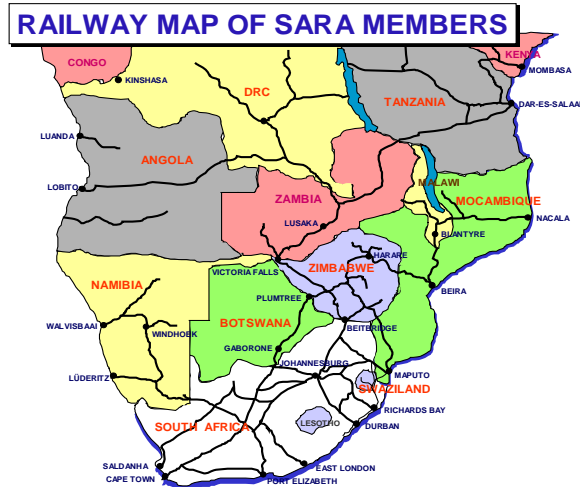




Railway Safety Management: Technical Requirements for Engineering and Operational Standards – Rolling Stock

FOR

SOUTHERN AFRICAN RAILWAYS ASSOCIATION



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Table of changes

| Change No. | Date | Scope |
|-------------------|-------------|--------------|
| | | |

Foreword**Foreword**

This SARA standard was approved by the SARA Board in November 2010.

This document was published in July 2011.

SARA Regional Safety Standards consists of the following documents,

SARA 001: SARA Safety Policy.

SARA 002: Technical requirements for engineering and operational standards – General.

SARA 003: Technical requirements for engineering and operational standards – Track, civil and electrical infrastructure.

SARA 004: Technical requirements for engineering and operational standards – Rolling stock.

SARA 005: Human Factors Management.

SARA 006: Technical requirements for engineering and operational standards – Track, Civil and Electrical Infrastructure – Level Crossings.

SARA 007: Technical requirements for engineering and operational standards – Train Operations Management. (In course of preparation)

SARA 008: Railway occurrence management. (In course of preparation)

SARA 009: Technical requirements for engineering and operational standards – Train control systems and equipment. (In course of preparation)

Annex A is for information only.

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Southern African Railway Association (SARA) Safety Standards

SARA 004:

Technical requirements for engineering and operational standards —
Rolling stock

1 Scope

This standard covers the asset life cycle components of design, construction/manufacturing and implementation, commissioning, monitoring and maintenance, modification, and decommissioning and disposal of rolling stock.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from Standards South Africa.

SARA 001: SARA Safety Policy.

SARA 002: *Technical requirements for engineering and operational standards – General.*

SANS 10007, *Quality management systems – Guidelines for configuration management.*

3 Definitions

For the purposes of this document, the definitions given in SARA 001 and the following apply.

3.1 Validation

Confirmation that particular requirements for a specific use are fulfilled

3.2 Verification

Testing and evaluation of an item of equipment or a system to assure compliance with its specification or other requirements

4 General

4.1 Standards and procedures shall be established, developed or adopted, implemented and maintained for the

- a) design (see clause 6),
- b) operating parameters (see clause 7),
- c) rolling stock items (see clause 8),
- d) manufacturing (see clause 9),

- e) inspection, testing and commissioning (see clause 10),
- f) monitoring, maintenance and in-service inspections (see clause 11),
- g) control of the process of modification or reconstruction (see clause 12), and
- h) decommissioning and disposal (see clause 13),

of rolling stock, including rolling stock systems, sub-systems and components to ensure that the appropriate safety requirements and standards are met.

4.2 Standards and procedures shall be established, developed or adopted, implemented and maintained for the validation and verification of:

- a) the design (see clause 6),
- b) all stages of manufacturing (see clause 9), and
- c) all other life cycle phases

of rolling stock, including rolling stock systems, sub-systems and components.

4.3 Standards and procedures shall be based on the consideration of detailed selection and design recommendations.

4.4 Consideration shall be given to the inclusion of the items listed in this standard in the railway operator's safety management system, as detailed in SARA 001, based on the operator's risk assessment and the type of operation being undertaken by the railway operator.

