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REGULATOR STANDARD

RAILWAY SAFETY MANAGEMENT

Part 2-3-1: Technical requirements for systemic engineering and operational standards – Rolling stock: Wheels, axles and bearings

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REGULATOR STANDARD
Railway Safety Management

Part 2-3-1: Technical requirements for systemic engineering and operational standards – Rolling stock: Wheels, axles and bearings

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Railway Safety Management

Part 2-3-1: Technical requirements for systemic engineering and operational standards – Rolling stock: Wheels, axles and bearings

NOTE: It is essential that this standards document is read together with the South African National Standards, SANS 3000-1, SANS 3000-1, SANS 3000-2-1 and SANS 3000-2-3.

Table of changes

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Foreword

This Regulator Standard was developed and approved by the *Technical Committee for the Development of Regulator Standards for Railway Safety* (TC RSR-001), in accordance with the *National Railway Safety Regulator Act* (Act 16, 2002), the *Safety Standards Development Regulations, 2006* and the *RSR Procedure for the Development of Regulator Standards.*

This document extends and augments the *SANS 3000* series of standards pertaining to railway safety that are published by the South African Bureau of Standards on behalf of the Railway Safety Regulator and in particular SANS 3000-2.1, Part 2-1: *Technical requirements for engineering and operational standards – General* and SANS 3000-2-3:2008, *Part 2-3: Technical requirements for engineering and operational standards – Rolling stock*. This document should be read in conjunction with those standards.

The *SANS 3000* series of standards presently consists of the following parts, under the general title of *Railway Safety Management*:

Part 1: Railway Safety management – General (in course of revision).

Part 2-1: Technical requirements for engineering and operational standards – General.

Part 2-2: Technical requirements for engineering and operational standards – Track and associated civil infrastructure and installations.

Part 2-3: Technical requirements for engineering and operational standards – Rolling stock.

Part 2-4: Technical requirements for engineering and operational standards – Train authorization, and control, and telecommunication.

Part 2-5: Technical requirements for engineering and operational standards – Operational principles for safe movement on rail.

Part 2-6: Technical requirements for engineering and operational standards – Interoperability, and interface and intraface management.

Part 4: Human factors management.

The *RSR 00* series of standards presently consists of the following parts, under the general title of *Railway Safety Management:*

Part 2-3-1: Technical requirements for engineering and operational standards – Rolling stock – Wheels, axles and bearing (this document).

Part 2-7: Technical requirements for systemic engineering and operational safety standards – Railway Stations (in course of preparation).

Part 3: Railway occurrence management (in course of preparation).

Part 4-1: Human factors management, Fatigue management.

Where reference is made to a specific published date, version or edition of a document, then that version of the document shall apply. Where reference is made to a document without specifying a date, version or edition, then it should be assumed that the latest published version shall apply.

Reference is made in clause 6.1.1.4 to the "relevant national railway safety regulator", in South Africa this shall mean the Railway Safety Regulator as established in terms of *National Railway Safety Regulator Act (*Act No. 16 of 2002).

Reference is made in clauses 1.3 and 13.1(d) to the "relevant national legislation", in South Africa this shall mean the *National Railway Safety Regulator Act* (Act No. 16 of 2002) as amended.

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1 Scope

1.1 This standard provides the generic technical requirements for rolling stock wheels, axles and bearings through all the life-cycle phases of these components. It includes requirements for transportation and storage of these components.

1.2 This standard applies to railway operators as defined in the relevant national legislation and also to all interested and affected parties.

1.3 This standard provides the mandatory limits for rolling stock wheelsets and bearings over the total life-cycle of those components as defined in Annex H of SANS 3000-1:2015.

1.4 This standard prescribes the mandatory operations to be carried out for which the specific values (and criteria) are to be defined in the operator's maintenance plan.

1.5 This standard is also applicable to wheelsets fitted with brake discs, final drives, transmissions and noise-damping systems as appropriate.

1.6 This standard is applicable to all rolling stock (RS) which is developed as a new product and to all existing rolling stock which is modified where such modification results in:

a) a change in functionality of any system, subsystem or component of the RS;
b) a change in the performance characteristics of the RS; or
c) the introduction of new technology of any nature and for whatever reason at system, subsystem or component level.

1.7 This standard covers wrought and cast carbon-steel wheels for locomotives, coaches and wagons of all classes. It also applies to high-speed service with severe braking under light, moderate and heavier wheel-loads.

2 Normative references

2.1 South African normative references

The following referenced documents are indispensable for the application of this standard. For dated references, the latest edition of the referenced document (including any amendments) applies:

SANS 3000-1 Part 1: Railway Safety management – General (in course of revision).

SANS 3000-2-1: Part 2-1: Technical requirements for engineering and operational standards – General.

SANS 3000-2-3, Part 2-3: Requirements for systemic engineering and operational safety standards – Rolling stock.

Information on current, valid South African National Standards (SANS) can be obtained from the SABS Standards Division. Website: *https://www.sabs.co.za/*

Information on current, valid Regulator Standards can be obtained from the Railway Safety Regulator of South Africa. Website: *http://rsr.org.za/.*

2.2 International normative references

The following referenced documents are indispensable for the application of this standard. For dated references, the latest edition of the referenced document (including any amendments) applies:

AAR M101, M107 and M208: *Wheels and Axles, Section G*.

