailed should be examined in accordance with 2.1.12 of this document and as a minimum this will include:

a) Measurement of back-to-back dimension

b) NDT axle examination.

It is permissible to rectify minor damage to a wheelset arising from a collision or derailment. Rectification should be in accordance with a procedure produced by a technically competent authority. The repaired area should be proved free of defects using an approved NDT procedure.

Wheelsets with minor tread damage (following collision or striking an object on the track) and with no visible damage to the axle, are excluded from the requirements to undertake an axle NDT examination. Minor damage is that which is within the criteria specified for rectification in GM/RT2466 and the associated guidance documents.

Wheelsets that have been involved in a collision, struck an object on the track or a derailment should be inspected for damage and defects that could have resulted from the incident. As each incident is unique the damage sustained is extremely variable, it is therefore not appropriate to generalise any inspection that can be applied to damaged wheelsets.

Where doubt exists in the nature of the damage, reference should be made to a technically competent authority to determine whether it can remain in service. Damage to the axle and wheel, although only minor, can rapidly lead to failure in service. Wheelsets, in particular axles, experience a large number of cyclic loads when in operation. This loading environment can initiate fatigue fractures from small imperfections that could propagate to fracture with the consequential risk of derailment. It is therefore essential that damage resulting from a collision and derailment should not be permitted to remain in wheelsets.
Recommendations for Railway Wheelset Maintenance

RC184 Wheelsets that have been involved in an accident or derailment require visual examination to determine whether they are suitable to run on the track or whether other means of recovery is necessary. Wheelsets that have been derailed or struck an object on the track are permitted to run on the line, provided the axle is not bent and does not have damage that is likely to lead to failure or damage the track on the journey to the depot for rectification. The use of a wheel skate could be necessary to recover wheelsets with serious tread damage or other defects that would jeopardise the safe movement of the vehicle. The movement of vehicles with damaged wheelsets should be at reduced speed. A detailed assessment and examination should be undertaken in accordance with GM/RT2466 when the vehicle has been returned to a suitable location.

RC185 Where a wheelset has any visible damage to the material of the wheel, axle or components of the wheelset, it should be withdrawn from service and dependent on the severity of the damage sent for overhaul. It is permissible to repair minor damage to the surface coating using a validated procedure.

RC186 The examination of wheelsets involved in collisions, striking an object on the track and derailed wheelsets should be examined in accordance with GM/GN2497 or an equivalent document.

RC187 The examination and any damage rectification should be recorded before a wheelset is returned to service. Where damage is not covered by an approved repair procedure, railway undertakings should apply the following criteria when assessing derailed wheelsets:

a) Where the derailment occurred at a speed of 10 mile / h or above, or where the wheelset ran derailed for 100 m or more, or where there is any physical damage, then the wheelset should be removed from the vehicle and sent for overhaul

b) Where the derailment was at a speed below 10 mile / h and where the wheelset ran derailed for less than 100 m the wheelset should be subject to:

i) A visual inspection, as set out in 2.1.12 of this document

ii) NDT inspection of the axle

iii) Back-to-back inspection, to ensure that a wheel has not moved or that the axle is not bent.

RC188 Where any aspect of the inspection fails the criteria set out in GM/RT2466, the wheelset should be despatched for overhaul.

3.6.4 Tread profile damage

RC189 Railway undertakings should ensure that wheelsets are regularly inspected for tread damage. When such tread damage is found it should be measured, reported and recorded. Where it exceeds the limits set out in GM/RT2466 the wheelset should be withdrawn from service and rectified or be sent for repair. Where the damage is such that it is not specifically detailed by this document, advice and guidance should be sought from a technically competent authority before the wheelset is repaired, overhauled or returned to service.

RC190 The tread and flange surfaces finish are to be in accordance with the respective standards: BS 5892 or BS EN 13262 or AAR standards, to minimise damage to the track, risk of derailment and damage to the wheel.

RC191 Railway vehicles generally have some form of friction braking applied to each wheelset, this can be in the form of a tread brake or brake disc. Tread braking is the application of friction force to the wheel tread by either a cast iron or composite brake block. Traditionally cast iron brake blocks were used on tread braked vehicles, these had the beneficial effect of conditioning the tread surface of the wheel, which improved the adhesion levels between wheel and rail. The non-conforming nature of cast iron tread brakes tends to remove irregularities in the surface of the treads. Composite brake block materials vary significantly in their composition and hence their friction and wear characteristics.
Generally they are more compliant and less abrasive than cast iron so do not provide the same degree of abrasion on the tread surface, causing lower wear of the treads. However, composite friction materials can pick up hard abrasive particles in the block surface, which can behave like an abrasive cutting material on the tread, in some cases resulting in severe wear of the tread.

