

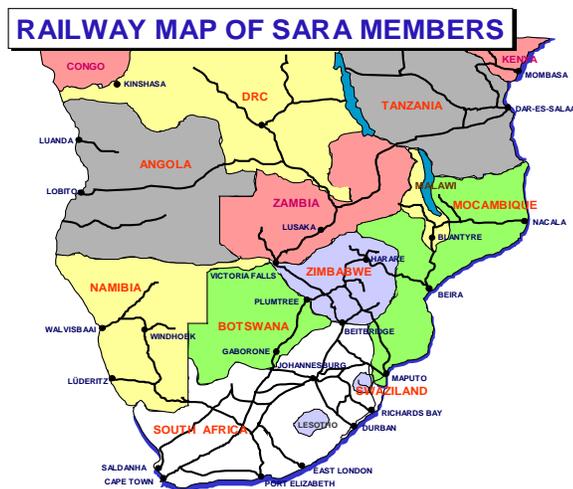


"Together we are better"

# Railway Safety Management: Technical Requirements for Engineering and Operational Standards – Track, Civil and Electrical Infrastructure

FOR

**SOUTHERN AFRICAN RAILWAYS ASSOCIATION**



*Issued with the Authority of the SARA Board, November 2010.*

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**Table of changes**

<b>Change No.</b>	<b>Date</b>	<b>Scope</b>

**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)*

Reference is made in 9.2(g) to the “relevant national legislation”. In each country the relevant occupational health and safety legislation.

Annexes A to C are for information only.

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## **Southern African Railway Association (SARA) Safety Standards**

### **SARA 003:**

Technical requirements for engineering and operational standards — Track, civil and electrical infrastructure

## **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.

## **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/ISO 10007, *Quality management systems – Guidelines for configuration management.*

## **3 Definitions**

For the purposes of this document, the definitions given in SARA 001 AND SARA 002 and the following apply.

### **3.1 Checkrail**

Rail positioned in track at particular locations to guide wheel sets through points and crossings

### **3.2 Gauge**

Distance between the running faces of the two rails, measured a nominal distance below the tops of the railheads

### **3.3 Guardrail**

Rail positioned in track at particular locations to restrict the lateral movement of derailed wheels

### **3.4 Permissible rolling-stock profile**

Outline that defines the limiting cross-sectional geometry for rolling stock and its load including kinematic effects

### **3.5 Permissible-structure profile**

Outline relative to the track cross section that defines the limiting cross-sectional geometry on which no part of any structure or trackside fixture may infringe

### **3.6 Point and crossing**

Track structure that provides for one track to join or cross another

**3.7 Rail temperature**

Neutral temperature at which the track has no longitudinal thermal stresses

**3.8 Superelevation**

Cant

Difference in the rail level of the two rails in track

**3.9 Track buckle**

Kick-out

Substantial misalignment contributed by longitudinal thermal stresses overcoming the lateral resistance of the track

**3.10 Track geometry**

Vertical and horizontal alignment, gauge, twist and superelevation of the track

**3.11 Twist**

Change in the cant between two track locations separated by a nominated distance interval

**3.12 Validation**

Confirmation that particular requirements for a specific use are fulfilled

**3.13 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) Track, civil and electrical infrastructure (see clause 8),
- d) Construction (see clause 9),
- e) Inspection, testing and commissioning (see clause 10),
- f) Monitoring and maintenance (see clause 11),
- g) Control of the process of modification or reconstruction (see clause 13), and
- h) Decommissioning and disposal (see clause 14),

of the track, civil and electrical infrastructure, including 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) Construction (see clause 9), and

c) All other life cycle phases

of the track, civil and electrical infrastructure, including 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 SARA 002 in the 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 operator.

## **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 track, civil and electrical infrastructure 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.