BS 5750-1, EN 29001, and ISO 9001: Quality systems: Specification for design/development, production, installation and servicing.

BS 5892 series: Railway rolling stock materials.

EN 12080: Railway applications: Axleboxes. Rolling bearings.

EN 12081: Railway applications: Axleboxes – Lubricating greases.

EN 12082: Railway applications: Axleboxes – Performance testing.

EN 12663 series: Railway applications: Structural requirements of railway vehicle bodies.

EN 13103: Railway applications: Wheelsets and bogies. Non-powered axles – Design method.

EN 13104: Railway applications: Wheelsets and bogies. Powered axles – Design method.

EN 13260: Railway applications: Wheelsets and bogies. Wheelsets – Product requirements.

EN 13261 Railway applications: Wheelsets and bogies. Axles – Product requirements.

EN 13262: Railway applications: Wheelsets and bogies Wheels – Product requirements.

EN 13715: Railway applications: Wheelsets and bogies. Wheels – Tread profile.

EN 13979-1: Railway applications: Wheelsets and bogies. Monobloc wheels – Technical approval procedure, forged and rolled wheels.

IEC 61133: Railway applications: Rolling stock – Testing of rolling stock on completion of construction and before entry into service.

ISO 1005 series: Railway rolling stock material.

RSSB GM/RT 2100: Requirements for rail vehicle structures.

RSSB GM/RT 2453: Registration, identification and data to be displayed on rail vehicles (wheelset data).

RSSB GM/RT 2141: Resistance of railway vehicles to derailment and roll-over (derailment criteria).

RSSB GM/RT 2466: Railway wheelsets.

Information on current, valid AAR standards can be obtained from the Association of American Railroads. Website: *https://www.aarpublications.com/.*

Information on current, valid British Standards (BS) can be obtained from the British Standards Institution. Website: *http://shop.bsigroup.com/.*

Information on current, valid European Standards (EN and BS EN) can be obtained from the British Standards Institution. Website: *http://shop.bsigroup.com/.*

Information on current, valid IEC standards can be obtained from the International Electrotechnical Commission. Website: *http://www.iec.ch/.*

Information on current, valid ISO standards can be obtained from the International Organization for Standardization. Website: *http://www.iso.org/iso/home/standards.htm.*

Information on current, valid Railway Group Standards (RSSB RT/RM) can be obtained from the Rail Safety and Standards Board of the United Kingdom. Website: *http://www.rssb.co.uk/.*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this document, the definitions given in SANS 3000-1, SANS 3000-2-1, SANS 3000-2-3 shall apply.

3.2 Abbreviations

For the purposes of this document, the abbreviations provided in the *National Railway Safety Regulator Act* (NSRA), national standards SANS 3000-1, SANS 3000-4 and the following shall apply.

NOTE: In the case of duplicated or differing abbreviations, the abbreviations provided here shall prevail for the purposes of this standard.

AAR	Association of American Railroads
ASTME	American Society for Testing of Materials
ASNT	American Society for Non-destructive Testing
BS	British Standard
CAR	Corrective action request
CIE	Chief Inspector of Explosives
DMU	Diesel multiple-unit
EMI	Electromagnetic interference
EMU	Electric multiple-unit
EN	European Standard (norm)
FEA	Finite element analysis
GSR	Government Security Regulator
HL	Hazard log
IEC	International Electrotechnical Commission
MCA	Mission-critical activity
MPI	Magnetic-particle inspection
MTBF	Mean time between failures
MTTR	Mean time to repair
NCR	Non-compliance record
NDT	Non-destructive testing
OEM	Original equipment manufacturer
OHTE	Overhead traction equipment
OOS	Out of service

Ops	Operations
Ra	Roughness average
RA	Risk assessment
RAMS	Reliability, availability, maintainability and safety
RS	Rolling stock
RSSB	Railway Safety and Standards Board, UK
SMS	Safety management system
TCIA	Technical Committee on Industrial Agents
TFEA	Thermal finite element analysis
TSI	Technical specification for interoperability
UAT	User acceptance testing
UIC	International Union of Railways
URS	User requirement specification
UT	Ultrasonic testing

4 Exclusions

4.1 The requirements to be met by components other than wheels, axles, and bearings (brake discs, final drive transmissions, noise damping systems, etc.) shall be defined in a separate document.

4.2 Rolling stock (RS) types that run on a rail network with a rail gauge of less than 600 mm are excluded from the requirements of this standard.

5 Common essential requirements

5.1 General

5.1.1 Rolling stock (RS) wheels, axles and bearings shall be designed and manufactured to minimise or eliminate faults which could cause failures.

5.1.2 Rolling stock (RS) wheels, axles and bearings shall be designed and manufactured to ensure that the consequences arising from any failure will be minimized by adhering to the following principles:

a) the operating parameters shall be determined in accordance with SANS 3000-1 and SANS 3000-2-3;
b) the structural integrity of wheelsets and wheelset components shall be maintained over the useful life of those components and the risks of in-service failures shall be mitigated; and
c) the integrity of wheelsets and wheelset components shall not be compromised under normal and abnormal operations.