RC192 Railway brake disc arrangements generally fall into the following categories:

a) Wheel mounted – disc brakes where a disc is mounted on either side of the wheel web and the brake pads are applied equally onto both discs or an integral disc surface as part of the web (freight vehicle applications)

b) Axle mounted – where single or multiple brake disc assemblies are secured to the axle usually between the wheels

c) Hub mounted disc – where discs are secured to the wheel hub

d) Wheel web – the disc surface is an integral part of the wheel web.

RC193 Brake disc systems can operate close to the limiting friction coefficient between wheel and rail. This increases the tendency for wheelsets to slide in poor adhesion conditions so producing tread damage. Tread damage such as flats and cavities can result in excessive force being produced in the track that can cause damage both to the wheelset and track. Tread damage can also increase the risk of derailment. Typical tread damage is depicted in GM/GN2497.

RC194 The most common damage that occurs on modern rolling stock is wheel flats that are caused by the wheel rotation stopping during braking due to poor adhesion. At low speed a flat is effectively machined into the tread surface as the wheel slides along the railhead. The same effect can result from a wheelset sliding whilst the parking brake is applied.

RC195 When operating at higher speed, braking in poor adhesion conditions can result in excessive differential speed between wheel and rail and in some instances cause the wheels to lock. When the wheel slides along the rail, friction at the interface can cause a localised increase in the wheel temperature. The high temperature at the wheel surface could produce a larger thermal gradient through from the tread contact area into the bulk material of the wheel rim. The high thermal gradient locally transforms the material structure at the tread surface to martensite, a hard brittle phase of steel. In subsequent operation the rolling effect at the wheel / rail interface could cause cracking of the localized areas of martensite produced during the wheel slide. The cracking could eventually completely encompass the martensite which eventually falls out of the tread surface producing a cavity. The discontinuity formed by the cavities could produce the regular ‘clicking’ sound heard in passenger vehicles that have suffered tread damage. Cavities are produced some time after the wheel slide incident occurred; it can take several weeks before significant cavities are formed. In some instances where the martensite layer is thin, the material can wear away before cavities are formed but frequently significant cavities can be produced as material falls from the tread surface.

RC196 The martensitic material can be observed in the tread as a slightly more silvery / polished area usually in the tread contact area. Large areas of martensite can have chevron shapes formed in the surface where the heated material has been dragged during braking. When re-profiling the wheel a significant depth of material should be removed from the tread to ensure that all the martensitic material has been removed. These irregularities in the tread surface, either flats or cavities, can result in high forces being produced which could be experienced by both the track and the wheelset. Such tread damage can seriously damage suspension components if not rectified promptly. Although both wheels slide by the same amount during a wheel slide incident, the damage is frequently most severe on one wheel only.

RC197 Wheels that have sustained tread damage, such as flats, and remained in service can roll out the visible evidence of damage, leaving the wheel with a degree of run-out. Although not visible, tread run-out can produce track forces greater than that permitted in
GM/RT2466. When a vehicle has generated a track force exceedance report, for example as measured by wheel impact load detection equipment, the affected wheelset should be checked for tread run out. This could be achieved by raising the wheelset from the track and with a dial test indicator mounted such that the plunger is perpendicular to the tread datum and the wheel is slowly rotated. The indicator measures variation in the radial position of the tread to determine the extent of tread run-out. The measurement of tread run-out is not expected to be a regular measurement, it is only necessary following a track force exceedance report and where no obvious cause has been identified.

RC198 The wheels of vehicles are often found to suffer rolling contact fatigue, the development of fine cracks in the tread surface that are caused by the interaction between wheel and rail. Rolling contact fatigue has historically been more prevalent on disc braked wheels, whereas tread braked wheels tend to wear the surface quicker than cracks can initiate and propagate. The greater mileages being achieved by many vehicles and the design of modern rolling stock could encourage the initiation of rolling contact fatigue. The development of rolling contact fatigue in wheel treads should be monitored and re-profiled when the crack criteria set out in GM/RT2466 are exceeded.

RC199 The suspension arrangement in some vehicles provides a good steering ability for the wheelsets. These wheelsets predominantly experience wear of the tread with little wear on the flange. As the flange thickness is measured at a constant height above the tread datum point, the flange thickness can appear to increase as the tread wears and flange height increases. Although the flange thickness measurement is greater than in the design condition the wear is limited by the flange height, as set out in GM/RT2466.

GM/RT2466 Railway Wheelsets
4.8 Inspection after identification of wheel flat and tread run-out
4.8.1 Tread damage in excess of the criteria requiring immediate wheelset removal from service, as set out in 4.6 and 4.7 of this document, can be the cause of underlying damage to the wheelset and other parts of the vehicle, including bearings, suspension, etc. The railway undertaking shall ensure that all tread damage is rectified by re-profiling and that the wheelset and associated suspension components remain serviceable.