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

## **7 Operating parameters**

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

## **8 Track, civil and electrical infrastructure items**

Standards and procedures for the selection and design of the track, civil and electrical infrastructure shall include the following items, where relevant:

- a) sight distance provision;
- b) operational signage;
- c) structure and electrical infrastructure clearances;
- d) track geometry;
- e) structures;
- f) flooding and storm damage management;
- g) earthworks;

- h) rail support systems;
- i) rail;
- j) guardrails;
- k) points and crossings;
- l) track lateral stability;
- m) access control and protection;
- n) fire prevention and control;
- o) operation and control of the electrical system;
- p) electric traction system capacity and integrity;
- q) separation distances from electrical equipment;
- r) working on live equipment;
- s) electrical switching and isolating procedures;
- t) earthing and bonding;
- u) spatial location of conductors;
- v) electrical fault protection;
- w) electrolysis mitigation; and
- x) electric traction system interference management.

NOTE The detailed recommendations and factors given in annex A are, in many instances, of particular relevance to steel wheels on steel rail systems using open-ballasted tracks. When preparing standards and procedures for other systems, the items given in annex A may be added or deleted from the list to correspond to the relevant type of operation.

## **9 Construction**

### **9.1 General**

The items listed in 9.2, including those in annex A and annex B, should be included in the operator's safety management system and determined in accordance with clause 6 to clause 8 (inclusive) and SARA 002.

### **9.2 Requirements**

Standards and procedures for the construction of the track, civil and electrical infrastructure (see clause 8) shall include the following:

- a) maintenance of safe railway operations during any system changes;
- b) process control in accordance with SARA 001 and SARA 002;

- c) work-site operation and management (see annex B for more information);
- d) access control and protection (see annex A for more information);
- e) compliance with design documentation, use of construction and installation practices and procedures consistent with the intent of the design (for the relevant items included see clause 8 and annex A);
- f) procedures to ensure use of approved and current plans and specifications; and
- g) compliance with the relevant national legislation (see foreword).

## **10 Inspection, testing and commissioning**

### **10.1 General**

Inspection, testing and commissioning of the track, civil and electrical infrastructure systems are essential elements in ensuring safety integrity. Inspection, testing and commissioning should complement and in no way substitute quality control of design, production and installation.

The inspection and testing requirements of the track, civil and electrical infrastructure items in 10.2, including those items given in annex A and annex B, should be included in the 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) the level of competency to conduct the commissioning;
- b) demonstration of independence of the commissioning organization;
- c) compatibility with the existing infrastructure and other functional disciplines;
- d) validation of the safety performance, i.e. confirmation that the particular safety performance requirements for each specific use are fulfilled;
- e) verification through testing and evaluation of the system to assure compliance with its design specification and the operating parameters of the railway;
- f) the assurance of safe transition during any system change;
- g) the handover process; and
- h) the provision of as-built plans, where relevant.

## **11 Monitoring and maintenance**

### **11.1 General**

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

## **11.2 Requirements**

Standards and procedures for monitoring and maintenance of the track, civil and electrical infrastructure, including systems, sub-systems and components, shall include the following:

- a) The inspection, testing, monitoring and maintenance of the relevant infrastructure listed in clause 8 (also see annex A for more information).
- b) The assessment of serviceability by means of either
  - 1) condition standards,
  - 2) assessment rules,
  - 3) detailed analysis, or
  - 4) any combination of the above.
- c) The carrying out of preventative or corrective action, including the following:
  - 1) process control in accordance with SARA 001, SARA 002 and SANS 10007;
  - 2) work-site operation and management (see annex B for more information);
  - 3) access control and protection (see annex A for more information);
  - 4) use of appropriate maintenance practices, procedures and records;
  - 5) procedures to ensure restoration of works to the required standard; and
  - 6) availability of manuals such as those referring to operating, maintenance and components of the track, civil and electrical infrastructure.