5.2 Wheels, axles and bearings – common design requirements

5.2.1 Processes and procedures shall be established, developed or adopted, implemented and maintained to ensure that the selection and design of wheels, axles and bearings include the following items, where relevant:

5.2.1.1 A unique type and serial number which is visible to the unaided eye when conducting a visual examination of the components without the assistance of any lifting or drop-pit equipment shall be stamped into the material of each wheel and axle.

5.2.2 The material specified shall comply with the standard selected and utilised for the design and shall be appropriate for the proposed application of the rolling stock (RS) with the minimum requirements as specified in AAR M101, M208 or BS EN 12663-1, EN 12663-2 or equivalent standards.

5.2.3 The fatigue design-life for wheels, axles and bearings shall be at least equal to the design-life of the RS or a predetermined maintenance interval, whereafter the wheel, axle or bearing shall be considered to be life-expired and unsafe for further use.

5.2.4 Wheelsets shall be designed using actual or predicted service-loads so that the fatigue-life is not finite.

5.2.5 Wheelsets shall be designed to withstand all the foreseeable input forces under which the vehicle is to remain fully operational.

5.2.6 Wheelsets shall be designed to be capable of being manufactured and maintained in accordance with this standard.

5.2.7 Wheels, axles and bearings shall comply with the requirements of SANS 3000-2-3 for running-gear, including the following:

a) axle load – the specified axle load shall comply to the network the RS is operating upon and with the design-standard being applied;
b) composition – the material composition of wheels shall be such that under normal operating conditions wheel fracture due to excessive heat under full load conditions will not result in a failure; and
c) wheel profile – standards and procedures shall be established, developed or adopted, implemented and maintained to ensure that the selection and design of wheels, axles and bearings includes the following items, where relevant:
    1) differential wheel diameters for wheels on the same axle;
    2) differential wheel diameters between wheels on the same bogie;
    3) differential wheel diameters between wheels on other axles of the same vehicle; and
    4) compliance to the requirements of the network that the RS will operate upon.

6 Concept

6.1 Rolling-stock wheels, axles and bearings – type-specific requirements

6.1.1 Standards

6.1.1.1 The design of RS wheels, axles and bearings shall adhere to standards which are applicable to:

a) the network upon which they will operate; and
b) the standards stipulated within the statutory requirements.

6.1.1.2 Where appropriate standards are not available, reference shall be made to applicable AAR, EN, RSSB or equivalent standards for guidance.

6.1.1.3 Details of wheel and axle surface-coating and corrosion protection systems shall be documented in the wheelset design and drawings.

6.1.1.4 Where the standards utilised are not in accordance with clauses 6.1.1.1, 6.1.1.2 and 6.1.1.3 above then the standards utilised shall be subjected to a thorough risk assessment (RA). The standards, specifications and the RA shall be submitted to the relevant national railway safety regulator (see Foreword) for review.

6.1.2 Essential requirements

6.1.2.1 Standards and procedures shall be established, developed or adopted, implemented and maintained to ensure that all wheel, axle and bearing types:

a) comply with the track infrastructure requirements of the network the RS is intended to operate upon in accordance with SANS 3000-2-2; and
b) have a unique identification and a serial number which are linked to manufacturer, manufacturing plant and batch.

7 Design

7.1 Wheel design

7.1.1 Wheel design methodology

7.1.1.1 To achieve consistency within a chosen methodology and industry practice where British standards (BS), Railway Group standards (RSSB), European standards (EN), Association of American Railroads standards (AAR) or other equivalent standards are adopted to comply with this national standard, the relevant full suite of the adopted standards shall be applied.

NOTE 1: Except where otherwise defined within this document, it is not permissible to use selected standards elements only, nor to mix between the standards regimes for the design, manufacture and maintenance of railway wheelsets.

NOTE 2: Wheels fitted with tyres cannot be permitted for passenger coaches in service.

7.1.1.2 Wheels shall be designed using actual, or predictions, of service loads so that the fatigue life is not finite. The design shall withstand all the foreseeable inputs under which the vehicle is to remain fully operational.

7.1.1.3 All new designs of wheels shall be validated using methods appropriate to the application to demonstrate that the design satisfies the requirements of the adopted suite of standards and complies with the requirements set out in this document.

7.1.1.4 Interchangeability requirements and tolerances for tread and flange contours shall be in accordance with the minimum specifications in current AAR, EN or equivalent standards.

7.1.1.5 A detailed stress finite element analysis (FEA) of the proposed wheel designs shall be done in accordance with the guidelines and requirements as laid down in the current UIC 510-5 O or equivalent standard to enable the prediction of in-service performance of the wheels.

7.1.1.6 A thermal finite element analysis (TFEA) shall be done to calculate the effect of thermal heating on the wheel design and material due to the use of tread brakes when fitted with composite brake blocks.

7.1.1.7 Alternative design methods may be used for integral steel wheels only. However, such alternative proposals shall be subject to review by a competent authority.