RC200 No recommendations

GM/RT2466 Railway Wheelsets
4.12 Tread roll-over and rim face bulging
4.12.1 Up to 5 mm of roll-over is allowed in-service provided no cracks in the roll-over shall extend into the tread or the rim face (see Figure 8).

4.12.2 In-service local tread collapse in the form of a rim face bulge in excess of 2 mm (see Figure 9) is not permitted and such a feature shall cause the wheelset to be removed from service within 24 hours of the fault being identified.

GM/RT2466 Railway Wheelsets
4.13 Monitoring and recording of cracks
4.13.2.1 The maximum length of multiple or isolated cracks in wheel tread or web shall be assessed by measurement and recorded. Limits for permissible cracks shall be set out in the appropriate maintenance procedure for the specific wheelset design / vehicle application and, where required shall not exceed those specified in 4.14 of this document.

GM/RT2466 Railway Wheelsets
4.14 Limits for permissible cracks
4.14.1 Wheelsets designed and manufactured to BASS design codes
4.14.1.1 The maintenance criteria included in 4.14.2, 4.14.3 and 4.14.4 are derived from the safe operating experience of wheelsets designed and manufactured to the British Rail (BR) bogie and suspension section (BASS) design codes and associated British Standards that operated on the BR network.
4.14.2 Cracks in the wheel tread, rim or flange
4.14.1.1 Where cracks are found in the transition between tread and rim, on the outside face of the rim, in the flange or in any roll-over (see Figures 8 and 10), then the wheelset shall be removed from service immediately. Any move to a repair facility shall be at a speed restricted to 45 mile/h or less.

4.14.3 Multiple cracks on the tread
4.14.3.1 Where multiple small cracks are found in the tread and one of the cracks exceeds 40 mm in length the wheelset shall be removed from service within 24 hours of the fault being identified.

4.14.4 Isolated cracks on the tread
4.14.4.1 Where an isolated crack longer than 30 mm is found in the tread, the vehicle shall be removed from service immediately. Where an isolated crack longer than 20 mm is found in the tread, the wheelset shall be removed from service within 24 hours of the fault being found.

4.14.5 Wheelsets designed and manufactured to other design codes
4.14.5.1 No limits for permissible cracks are set for wheelsets designed and manufactured to design codes other than BASS design codes. Limits shall be derived by comparison with the limits set for wheelsets designed to BASS design codes, taking into account the specific characteristics of the wheelset concerned.

RC201 The wheel tread crack criteria set out in GM/RT2466 have proven reliable for traditionally designed and manufactured wheelsets operating on the network. Railway undertakings may choose to apply more restrictive limits on the permitted cracks in the wheel tread than those identified in the standard where service experience, wheelset design, operating conditions, etc. determines. The crack criteria for multiple cracks is more relaxed than that for single cracks as the stress concentration effect of a single crack is greater than for multiple cracks. Hence, within an area of multiple cracking the longest crack permitted is greater than an isolated crack.

RC202 Rolling contact fatigue of the wheel tread can result in considerable sub-surface cracking which can become detached leaving cavities in the surface. This should only be rectified by re-profiling with a deep cut. The effects of rolling contact fatigue may be reduced by the application of a low rolling contact fatigue propensity tread profile although this may have other effects on the performance of the vehicle. Alternatively, frequent re-profiling of affected wheelsets may reduce the extent of damage and limit the depth of material that needs to be turned off the wheels.

RC203 In addition to the wheel tread examinations wheelsets having integral disc brakes wheels should have the friction surfaces examined for thermal cracks as defined by the vehicle maintenance plan.

GM/RT2466 Railway Wheelsets
4.15 Tread cavities
4.15.1 The wheelset shall be removed from service within 24 hours of either of the following faults being found:
   a) Any single cavity greater than 15 mm long circumferentially around the wheel
   b) Any two cavities, separated by less than 50 mm, having a total length in excess of 15 mm circumferentially around the wheel.

RC204 No recommendations.
GM/RT2466 Railway Wheelsets

4.5 Maximum force

4.5.1 Where it is established, for example by wheel impact load detection equipment, that any defect in a wheel contributes to producing a total vertical force of more than 350 kN per wheel, the wheelset shall be examined.

RC205 this examination should be such as to identify any possible cause of the vertical force including, but not exclusively, wheel out-of-round, wheel discontinuities, suspension defect, etc.

GM/RT2466 Railway Wheelsets

4.21 Inner rim damage

4.21.1 Wheels shall be scrapped where damage on the inner surface of the rim exceeds 4 mm in depth. No damage with sharp, internal angles shall be permitted. It is permissible to grind out damage less than 4 mm deep by grinding 1 mm deeper than the damage and blending in the hollow over a length of five times the depth as shown in Figure 11. The rim shall then be proved to be defect-free by MPI, taking note of any machining processes that could mask any cracks.