## **12 Temporary operating restrictions**

### **12.1 General requirements**

Standards and procedures shall be established, developed or adopted, implemented and maintained for the imposition of temporary operating restrictions and shall include the following:

- a) determination of conditions and events which are likely to result in reduced operating safety;
- b) determination of sections of track, civil and electrical infrastructure at risk;
- c) methods of detection of and reporting on the onset of conditions and events described in (a) and (b); and
- d) frequency of scheduled inspections and requirements for special inspections.

NOTE A recommended list of items to consider for both scheduled and unscheduled inspections is given in annex C.

### **12.2 Factors to be considered**

Standards and procedures shall take into consideration the following factors:

- a) relevant serviceability criteria (see 11.2(b));
- b) track, civil and electrical infrastructure features where the potential for obstruction is higher than usual, for example at level crossings, utility crossings, tunnels and structures;
- c) historical records of conditions and events (natural and other) which have caused reduced operating safety or obstruction of the track, including vegetation encroachment, vandalism and unauthorized access;
- d) potential problems noted at scheduled inspections such as changes in condition; and
- e) requirements at work sites.

### **13 Modification**

Standards and procedures for the control of the process of modification or reconstruction of track, civil and electrical infrastructure, including 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 part or re-build in accordance with clause 6 to clause 10 (inclusive).
- d) Effective recording, publication and communication of changes and modifications where especially operational safety is affected.
- e) Configuration management.

### **14 Decommissioning and disposal**

Standards and procedures shall be established, developed or adopted, implemented and maintained for the decommissioning and disposal of track, civil and electrical infrastructure, including systems, sub-systems, components, including the 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 track, civil and electrical infrastructure, including 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 impacts.

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



## **Annex A** (informative)

### **Infrastructure elements**

#### **A.1 General**

This annex lists detailed recommendations and factors in respect of each of the track, civil and electrical infrastructure items listed in this standard.

#### **A.2 Sight distance provision**

##### **A.2.1 Detailed recommendations**

Standards and procedures for the provision of sight distance for train crew should include the following:

- a) the minimum required sight distance for all pertinent features and devices, for example signals and track side indicators;
- b) requirements for advance warning where line-of-sight is either permanently or temporarily obstructed; and
- c) characteristics and performance requirements for such advance warning devices.

##### **A.2.2 Factors**

The following factors should be considered:

- a) The action that the feature or device requires from the train crew.
- b) The visibility, legibility and intelligibility of the pertinent features and devices.
- c) Permanent obstructions and the possibility of temporary obstruction of, or encroachment on, the minimum required distance for line-of-sight (for example by topography, vegetation, vehicles, equipment or structures).
- d) Environmental, climatic and seasonal conditions.
- e) Maximum allowable line speed.
- f) Train-handling characteristics.

#### **A.3 Operational signage**

##### **A.3.1 Detailed recommendations**

Standards and procedures for operational signs, including those associated with track, civil and electrical infrastructure should include the following:

- a) physical description, design, size and placement of signage both permanent and temporary, including those in the following categories:

- 1) signage that indicate operational system requirements,
  - 2) speed restriction signage,
  - 3) structure and location identification signage,
  - 4) signage that indicate working areas, for example track occupation and electrical permits,
  - 5) non-electrified section signage,
  - 6) trackside equipment identification labels and signage, for example hot axle box detectors, points machines and signal identification numbers, and
  - 7) station signage, for example emergency equipment.
- b) characteristics and performance requirements for signage; and
- c) procedures for commissioning and decommissioning of signage.

NOTE Signage and barriers for access control and protection are given in A.14.2.

### **A.3.2 Factors**

The following factors should be considered:

- a) The consistency of signage throughout the system and, where practicable, with other systems.
- b) The visibility and legibility of signage to convey a clear, concise and unambiguous meaning at all times and under all conditions.

## **A.4 Structure and electrical infrastructure clearances**

### **A.4.1 Detailed recommendations**

**A.4.1.1** Standards and procedures should ensure that there are safe clearances between:

- a) rolling stock and fixed or moveable structures, equipment or vegetation;
- b) track, civil and electrical infrastructure and rolling stock; and
- c) rolling stock on adjacent tracks.