7.1.2 Flange design

7.1.2.1 The following shall be specified for the flange design:

a) the range of the nominal flange angle of a new tread profile design; and
b) the radius between the flange tip and the flange back-blend, when new.

7.1.3 Flange and toe radius

7.1.3.1 The flange toe radius, when new, shall not be less than 10 mm.

7.1.4 Tread profiles

7.1.4.1 The wheel tread profile for new wheelset designs shall be selected from those listed in the adopted AAR, EN or equivalent standards. The tread profile shall be chosen to suit the vehicle and suspension design, taking into account its effect on the wheel to rail interface, vehicle dynamics and wheel or rail wear and maintenance.

7.1.5 Monobloc wheel material

7.1.5.1 The wheel material shall be selected from grades of steel as specified in the relevant standard adopted for particular applications.

7.2 Axle design

7.2.1 Axles designs shall take into account the mass, traction and braking conditions of the RS. The designs shall comply with the requirements spelt out in BS EN 13104, AAR or other equivalent standards.

7.2.2 Axle designs shall comply with the requirements specified in BS EN 13104, AAR or other equivalent standards.

7.2.3 Axle designs shall specify the non-destructive testing (NDT) requirements for both manufacturing and all future life-cycle phases.

7.3 Bearing design

7.3.1 Bearing designs shall comply with the requirements specified in appropriate EN, AAR or equivalent standards and with recommended practices for roller bearing manufacturing.

7.3.2 The design-life of a bearing shall be determined using a proven method in accordance to the relevant standards adopted.

8 Execution (manufacturing)

8.1 Wheel manufacture

8.1.1 The qualification as a manufacturer of wheels shall be in accordance with the adopted AAR, GM/RT2466, EN or equivalent standards.

8.1.2 All materials shall be sampled to demonstrate that the material from which the component is manufactured is homogeneous and free from macro-segregation that is likely to have a detrimental effect on wheel performance. The metallurgical content shall be consistent with material grade. Any failure to satisfy the requirements of the specified tests shall result in the complete batch of wheel components being rejected.

8.1.3 Wheels shall either be wrought-steel or cast-steel and manufactured in accordance with one of the following or equivalent standards:

c) for wrought-steel – AAR specification M 107, BS-5892-3 or equivalent EN standard; or
d) for cast-steel – AAR specification M 208, BS5892-3 or equivalent EN standard.

8.1.4 Processes and procedures shall be established, implemented and maintained to ensure that the removal of defects from manufacturing processes on the web and wheel surface does not affect the mechanical properties of the wheel.

8.1.5 Deposition of material, including welding, that could conceal defects shall not be permitted. If any concealment of defects is found to be present, the entire batch submitted for inspection shall be rejected.

8.1.6 Wheels shall be machined accurately to the dimensions and tolerances in the relevant drawings or specifications contained in AAR M-107/M-208, EN 13103, EN 13104, BS 5892, ISO 1005-8 or equivalent standards.

NOTE 1: It is important when machining wheel tread and flange profiles that the surface finish be maintained within acceptable limits.

NOTE 2: This is to ensure that surfaces which can normally contact the rail or check-rail are smooth, free of machine chatter marks, surface waviness or grooving which could contribute to a wheel flange-climb type of derailment.

8.1.7 The following identification markings shall be cast, stamped or engraved on each wheel in a visible and accessible location as specified by the designer or purchaser:

a) the manufacturer's mark;
b) a unique serial number;
c) date of manufacture; and
d) wheel type or class.

8.1.8 After inspection and prior to storage or despatch the finished, machined wheels shall be provided with protection against corrosion. The corrosion protection agent shall be specified and agreed between the operator or purchaser and the manufacturer.

8.1.9 The manufacturer and the operator shall, between them, establish safety criteria for the possible acceptance of wheels that may exhibit some corrosion.

8.1.10 The manufacturer shall provide a certificate of conformance to the applicable standards which shall certify that the batch of wheels was manufactured and tested in accordance with the requirements of the applicable specifications and standards.

8.1.11 The manufacturer shall provide a report of all relevant test results together with the test certificate. This report shall identify and provide a trace to the wheels' cast and heat treatment batch.

8.2 Axle manufacture

8.2.1 The qualification as a manufacturer of axles shall be in accordance with the adopted AAR, GM/RT2466, EN or equivalent standards.

8.2.2 Axles shall be manufactured in accordance with BS 5892, AAR M101 EN or equivalent standards.

8.2.3 Axles shall be made directly either from an ingot or from blooms. The total reduction from an ingot or a strand-cast bloom to forging or rolling shall not be less than 3 to 1 unless otherwise specified.

NOTE: The process for manufacturing strand-cast blooms shall be designed to ensure freedom from centre porosity and undue segregation.

8.2.4 Each new axle shall be branded with a unique serial number allocated from the manufacturer's own series of numbers. An axle shall not be given the serial number of:

a) an axle that it replaces; or
b) a previously scrapped axle.