4.5 The railway operator should consider including the relevant items listed in clause 8 and annex A in his/her safety management system in accordance with SARA 001.

5 Independent evaluation

The validation and verification processes shall be performed at an appropriate level of independence. The degree and the nature of independence shall be determined by at least the following factors:

- a) the risk of errors, omissions and biases being perpetuated; and
- b) the risk of interference between the new and existing systems.

NOTE Independence does not necessarily imply the usage of an external party.

6 Design

Design and construction of rolling stock should aim not only at eliminating faults which will lead to failures, but also at ensuring that the consequences arising from any failure will be minimized.

7 Operating parameters

Operating parameters shall be determined in accordance with SARA 001 and SARA 002.

8 Rolling stock items

8.1 Standards and procedures for the selection and design of rolling stock shall include the following items, where relevant:

- a) Vehicle body:
 - 1) body structure;
 - 2) exterior aesthetics;
 - 3) exterior doors and steps;
 - 4) couplers and draw gear;
 - 5) gangways;
 - 6) window units;
 - 7) body additions;
 - 8) visibility.
- b) Bogies and running gear:
 - 1) bogie structure;
 - 2) suspension;
 - 3) wheel set;
 - 4) traction link;
 - 5) bogie additions.
- c) Motive power supply:
 - 1) line voltage system;
 - 2) electric power conditioning;
 - 3) electric power conversion;
 - 4) engine system;
 - 5) mechanical power conversion.
- d) Train system control.
- e) Propulsion:
 - 1) drive system;
 - 2) traction controller;
 - 3) adhesion optimization.
- f) Braking:

- 1) braking system;
 - 2) braking control;
 - 3) adhesion optimization;
 - 4) braking performance.
- g) Auxiliaries:
- 1) air system;
 - 2) hydraulic system;
 - 3) battery system;
 - 4) electric supply system.
- h) Communication:
- 1) fault and diagnostic systems;
 - 2) data communications;
 - 3) information/voice communication.
- i) Coach interior or driver/operator cab interior:
- 1) interior architecture;
 - 2) heating, ventilating, and air conditioning (HVAC);
 - 3) interior doors;
 - 4) water services;
 - 5) catering;
 - 6) ticketing;
 - 7) lighting;
 - 8) ergonomics.
- j) Special:
- 1) tilt system;
 - 2) maintenance vehicles;
 - 3) remote control;
 - 4) fire and vandalism.

NOTE A detailed description of the items above is given in annex A.

9 Manufacturing

9.1 General

The items listed in 9.2, including those in annex A, should be included in the railway operator's safety management system and determined in accordance with SARA 002 and this standard.

9.2 Requirements

Standards and procedures for the manufacturing of rolling stock (see clause 8) shall include the following:

- a) process control in accordance with SARA 001;
- b) appropriate manufacture and installation practices and specifications;
- c) procedures to ensure the use of approved and current plans; and
- d) preparation of operating and maintenance procedures and instructions.

10 Inspection, testing and commissioning

10.1 General

Inspection, testing and commissioning of rolling stock are essential elements in ensuring safety integrity. Inspection, testing and commissioning should complement and in no way substitute, quality control of the design, production, and installation.

The inspection and testing requirements of rolling stock in 10.2, including those items given in annex A, should be included in the railway operator's safety management system and determined in accordance with SARA 002.

10.2 Inspection and testing requirements

Standards and procedures shall include inspection, testing requirements and checking of the following, where applicable:

- a) Independence in the performance of inspection, testing and commissioning.
- b) Compatibility between new or modified rolling stock, rolling stock elements, and systems, and with other functional disciplines and the environment.
- c) Validation and verification of the rolling stock, rolling stock systems, sub-systems, or components, as applicable.
- d) Safe phasing in of any system change.
- e) Procedures for handover and acceptance of rolling stock.
- f) Inclusion of rolling stock in the operational vehicle fleet.
- g) Provision of relevant documentation, including manufacturing drawings, maintenance manuals and operating procedures.