**A.4.1.2** These standards and procedures should also include the determination and assessment of

- a) permissible structure profiles;
- b) permissible rolling-stock profiles; and
- c) control of tolerances under the prevailing operating and maintenance conditions for track, civil and electrical infrastructure and rolling stock.

### **A.4.2 Factors**

The following factors should be considered:

- a) Kinematic effects.
- b) Electrical static and passing clearances.
- c) Track geometry and smoothness, which, under conditions of reduced clearances, may require detailed consideration of the following:
  - 1) wheel flange to rail clearances and tolerances,
  - 2) rail side wear,
  - 3) gauge widening,
  - 4) gauge tolerances, and
  - 5) variation from design track centre line, curvature or superelevation.

## **A.5 Track geometry**

### **A.5.1 Detailed design recommendations**

Standards and procedures for track geometry design should include the following:

- a) gauge;
- b) horizontal alignment, including curves and transitions;
- c) vertical alignment, including grades and vertical curves;
- d) twist; and
- e) superelevation.

### **A.5.2 Detailed recommendations for actual geometry**

Standards and procedures should include monitoring and maintenance of the actual track geometry to account for permissible variations from design track geometry (including discrete and cyclic variations).

The design of the monitoring systems should include the following:

- a) Parameters to be measured, for example measured track geometry or rolling stock forces imposed on the track.
- b) Sensitivity, repeatability and other characteristics of the measuring system.
- c) Effects on track geometry of the loads imposed on the track.

### **A.5.3 Factors**

The following factors should be considered:

- a) Rate of change of track geometry.
- b) Dynamic characteristics of the train and rolling stock.
- c) Adverse combinations of track geometry factors.
- d) Effect of rail joints.
- e) Track structure.
- f) Point and crossing structures.
- g) Level crossings.
- h) Rolling stock and structure clearance requirements.
- i) Relationship between electrical overhead and track geometry.

## **A.6 Structures**

### **A.6.1 General**

Standards and procedures for structures under, over and adjacent to the track should include consideration of the following factors:

- a) Traffic type, including speed, density and configuration.
- b) Environmental conditions likely to affect the integrity of structures.
- c) Structures that are able to withstand the required operating loads and load distribution under all service conditions.
- d) Impact protection.
- e) Structural condition of safety critical elements.

### **A.6.2 Structures owned by owners other than railway authorities**

Procedures should be established and maintained to ensure the safety of railway operations of all structures owned by owners other than railway authorities, under, over and adjacent to the track.

## **A.7 Flooding and storm damage risk management**

### **A.7.1 Detailed recommendations**

Standards and procedures for the management of the infrastructure under conditions leading to possible flood and storm damage should include the following:

- a) Determination of significant events likely to lead to reduced safety.
- b) Methods of detection and reporting of the onset of such defined events.

- c) Estimation of infrastructure at risk.
- d) Provision of flood mitigation structures and devices.
- e) Frequency of scheduled inspections of items likely to affect levels of flooding, and requirements for special inspections.
- f) Collection and recording of event data, and, if appropriate, the provision and operation of monitoring devices.

### **A.7.2 Factors**

The following factors should be considered in respect of locations susceptible to flooding and storm damage:

- a) Historical records of flooding and flood damage, and maintenance records.
- b) Checks, including hydraulic capacities of structures and drains.
- c) Upstream or downstream development, waterway restrictions and changes in other catchment conditions.
- d) Condition of flood protection structures and devices.
- e) Extent of existing flood damage.
- f) Landslips or rock falls.
- g) Frequency and type of rail traffic.
- h) Seasonal factors.

## **A.8 Earthworks**

### **A.8.1 Detailed recommendations**

Standards and procedures for earthworks and for monitoring conditions leading to possible instability of earthworks should include the following:

- a) Determination of significant events likely to lead to reduced safety.
- b) Methods of detection and reporting of the onset of such events.
- c) Frequency and type of inspections, including methods and levels of detail required.
- d) Collection and recording of event data, and, if appropriate, the provision and operation of monitoring devices.