8.2.5 Manufacturers shall maintain the following records which shall be provided upon request by the operator:

a) the procedural specification for each validated ultrasonic testing (UT) process;
b) a posted, controlled copy of each UT specification in each UT equipment area; and
c) all individual axle test results including individual heat, axle serial number, and date of inspection shall be retained for a minimum period of 10 years from date of manufacture.

8.2.6 An inspector representing the operator or purchaser shall have free entry at all times to all parts of the manufacturer's works that concern the manufacture of the material

or components ordered while the work on the contract of the operator or purchaser is being performed.

8.2.7 The manufacturer shall afford the inspector, free of charge, all reasonable facilities and necessary assistance to satisfy the inspector that the material is being furnished in accordance with the operator's or purchaser's specifications and all relevant standards. Tests and inspections for acceptance shall be made at the place of manufacture.

8.2.8 The inspector shall examine each axle in each "heat" for workmanship, defects and conformity to the dimensions given on the purchaser's order, specifications or drawing. If, in this inspection defects are found that the manufacturer can remedy without impacting on the safety and longevity of the component, with the agreement of the operator or purchaser, the manufacturer may correct such defects.

8.2.9 The manufacturer shall not remedy any defects unless it is specifically permitted to do so by the applicable standards and that this is acceptable to the operator or purchaser.

8.2.10 Upon request of the operator or purchaser, a manufacturer's certification that the component or material was manufactured and tested in accordance with the applicable specification and standards, together with a report of the test results shall be provided.

8.2.11 The manufacturer shall provide a certificate of conformance to the applicable standards which shall certify that the batch of axles was manufactured and tested in accordance with the requirements of the applicable specifications and standards

8.2.12 The manufacturer shall provide a report of all relevant test results together with the test certificate. This report shall identify and provide a trace to the axles' cast and heat treatment batch.

8.3 Bearing manufacture

8.3.1 Steel manufacture

8.3.1.1 The process of steel manufacturing in mass production shall be such that the metallurgical characteristics are the same as those of the roller-bearings submitted for the approval procedure.

NOTE: The choice of manufacturing procedures is left to the discretion of the supplier using the applicable standards.

8.3.2 Heat-treatment

8.3.2.1 The heat-treatment processes for roller-bearing components shall be such that the hardness values are specified for surface hardness and depth of case-hardened

steel. The heat treatment processes shall be such that all the roller-bearings produced in a production batch are treated uniformly.

8.3.2.2 The bearings shall be heat-treated to retain dimensional stability and material properties for operating temperatures up to a value as specified in the applicable standard.

8.3.3 Traceability

8.3.3.1 The manufacturer shall set up and maintain a system of identification and traceability of finished products (see section 4) which allows the detection of the following elements based on an identification marking:

a) material origin including the chemical analysis of every “heat” and steel manufacturing batch;
b) heat treatments;
c) inspection of boundary dimensions as well as inspection of soundness; and
d) batch number.

8.3.3.1.1 The manufacturer shall make this identification information available to the operator or purchaser on request.

8.3.4 Certification

8.3.4.1 The manufacturer shall provide a certificate of conformance to the applicable standard of the operator or purchaser. The certificate shall certify that the batch of bearings was manufactured and tested in accordance with the requirements of the applicable standard.

8.3.4.2 A report of all test results shall be accompanied by the test certificate.

9 Inspections

9.1 Wheel inspections

9.1.1 Quality

9.1.1.1 A quality inspection of each wheel shall be made in accordance to the requirements specified in BS 5892-3, AAR M107, AAR M208, EN 13262, UIC or equivalent standards.

9.1.1.2 The inspection of wheels shall be undertaken in at least one of the following ways:

a) by the operator, purchaser or a competent nominated representative who shall be enabled to inspect the product and witness any of the tests;
b) by the operator or purchaser delegating the responsibility for the inspection to the manufacturer; or
c) by the application of an approved quality assurance system such as specified in BS 5750 or equivalent standard.

9.1.2 Rejection criteria

9.1.2.1 Unless otherwise specified, one test wheel per batch shall be selected by the operator’s or purchaser’s accredited quality assurance inspector for inspection and testing by the manufacturer, the operator or the purchaser.

9.1.2.2 If the test wheel fails inspection or testing or it is established that the test wheel has been specifically conditioned so that it no longer represents the other wheels in its batch, that entire batch of wheels shall be rejected.

9.1.2.3 For fatigue testing, BS 13979-1:2011 EN 13262 or equivalent standards shall be used.

9.2 Axle inspection

9.2.1 Inspection

9.2.1.1 As specified in the AAR M101, EN 13261 or equivalent standards, the inspector representing the operator or purchaser shall have free entry to all parts of the manufacturer's works that concern the manufacture of the material or components ordered, at all times while the work on the contract of the operator is being performed.

9.2.1.2 The operator or purchaser shall be permitted to carry out tests to determine the acceptance or rejection of the material or components in operator's or purchaser’s own laboratory or elsewhere.

9.2.1.3 The operator or purchaser shall be permitted to carry out tests to determine the acceptance or rejection of the material or components in operator's or purchaser's own laboratory or elsewhere.

9.2.1.4 The inspector shall examine each axle in each "heat" for workmanship, defects, and conformity to the dimensions given in the applicable standard.