11 Monitoring, maintenance and in-service inspections

11.1 General

The items listed below, including those in annex A, should be included in the railway operator's safety management system and determined in accordance with SARA 002.

11.2 Requirements for monitoring

11.2.1 General

11.2.1.1 Monitoring shall include the following, where relevant:

- a) a system to ensure that rolling stock is available for scheduled inspections;
- b) rolling stock inspection and testing in accordance with specified safety requirements;
- c) train integrity checking before departure and en route;
- d) identification of safety critical faults and abnormal deterioration rates; and
- e) notification of reduced serviceability.

11.2.1.2 In-service inspections of rolling stock items as listed in clause 8 shall be considered when required and as specified in the organization's safety management system.

11.2.2 Requirements for maintenance

Maintenance processes necessary for rolling stock, including rolling stock systems, sub-systems and component reliability, availability, maintainability and safety, shall be identified and planned. Processes shall include the following:

- a) Preventive or corrective maintenance plans such as
 - 1) process control in accordance with SARA 001, including record-keeping;
 - 2) procedures to ensure restoration to the required standard; and
 - 3) procedures for configuration management in accordance with SARA 002 and SANS 10007.
- b) Availability of manuals such as those that cover operating, maintenance and components of rolling stock.

12 Modification

Standards and procedures for the control of the process of modification or reconstruction of rolling stock, including rolling stock systems, sub-systems and components, shall include consideration of the following:

- a) Effects of the proposed modification on the railway system as a whole.
- b) Effects of the environment on the proposed modification.
- c) Design, implementation and commissioning of the modification or re-build in accordance with clause 6 to clause 10 (inclusive).

- d) Effective recording, promulgation, and communication of changes and modifications where especially operational safety is affected.
- e) Configuration management.

13 Decommissioning and disposal

Standards and procedures shall be established, developed or adopted, implemented and maintained for the decommissioning and disposal of rolling stock, including rolling stock systems, sub-systems, components, and means of preventing inappropriate usage before disposal. The following shall be included:

- a) Appropriate marking of each decommissioned item for identification purposes.
- b) Procedures for the movement of decommissioned rolling stock, including rolling stock systems, sub-systems and components, and the identification of persons authorized to allow such movement.
- c) Ensuring safe operations during decommissioning, scrapping, and disposal.
- d) Ensuring that the condition of decommissioned material and equipment is clearly identified.
- e) Prevention of inappropriate reuse of decommissioned material.
- f) Minimization of environmental risks, including health, safety, and pollution hazards associated with the decommissioned items, considering both short-term and long-term impact.

The items listed above shall be included in the railway operator's safety management system in accordance with SARA 001.

Annex A
(informative)

Detailed description of rolling stock items

This annex provides a detailed description of the items listed in clause 8.

Table A.1 — Detailed description of rolling stock items

| 1 | 2 | 3 |
|------------|---|--|
| No. | System | Characteristic hardware, components, parts, etc. |
| 1 | Vehicle body: | |
| | Body structure | Body sides, body ends, roof, including welded items, under-frame, including welded items, floor, integrity of pressure vessels, crashworthiness, structural partitions, articulation joints/structure, skirt, obstacle deflector (cowcatchers), anti-climb units, roof hatches, centre of gravity, static and kinematic rolling stock profile, fixtures for jacking lifting and towing |
| | Exterior aesthetics | Exterior finish panels, paint, decals, stickers, plates |
| | Exterior doors and steps | Exterior doors, door gear and control components, steps (folding/sliding), ladders, hatches, bottom discharge, securing mechanisms, accessibility |
| | Couplers and draw gear | Coupler control components, buffing and draw gear, supporting components, coupler type, coupler heights, strength, energy absorption, coupling and uncoupling operation, recovery of failed trains, horizontal and vertical coupler angles |
| | Gangways | Doors, gates, vestibule enclosure, safety covers and flooring |
| | Window units | Safety glass, window unit design (material and size), windscreen, stone guards, glare, emergency exit and demisting |
| | Body additions | Exterior fittings (grab rails, etc.), skirt, cab module, under-frame equipment, under-slung equipment (e.g. engines, transformers, generators) fixtures (e.g. twist locks, tarpaulin hooks), tanks (fuel, water, air, hydraulic, etc.), mirror, horn, windscreen wash/wipe, identification, signage and antennas |
| Visibility | Exterior lighting (headlights, tail-lights and step lights) end-of-train markers, reflective material and colour scheme | |
| 2 | Bogies and running gear: | |
| | Bogie structure | Bogie frame and bogie-to-body interface |
| | Suspension | Dynamic behaviour (running safety, track loading, ride characteristics), slewing bracket, springs (coil, blade, rubber, chevron, airbags), surge reservoir, bump stops, dampers, resilient components and motor nose suspension |