RC206 Wheels with inner rim damage caused by the application of wheel lathe ‘drive dogs’ should be examined for tread run-out and assessed in accordance with the criteria set out in 4.18 of GM/RT2466.

RC207 Where a wheelset being reprofiled is driven by means of drive dogs these are usually positioned equally around the wheel rim. Any rectification should usually not affect the wheelset balance but consideration should be given to dynamically balancing to ensure the balance requirements have been maintained.
Recommendations for Railway Wheelset Maintenance

Definitions

AAR
Association of American Railroads.

Axlebox
The structure, including cartridge bearing adaptor, which houses, or is in contact with, the axle journal bearing and provides an interface with the bogie and / or suspension arrangement.

Axle run-out
The total radial displacement measured at the centre of the axle when it is rotated on rollers supporting the wheelset bearing journals.

Change of use
Where a wheelset is fitted to a different design of vehicle to that originally intended by the wheelset designer, or where the vehicle is to be used in a different way, which alters the loads experienced by the wheelset.

Defect / defective
Any fault(s) in a component, or assembly, which may prevent the component, or assembly, from fulfilling its design purpose.

Earth return
Includes traction return current and equipotential bonding equipment.

Hollow axles
An axle that has a hole through its centre. Such axles may be tested to a routine, internal, non-destructive testing process.

Interference fit
The shrink or press fit between a wheel centre and a tyre or between the axle and any item, other than a wheelset bearing.

Longitudinal indication
A linear indication obtained when carrying out non-destructive testing which lies parallel to the longitudinal axis of the axle or which is less than 45° out of parallel.

Magnetic particle inspection
Magnetic particle inspection (MPI) is a method of detecting surface, or near surface, discontinuities in magnetisable materials by the generation of a magnetic flux within the material and the application of suitable ferromagnetic particles to the surface, so as to render the discontinuity visible.

Maintenance
The routine process of examination, inspection, measurement and lubrication which, together with the completion of identified repairs, ensures the wheelset remains safe throughout its current service life.

Manufacture
All the processes and assembly operations which culminate in the production of a completely new wheelset.

Monobloc wheel
A wheel comprising a hub, a wheel web and rim with the full wheel tread profile manufactured from a single piece of steel as a single entity.
Recommendations for Railway Wheelset Maintenance

**Non-destructive testing**
Non-destructive testing (NDT) is the process of examination of a wheelset to enable its integrity to be assessed by a means which does not compromise the service life or the design life of the wheelset.

**Overhaul**
Any attention given to the wheelset when it is removed from a vehicle or bogie and when an interference fit is broken (excluding the removal of axle journal bearings).

**Retaining ring (Gibson)**
A split ring of material used to retain the tyre on the wheel centre.

**Repair**
The physical attention given to the wheelset to enable it to remain safe throughout its current service life. Such attention does not require the breaking of any interference fit. Re-profiling of wheel treads is not deemed to be a wheelset repair.

**Roll-over**
A burr of extruded material forming on the outer rim side of the wheel during service by plastic deformation.

**Rolling contact fatigue**
A series of fine, typically closely spaced cracks in the centre of the wheel tread which eventually form a complete circumferential band of cracks but may be more extensive.

**Service life**
The time or distance over which a wheelset safely continues to meet defined technical standards before overhaul is required.

**Sharp flange**
A sharp corner on the flange tip.

**Technically competent authority**
A company, or person, having proven competence in a particular technology or process and being independent of the company requiring the services of the technically competent authority.

**Thermal crazing**
A pattern of fine, superficial cracks in the wheel tread or web caused by the thermal, rubbing input from the brake block or pad.

**Toe radius build-up**
Extruded material on the flange tip.

**Tread run-out**
The total radial displacement measured at the wheel tread when the wheelset is rotated on rollers supporting the wheelset bearing journals.

**Tyred wheel**
A wheel which comprises at least a wheel centre and a separately manufactured tyre.

**UIC**
Union Internationale de Chemins de Fer.

**Ultrasonic testing**
Ultrasonic testing is a process in which high frequency sound waves are transmitted through materials such that the reflections can be analysed to find imperfections in the material. Ultrasonic axle testing (UAT) is when the process is applied to railway axles.
Wheel centre
The wheel hub, web and rim on which a tyre is fitted.

Wheelset
A complete unit comprising an axle and two complete wheels together with any gear wheels, brake discs, etc, but without axle bearings and their end caps, spacers, seals and other associated fittings. The wheels may be either tyre or monobloc, Figure 1 of GM/RT2466 identifies the relevant features.
References

The Catalogue of Railway Group Standards and the Railway Group Standards CD-ROM give the current issue number and status of documents published by RSSB. This information is also available from www.rgsonline.co.uk.

Documents referenced in the text

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**RSSB documents**

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<td>Recommendations for Railway Wheelset Design</td>
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