9.2.1.5 The manufacturer shall not remedy any defects unless it is specifically permitted to do so by the applicable standards and is acceptable to the operator or purchaser.

9.2.2 Rejection

9.2.2.1 Any axle that fails to meet the requirements of the operator or purchaser's specifications or the applicable standards shall be rejected.

9.2.2.2 Any axle that shows manufacturing or material defects subsequent to its original inspection and acceptance at the manufacturer's works or elsewhere shall be rejected and the manufacturer shall be notified whereupon the whole batch shall be rejected.

9.2.2.3 Any axle that suffers or shows damage that renders the axle unserviceable subsequent to its original inspection and acceptance at the manufacturer's works or elsewhere shall be withdrawn and removed from service.

9.3 Bearing inspection

9.3.1 Inspection

9.3.1.1 The bearing manufacturer or refurbisher shall conduct inspections of the bearings in accordance with the applicable standards and specifications for bearing manufacture or refurbishment as the case may be.

9.3.2 Rejection

9.3.2.1 Any bearing that suffers or shows damage subsequent to its original inspection and acceptance at the manufacturer's works or elsewhere shall be withdrawn and removed from service.

9.3.2.2 Any bearing that fails to meet the requirements of the operator's specifications or the applicable standards shall be rejected.

9.3.2.3 Any bearing that shows manufacturing or material defects subsequent to its original inspection and acceptance at the manufacturer's works or elsewhere shall be rejected. The manufacturer shall be notified and the whole batch shall be rejected.

9.3.3 Certification

9.3.3.1 The manufacturer shall provide a certificate of conformance to the applicable standards and specifications. The certificate shall certify that the bearing was manufactured or refurbished and tested in accordance with the requirements of the applicable standards and specifications.

9.3.3.2 A report of all test results shall accompany the test certificate.

10 Operations

10.1 Assembly of wheelsets

10.1.1 Wheelsets shall be assembled in accordance with the requirements of the respective standard, BS EN 13260 or BS 5892 Part 6, *AAR Manual of Standards and Recommended Practices Section G – Part II* or equivalent standards.

10.1.2 Wheelsets shall be measured and inspected in accordance with the applicable standards.

10.1.3 Wheels and other components that are secured to the axle by interference fit shall be designed:

a) to remain secure for the entire expected service life, and
b) to be run over the full operational temperature range, including thermal effects caused by the environment and in-service operation.

10.2 New and used components

10.2.1 If a wheelset is assembled with used components or a combination of new and used components, that wheelset shall comply with the original design specifications and permitted tolerances.

10.3 Wheelset testing

10.3.1 The wheelset shall be tested to comply with the requirements of the applicable standard for electrical continuity.

NOTE: The wheelset electrical resistance should be measured to ensure that the wheelset is capable of transmitting both the small electrical current produced by track circuits and the larger traction return currents.

10.4 Unique identification of wheelsets

10.4.1 Each wheelset shall be fitted with locking plates that comply with the AAR Manual, Section G upon which the axle's serial number shall be inscribed.

10.5 Handling and care of wheelsets

10.5.1 Wheelsets which are not in service and wheelset components prior to their assembly, shall be protected, stored, handled and transported in a manner which is not detrimental to the wheelset's life. Guidance is set out in the RSSB document, GM/GN2498: *Guidance on Railway Wheelset Handling*.

10.5.2 Records to ensure traceability

10.5.3 Records shall be maintained so that each wheelset can be identified against a wheelset manufacturer, a casting batch and year of manufacture. These records

shall include the cast batch numbers, manufacturers' codes and the years of both component manufacture and wheelset assembly.

10.5.4 The railway operator shall require the wheelset manufacturer to create and retain records of tests and assembly details.

10.5.5 Defects identified on wheelsets and associated equipment that may introduce a risk to safe railway operations shall be reported to the manufacturer and supplier.

NOTE: In the event of identification of a manufacturing defect, the provision of traceability mechanisms will allow all other wheelsets that may be similarly affected to be identified and assessed.

10.5.6 Information to be recorded

10.5.6.1 For all wheelset assemblies, the following information shall be recorded:

a) the date of the wheelset's assembly;
b) the wheelset's unique identification number;
c) the axle and wheelset diameter, measured at 90 degree intervals around the circumference, and in two planes on the wheelset;
d) the wheel bore diameter, measured at 90 degree intervals around the circumference, and in two planes of the wheel bore;
e) the press-on tonnage achieved for each wheel pressed-on and, where applicable, force displacement diagrams;
f) the wheelset back-to-back dimension, measured at three points equidistant around the outer wheel circumference, 40 mm below the outer circumference of the wheel flange;
g) individual wheel and axle identification;
h) if press-fitted, the lubricant type used;
i) if shrink-fitted, the wheel test load;
j) the variation in wheel diameters; and
k) relevant bearing information.

10.6 Wheelset dimensions and tolerances

10.6.1 The operator shall specify wheelset dimensions and tolerances. These dimensions shall include back-to-back and wheel profiles. The dimensions and tolerances shall be indicated clearly on the operator's and manufacturer's wheelset drawings.