NOTE See clause 12 regarding standards and procedures for controlling traffic at times of temporary operating restrictions.

## **A.8.2 Factors**

The following factors should be considered:

- a) Historical records of instability, and records of scheduled inspection results and maintenance.
- b) Design checks, measurement and testing of geotechnical properties and conditions, including
  - 1) erosion of formation width,
  - 2) weathering of rock faces and minor slips in cuttings, and
  - 3) landslips or rock falls.
- c) Maintenance of physical controls for prevention of instability.
- d) Restrictions to free drainage along the formation and through culverts and waterways.
- e) Track geometry faults due to earthwork instability.
- f) Seasonal factors.

## **A.9 Rail support systems**

### **A.9.1 Ballasts**

#### **A.9.1.1 Detailed recommendations**

Standards and procedures for ballasts should include the following:

- a) Provision of effective lateral, vertical and longitudinal sleeper support.
- b) Distribution of load to the formation.

#### **A.9.1.2 Factors**

The following factors should be considered:

- a) Cross-sectional profile of the ballast layer.
- b) Material properties of the ballast.
- c) Degree of consolidation of the ballast.
- d) Provision of effective drainage of the track structure.
- e) Evidence and extent of fouling, including mud pumping.
- f) Service loads.
- g) Electrical track impedence.

## **A.9.2 Sleepers, bearers and other rail support systems**

### **A.9.2.1 Detailed recommendations**

Standards and procedures for sleepers, bearers and other rail support should include the following:

- a) Provision of effective restraint and support for the rail fastening system, so as to maintain gauge, vertical, horizontal and longitudinal position and to resist rotation.
- b) Distribution of loads.

### **A.9.2.2 Factors**

The following factors should be considered:

- a) Means of determining effectiveness of individual sleepers, bearers and other rail support, including identification of failure modes.
- b) Limits on the percentage and distribution of effective sleepers, bearers and other support in the track.
- c) Track geometry and smoothness.
- d) Support condition.
- e) Service loads.
- f) Track circuit requirements.
- g) Other loads such as motor vehicles.

## **A.9.3 Fastening assemblies**

### **A.9.3.1 Detailed recommendations**

Standards for fastening assemblies should include the following:

- a) Provision of an effective location and fastening of the rail onto the sleeper.
- b) Transferring of loadings to the sleeper or support system.

### **A.9.3.2 Factors**

The following factors should be considered:

- a) Means of determining effectiveness of individual fastening assemblies.
- b) Limits on the percentage and distribution of effective fastening assemblies.
- c) Track geometry and smoothness.
- d) Restriction of longitudinal rail creep or movement to acceptable levels.
- e) Abrasion between rail seat and top of sleepers.
- f) Effectiveness of rail seat pads and spacers.

- g) Insulation requirements.
- h) Service loads.

## **A.10 Rail**

### **A.10.1 Detailed recommendations**

Standards and procedures for rail should include the following:

- a) Assessment of the condition, quality and limits on permissible defects of all rail to ensure that rail that do not comply with acceptable requirements and limits is not used.
- b) Detection, assessment and repair of rail defects, including those occurring in welded joints so as to maintain track integrity, wheel support and guidance.
- c) Rail wear and, if necessary, profiles.
- d) Rail temperature stress control during rail laying, insertion and adjustment.
- e) Rail joints, including welded joints.
- f) Running surface alignment.
- g) Rail lubrication practices.