Table A.1 (continued)

| 1 | 2 | 3 |
|-----|---------------------------------|---|
| No. | System | Characteristic hardware, components, parts, etc. |
| 2 | Bogies and running gear: | |
| | Wheel set | Solid/tyred wheels, resilient/noise reduction wheels, assembly, geometric tolerances, electrical resistance, heat dissipation, balancing, identification, axle bearings (lubrication), axles (material, identification), wheels (wheel profile, material, identification), gear wheels, cannon boxes, u-tube and quill |
| | Traction link | Traction rod, centre pivot and slew bracket |
| | Bogie additions | Flange lubrication components, sanding components, inter-bogie control, jacking/lifting points, life guards/derailment bars/rail sweepers, earthing and friction liners |
| 3 | Motive power supply: | |
| | Line voltage system | Pantograph and control components (location and number of pantographs, dynamic behaviour, isolation, current collection), high voltage filter, main circuit-breaker, line circuit-breaker, surge/lightning arrester, pantograph switch, earthing switch, measuring transformer, current balance measurement device (return transformer, resistor, current balancing relay), contactors, fuses, axle earthing, high voltage cabling and clearances |
| | Electrical power conditioning | Line filter, power factor correction and harmonic filter |
| | Electrical power conversion | Main transformer, line converter/rectifier, inverter, DC-link filter, switchgear, voltage regulator, discharge and protective resistors, earth fault detector, earth switch, cooling system (including fan and pump), air filters, duct, supporting and control components |
| | Engine system | Engine rating, exhaust emissions, fuel/lubricant/coolant system (filling, tank size, etc.), control/monitoring components and noise suppression (engine and exhaust) |
| | Mechanical power conversion | Generator/alternator, hydraulic pump, direct drive and torque converters |
| 4 | Train system control: | Driver safety device (dead man's feature), vigilance, train continuity, door continuity, automatic train control (ATC), automatic train protection (ATP), automatic train operation (ATO), communication, interlocking and remote control of multiple consists |
| 5 | Propulsion: | |
| | Drive system | Traction motor, fans and pumps, heat exchanger, air inlet, filter, duct, motor supporting components, gear box, final drive, coupling, drive shaft, transmission, speed sensor and wheel |
| | Traction controller | Traction power controller (inverter, converter, chopper, hydraulic valves, etc), switchgear and cooling system (including fans and pumps) |

Table A.1 (continued)