11 Monitoring and maintenance requirements

11.1 Maintenance plan

11.1.1 The operator shall establish, develop or adopt, implement and maintain a maintenance plan that shall incorporate all specifications, procedures and processes for the monitoring, examination, inspection, testing and when necessary the replacement of wheelsets.

11.1.2 The maintenance plan shall be applied at an adequate frequency to ensure that all wheelsets are at all times in compliance with applicable specifications and operating conditions.

11.1.3 The maintenance plan shall cover both in-service and out-of-service wheelsets and shall specify:

a) the inspections and measurements required to ensure compliance with the operator's applicable specifications and standards;
b) the mandatory actions to ensure compliance with the applicable specifications and standards; and
c) the required maintenance intervals and inspection cycles. The type of vehicles, axle-loads, routes covered, speeds, transportation of corrosive commodities shall as a minimum be taken into account in determining and specifying the inspection intervals.

11.2 Compliance to limits of wear and defects

11.2.1 The operator shall, as part of its safety management system, define in its maintenance plan the processes and procedures to be used to ensure that wheelsets are maintained to within specified limits.

11.2.2 Dimensional limits and tolerances for wheelsets shall be specified to ensure that safety limits for both wear and defects are not breached in the period between examinations whilst in in-service operation.

11.2.3 The safety limits shall be defined in a wheelset database and form part of the relevant maintenance plan.

11.2.4 The following minimum geometric requirements for new, re-profiled and in-service wheelsets shall be specified and tabulated for each type of vehicle:

a) minimum wheel diameter;
b) minimum rim thickness;
c) maximum wheel wear;
d) tolerance between diameters of wheels on the same axle;
e) tolerances between diameters of wheels on the same bogie;
f) tolerances between wheelsets in the same wagon, coach or locomotive;
g) minimum flange thickness;

h) back to back dimensions;
i) flange and tread profiles;
j) wheel tread surface damage;
k) wheel surface defects limits;
l) marks on axles;
m) bearing floats and clearances; and
n) bearing grease.

NOTE: All gauges and measuring equipment used shall be regularly checked and calibrated.

11.3 Assessment of tread condition

11.3.1 The tread profiles shall remain within the specified limits for the appropriate profile. This shall be ensured through regular inspection and measurements as defined in the maintenance plan.

11.3.2 The tread profile and wheel dimensions after re-profiling shall be defined on the basis of:

a) the results of vehicle acceptance testing (for example: stability verification, etc.); and
b) service experience.

11.3.3 The wear limits and the minimum re-profiling diameters shall be specified. Appropriate gauges shall be used when determining acceptability of the profile.

11.3.4 Wheel profiles shall be rectified before the profile limits are infringed.

11.4 Corrosion protection

11.4.1 The maintenance plan shall incorporate the requirement for the examination of wheelsets to ensure that the integrity and quality of the corrosion protection where used is intact.

11.4.2 Procedures detailing the actions necessary to rectify damaged corrosion protection on a wheelset shall be documented.

11.4.3 Wheelsets that come into contact with materials that can contaminate or cause corrosion of the wheelsets shall be subject to NDT inspection at an increased frequency to ensure that defective or corroded wheelsets are detected and withdrawn from service.

11.4.4 The NDT regime shall be maintained even after a change of use to a less corrosive cargo until wheelsets are overhauled, stripped of the protective coating and subjected to magnetic particle inspection (MPI) or similar NDT technique.

11.5 Old wheelsets

11.5.1 Wheelsets or wheelset components that are over 40 years old shall be permitted only to continue in use subject to their continuing to meet the required tests and examinations. The maintenance plan should ensure that those wheelsets or wheelset components are:

a) subjected to NDT at a frequency twice as often as that of similar wheelset or wheelset components that are less than 40 years old;
b) that such wheelset or wheelset components are identified with an “X” stamped in front of the manufacturing or assembling contractor’s code; and
c) that the wheelset database is updated to recognise the increased frequency of NDT.

11.6 Replacement wheelsets

11.6.1 Replacement wheelsets shall be:

a) within the tolerance limits specified for the particular wagon, coach or locomotive;
b) be compatible with the other wheelsets on the vehicle; and
c) satisfy the requirements of any subsystems fitted to the vehicle.

11.6.2 Replacement wheelsets shall have valid NDT certification.

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

11.6.4 Wheelset records shall be updated before a wheelset is despatched for overhaul.

11.7 Non-destructive testing

11.7.1 NDT inspection

11.7.1.1 The NDT periodicity shall be specific to the vehicle type, wheelset type and its duty.

11.7.1.2 The NDT testing of axles shall be in accordance with the wheelset maintenance plan.

11.7.1.3 Records of NDT inspections shall be captured and archived in a proper documented system for the life of the axle, wheel or wheelset as applicable.

11.7.2 NDT periodicity

11.7.2.1 The wheelset NDT periodicity shall be recorded in the maintenance plan and the wheelset database.

11.7.2.2 The NDT periodicity may be either time or distance-based but if time-based shall not be greater than eight years.