### **A.10.2 Factors**

The following factors should be considered:

- a) Service loads.
- b) Type and cross-sectional shape of rail.
- c) Standards for new and recycled rail to be used in track.
- d) Wear limits.
- e) Vertical and horizontal straightness, and twist of new rail.
- f) Metallurgical properties.
- g) Quarantining of unserviceable rail after removal from track.
- h) Track geometry and smoothness.
- i) Identification of types of defect and limits on the extent to which they can be tolerated for normal or restricted service, including discontinuities in the running surface.
- j) Possibility of high rates of growth of defects and consequences of failure.
- k) Wheel profile and contact band.
- l) Location and proximity of joints.
- m) Track structure and condition.

### **A.10.3 Welding of rail joints**

The following additional factors should be considered in the welding of rail joints:

- a) The level of quality control required on materials and procedures.
- b) The level of assessment needed to determine the integrity of completed joints, repairs and build-up welds.
- c) Weld type and strength.
- d) Rail to weld metallurgical compatibility.
- e) Weld reliability and performance.
- f) Testing for, and identification of, weld defects.
- g) Rail profile matching.

### **A.11 Guardrails**

Standards and procedures for guardrails in respect of policy on their use and location should include consideration of the following factors:

- a) Structure clearance.
- b) Positioning, length and distance from the running rail.
- c) Fixation to the track structure to maintain guidance of derailed wheels.
- d) Rail end configuration.

### **A.12 Points and crossings**

#### **A.12.1 Detailed recommendations**

Standards and procedures for points, crossings and all related components should include the following:

- a) Dimensional requirements for clearances and wheel set interaction.
- b) Component support, movement and mating.
- c) Structural integrity.
- d) Track geometry.

#### **A.12.2 Factors**

The following factors should be considered:

- a) Wheel set back-to-back and wheel cross-sectional profile.
- b) Switch blade requirements, including throw, clearances, alignment, mating with stock rail and stops, profile and cross section, and support.

- c) Crossing and checkrail profile and cross section, back-to-back and end flaring.
- d) Permissible wear limits and defects.
- e) Rodding and interlocking effectiveness, including coordination of switches and swing nose.
- f) Service loads.
- g) Performance under trailing movements.
- h) Track circuit requirements.

## **A.13 Track lateral stability**

### **A.13.1 Detailed recommendations**

Standards and procedures for ensuring the lateral stability of ballasted track should include the following:

- a) Ballast cross-sectional profile.
- b) Sleeper support.
- c) Rail creep relative to sleepers, ballast bed or fixed marker.
- d) Gaps at rail joints.
- e) Temperature related restrictions on operations, i.e.
  - 1) hot weather train operations, and
  - 2) track work during extreme weather, hot or cold.
- f) Temperature stress control during laying, insertion and adjustment of both welded and jointed rail.
- g) Procedures for train operation following track maintenance or disturbance.

### **A.13.2 Factors**

The following factors should be considered:

- a) Identification of vulnerable locations.
- b) Stress-free temperature (design, predicted or measured).
- c) History of rail temperature extremes.
- d) Type and condition of the track structure.
- e) Track buckling records.
- f) Track geometry and service loadings.
- g) Lateral movement or misalignment of the track or rails.

## **A.14 Access control and protection**

### **A.14.1 General**

Standards and procedures for control of access and protection for persons and equipment on or in the vicinity of the railway should include consideration of the following factors:

- a) Access to areas for public use.
- b) Access to non-public areas of the railway.
- c) Access for vehicles, plant and other equipment.
- d) History of incidents that involve injury to a member of the public or damage to public property.
- e) Provision of protection devices.

### **A.14.2 Protection devices**

Standards and procedures for control or protection devices should include consideration of the following factors:

- a) Location and type of control and protection devices, including those at work sites, level crossings, structures and electrified line areas.
- b) Signs and barriers, including physical description, design, size and placement, for the following purposes:
  - 1) control of access to railway property generally;
  - 2) prevention of access to, and accidental contact with, electrical equipment;
  - 3) warning and delineation of hazardous areas; and
  - 4) physical containment of persons, vehicles and equipment.
- c) Use of conventional or standard signs where they apply to the general public.
- d) Safety clearances, including electrical clearances.
- e) Condition of control and protection devices, including
  - 1) visibility of markings and signage designating public access and safe areas,
  - 2) condition of walkways and refuges,
  - 3) visibility and security of handrails,
  - 4) effectiveness of ventilation systems, and
  - 5) sight distances for oncoming trains or road vehicles.