| 1 | 2 | 3 |
|-----|---------------------------------|--|
| No. | System | Characteristic hardware, components, parts, etc. |
| 5 | Propulsion: | |
| | Adhesion optimization | Wheel slip and slide control (creep control, sanding, flange lubrication, wheel speed differentiation) and wheel/rail profile |
| 6 | Braking: | |
| | Braking system | Wheel brakes, disc brakes, and tread brakes, electric/dynamic brakes, magnetic track brakes, parking brakes, hand brakes, air/vacuum, brake rigging and emergency brakes |
| | Braking control | Brake controller, emergency brake vent valve, load sensing, electronic control pneumatic braking (ECPB), automatic train protection (ATP), single vehicle manual release/isolation/blow down |
| | Adhesion optimization | Wheel slip and slide control, sanding, brake system interlocking and blending, and set limit adhesion level |
| | Braking performance | Stopping distances, brake ratios and holding capability |
| 7 | Auxiliaries: | |
| | Air system | Main compressor, auxiliary compressor, oil separator, air dryer, exhausters, filter, protection components supporting components and control components, main reservoir and components, shore supply connections for air supply system, airbags, sanding, door operating, auto coupler, main circuit-breaker, pantograph, pneumatic cocks, piping/hoses and test points for gauges |
| | Hydraulic system | Pump, motor, accumulator, cooler, piping/hoses and controls |
| | Battery system | Battery, ventilation, protection, charger, contactors and controls |
| | Electric supply system | Auxiliary transformer, motor generator/alternators, converter/inverter, filter, protection, earthing, contactors, control components, shore supply connections and distribution |
| 8 | Communication: | |
| | Fault and diagnostic system | Vehicle testing, fault detection storage, conditioning monitoring, maintenance support system, machine interface and event recorder/accident recorder ("black box") |
| | Data communications | Train communication network, data link, train and vehicle bus gateway |
| | Information/voice communication | Passenger and crew information, telecommunications, driver communication, public address system, CCTV, train crew "bell" signals and emergency passenger to driver communication |
| 9 | Coach interior: | |
| | Interior architecture | Flooring, wall panels, ceilings, partitions, seats, beds and bedding, fittings (strength of fixture and fittings), luggage areas/racks, painting, notices/signage, facilities for disabled passengers, passenger emergency communication, grab poles and rails, fire and emergency equipment, fire retardant and non-toxic materials, storage compartments and securing/locking of equipment cupboards |

Table A.1 (concluded)

| 1 | 2 | 3 |
|------------|--|--|
| No. | System | Characteristic hardware, components, parts, etc. |
| 9 | Coach interior: | |
| | HVAC | Heating, ventilation, air conditioning, air treatment, ducting and control components |
| | Interior doors | Internal doors (including safety interlocking), door gear and control components |
| | Water services | Sanitary equipment, ablution facilities, fresh water supply and effluent tank |
| | Catering | Refrigerator, freezer, oven, stove, hot plate, microwave ovens, coffee maker, components (work surfaces, storage, etc.) |
| | Ticketing | Equipment for selling and validating passenger tickets and the necessary communication system |
| | Lighting | Seat, emergency, entrance, passageways |
| | Ergonomics | Noise and heat/cold insulation, vibration, ride comfort |
| 10 | Driver/operator cab interior: | |
| | Interior architecture | Flooring, windows (composition, tint and protection), windscreen wipers, demisting, sun visor, side mirrors, safety panels and doors, ceiling, cab back wall/bulkhead, seats, fittings (strength of fixture and fittings), drivers desk, drivers control panel, train assistants/guards desk, notices/signage, safety components (warning devices), fire and emergency equipment, fire retardant and non-toxic materials, storage compartments |
| | HVAC | Heating, ventilation, air conditioning, air treatment, ducting |
| | Interior doors | Internal doors (including safety interlocking), control components |
| | Water services | Sanitary equipment, fresh water supply, effluent tank |
| | Catering | Hot plate, fridge, microwave |
| | Ticketing | Equipment for selling and validating passenger tickets and the necessary communication system |
| | Lighting | General, seat, emergency, entrance, toilet, drivers cab lighting, head and tail lights, drivers control panel lighting |
| Ergonomics | Noise and heat/cold insulation, vibration, ride comfort, line of sight, position of controls, percentile person and anthropomorphic considerations | |
| 11 | Special: | |
| | Tilting system | Control components |
| | Maintenance vehicles | Specialized components |
| | Remote control | Shunting |
| | Fire and vandalism | |

Bibliography

SARA 003: *Technical requirements for engineering and operational standards – Track, civil and electrical infrastructure.*

Southern African Railway Association