11.7.3 Changes in NDT periodicity

11.7.3.1 Before the NDT periodicity is lengthened, a documented technical review shall be undertaken to ensure that the risk of such a change has been addressed. Such NDT periodicity amendments shall be incorporated into the maintenance plan and wheelset database.

11.7.3.2 The technical review shall consider factors that affect the fatigue life, including the following:

a) loadings;
b) duty cycle;
c) axle material properties;
d) wheel material properties;
e) suspension designs;
f) NDT inspection period;
g) fracture propagation prediction;
h) defect size; and
i) probability of detection (NDT method used and flaw-detection capabilities).

11.7.4 Examination

11.7.4.1 Wheelsets shall be examined whenever a vehicle is presented for:

a) wheelset maintenance, as set out in the vehicle maintenance plan;
b) general vehicle condition examination; and
c) a vehicle repair that affects either the wheelsets, bogies or suspensions.

11.7.4.2 Additionally, wheelsets shall be examined whenever required by the following:

a) receipt of an incident report, for example: rough-riding, striking an object, unusual noise, wheel-flats, derailment;
b) report of a wheel load impact detector exceedance;
c) activation of a hot-box detector;
d) detection of seized brakes or heat discolouration;
e) detection of a seized or damaged bearing;
f) bearing grease leakage or loss,
g) water ingress into a wheel bearing;
h) after vehicle shipment or transhipment; or
i) when the vehicle has been stationary for a period of time longer than as defined in the maintenance plan.

NOTE: It is permissible for the scope of an examination to be vehicle or wheelset specific.

11.7.5 General examination requirements

11.7.5.1 The wheelset shall be examined for integrity including the following:

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 could 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 cracking and rolling contact fatigue cracks in the centre of the tread surface should not exceed the limits stated in the appropriate maintenance specification; and
f) any sign of movement at interference-fit interfaces;

11.7.5.2 Where there is reason to suspect that dimensions are at variance with requirements, a check shall be made to ensure that all relevant dimensions are within limits:
a) back-to-back dimension, measured at axle height and at three equi-spaced locations around the wheelset;
b) wheel tread diameters;
c) wheel profiles; and
d) wheel tread diameter difference between wheelsets.

11.7.6 Axle examination

11.7.6.1 The axles shall be examined for at least the following:
a) Flame-cutting damage, weld-spatter or electric-arc damage;
b) integrity of the axle's surface coating;
c) damage to axle end threaded holes when the holes are exposed for reasons other than the visual inspections.

11.7.7 Tread examination

11.7.7.1 Where the visual inspection of the tread profile suggests that it is worn or damaged, the following shall be done:
a) examine for, and measure, tread damage, flats and cavities;
b) measure or gauge tyre and 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); and
f) examine the profile for grooving, false flange, flange step, hollow wear, etc. to ensure they are within allowable limits.

11.7.8 Wheelset defects

11.7.8.1 Procedures, processes and instructions shall be established, developed, adopted, implemented and maintained for corrective action to be taken to address wheelset defects.

11.7.8.2 The corrective actions for the identified defects shall comply with the mandatory requirements specified in the adopted suite of applicable standards; for example, EN 15313 or other equivalent standards.

12 Modification

12.1 Processes and procedures for modification

12.1.1 The processes and procedures for the modification of wheelsets and associated components shall include the following:

a) subjecting the proposed modification to the life-cycle phases of design, manufacturing, testing, monitoring and maintenance;
b) the effects of the proposed modification on safety of interested and affected parties including the public, passengers, employees, contractors or service providers over all life-cycle phases; and
c) the communication of changes, modifications and transitional arrangements to all interested and affected parties during the life cycle phases.

12.1.2 Factors to be considered shall include:

a) process management in accordance with SANS 3000-1;
b) procedures for configuration management in accordance with SANS 3000-1 and ISO 10007/SANS 10007;
c) requirement for systemic engineering and operational safety standards – rolling stock SANS 3000-2-3;
d) existing performance or requirements for increased functionality or performance (or both);
e) safety performance;
f) defects and railway occurrence history;
g) availability of resources and components and appropriately calibrated and certified test, repair and measurement equipment; and
h) recommendations or findings (or both) arising from railway occurrence investigations, audits and inspections.

13 Decommissioning and disposal

13.1 Processes and procedures shall be established, developed or adopted, implemented and maintained for the decommissioning or disposal of wheelsets and associated components and the means of preventing inappropriate usage thereof. The following shall be included:

a) the identification of persons authorized to decommission, and where relevant remove and dispose of such decommissioned wheelsets and associated components;
b) appropriate marking of decommissioned wheelsets and associated components for identification purposes, to avoid operational and technical confusion during decommissioning and to prevent inappropriate re-use;
c) ensuring safe operations during decommissioning and where applicable, the disassembly and disposal of wheelsets and associated components;
d) minimization of environmental health and safety risks associated with the decommissioned wheelsets and associated components. Refer to relevant national legislation (see *Foreword*);
e) update the database of wheelsets and associated components; and
f) where the wheelsets and associated components are decommissioned with the intention for future use (mothballed), appropriate steps should be taken to protect these assets from deterioration, theft or malicious damage.

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