## **A.15 Fire prevention and control**

### **A.15.1 General recommendations**

Standards and procedures for the prevention, reporting and control of fires should include, as appropriate, the adoption of existing fire prevention and control standards and the management of the infrastructure.

### **A.15.2 Factors**

The following factors should be considered:

- a) Requirements for the control or prevention of ignition points.
- b) Fire-fighting equipment and its maintenance.
- c) Use of fire-fighting equipment near electrical infrastructure.
- d) History of incidents involving injury to persons and damage to property.
- e) Condition of the railway reserve.
- f) Loading of hazardous material.
- g) National legislation and local by-laws.

## **A.16 Operation and control of the electrical system**

Standards and procedures for operation and control of the electrical system should include, but not be limited to, consideration of the following factors:

- a) Coordination with other railway operations and electricity supply authorities.
- b) Handling of faults and incidents.
- c) Continuous supervision and communication.
- d) Load and supply characteristics.
- e) Circuit-breaker reclosure.
- f) Signalling and other auxiliary loads.

## **A.17 Capacity and integrity of the electric traction system**

Standards and procedures for monitoring the capacity and integrity of the electric traction system should include the following:

- a) Overall system capacity.
- b) Pantograph performance interface.
- c) Mechanical integrity of conductor systems.

- d) Pantograph characteristics, numbers, dynamics and wear.
- e) Train and traffic characteristics.
- f) Ambient conditions.
- g) Integrity under adverse weather conditions.
- h) Conductor and component dynamics and wear.

### **A.18 Separation distances from electrical equipment**

Standards and procedures for controlling separation distances from electrical equipment should include, but not be limited to, the following:

- a) Determining safe separation distances for people and objects from electrical equipment.
- b) Controlling the approach to electrical equipment and maintaining safe separation distances for people and objects.
- c) Provision of warnings of hazards due to electrical equipment.
- d) Controlling the activities above, on, near and to clearance from overhead electric traction wiring and other electrical equipment.
- e) Precautions when using machines, including cranes and lifting machines.
- f) Loading and unloading of trains.
- g) Climbing on or working on locomotives and other rolling stock.
- h) Safety procedures for repair and replacement of metallic pipes and other long conducting items.
- i) Using water near live conductors.
- j) Service crossings, for example level crossings, pipe lines and telecommunication lines.

### **A.19 Working on live equipment**

Standards and procedures for safe working on live equipment should include consideration of the following:

- a) Clearances to earth and earthed structures.
- b) Tools and equipment.
- c) Specialized techniques.
- d) Safety from rolling stock and train movement.
- e) Location of live equipment on trains and structures.
- f) Attachments to overhead traction wiring equipment.

## **A.20 Electrical switching and isolating procedures**

### **A.20.1 Detailed recommendations**

Standards and procedures for switching and isolating the electrical system, when necessary for safety of operations and works personnel should include the following:

- a) All procedures for isolation of electric traction distribution equipment and restoring to service.
- b) Equipment for isolation of electric traction wiring equipment and restoring to service.
- c) Responsibility of person in charge of work.
- d) Overriding normal isolation procedures in case of an emergency.

### **A.20.2 Factors**

The following factors should be considered:

- a) Integrity of earthing, bonding and traction return systems.
- b) Emergency situations.
- c) Design, testing and inspection of the equipment required for testing and earthing.

## **A.21 Earthing and bonding**

### **A.21.1 Earthing**

Standards and procedures for earthing should include the following:

- a) Controlling touch and step voltages between structures, rails and equipment.
- b) Requirements for separating earthing systems and traction return systems.
- c) Means of determining equipment to be bonded or earthed.
- d) Testing and verification of the integrity of bonding/earthing systems.

### **A.21.2 Bonding and traction return systems**

Standards and procedures for bonding and traction return systems should include the following:

- a) Identification and integrity of load current and fault current paths.
- b) Identification and integrity of power, signalling and telecommunications circuits, and earth impedance.

## **A.22 Spatial location of conductors**

Standards and procedures for specifying and monitoring the spatial location of conductors and electrical clearances should include the following:

- a) Conducting elements of electric traction systems.
- b) Height and location with respect to track and pantograph system.
- c) Static and passing clearances.

## **A.23 Electrical fault protection**

Standards and procedures for specifying and monitoring fault protection should include the following:

- a) Protection of rolling stock, signalling, telecommunication and other electrical systems.
- b) Load and supply characteristics.
- c) Protection and insulation grading.

## **A.24 Electrolysis mitigation**

Standards and procedures for electrolysis mitigation should include the following:

- a) Liaison with utilities owners and relevant oversight bodies and stakeholders.
- b) Isolation of services that make use of metallic infrastructure.
- c) Physical integrity or isolation of structures, track components and utilities.
- d) Electrical integrity of traction, signalling, telecommunication and other electrical systems.

## **A.25 Electric traction system interference management**

Standards and procedures to ensure that the electrical infrastructure does not significantly degrade the railway system or other electrical systems performance should include the following:

- a) Traction system/signalling compatibility.
- b) Electromagnetic compatibility.
- c) Electrical interference, harmonics, disturbances and induction imposed on power supply, traction, signalling, telecommunications and other electrical systems.

## **Annex B** (informative)

### **Management of work sites**

#### **B.1 Detailed recommendations**

Standards and procedures for the safe passage of trains through a work site, including the safety of workers, plant and equipment should include the following:

- a) Delineation and protection.
- b) Provision and enforcement of specific operating requirements.
- c) Provision of temporary track, civil and electrical structures.
- d) Handover for normal operations at completion of works.
- e) Safe operation of plant and equipment in the vicinity of high-voltage electrical equipment.
- f) Working on high-voltage electrical equipment.

#### **B.2 Factors**

Standards and procedures should take into consideration, where appropriate, the following:

- a) Preparatory work including the safe storage and placement of materials, plant and equipment.
- b) Other standards and procedures related to the restoration of the track for the safe passage of trains through the work site.
- c) Train and rolling stock operating requirements.
- d) Inadvertent energizing or de-energizing of high-voltage electrical equipment.
- e) Running electric trains into de-energized sections.
- f) Maintenance of electric traction returns continuity and bonding.
- g) Track condition and structure.

**Annex C**  
(informative)

**Frequency of inspection and assessment**

**C.1 General**

Inspection and assessment are the activities (scheduled or otherwise) used to determine both the condition and the deterioration in condition of the track, civil and electrical infrastructure and operational capacity. SARA 001 and SARA 002 require inspection, assessment and corrective actions to be carried out to ensure that the infrastructure components and their operation are safe for persons and property.

**C.2 Scheduled inspections**

The following list of factors might influence the required frequency of scheduled inspections and assessment of the track, civil and electrical infrastructure:

- a) Operating parameters, including
  - 1) axle loads,
  - 2) speed,
  - 3) frequency of trains,
  - 4) gross annual tonnages,
  - 5) train and rolling stock characteristics, and
  - 6) train-handling techniques.
- b) Track, civil and electrical infrastructure parameters, including
  - 1) structure design,
  - 2) condition, integrity and stability,
  - 3) past and predicted rates of deterioration, wear, or defect growth, and
  - 4) track, civil and electrical alignment, gradient and geometry.
- c) Results of monitoring systems.
- d) Environmental factors and seasonal variations including temperature and rainfall.
- e) Location (for example high banks, tangent track, level crossings, platforms, joints, points and crossing work).
- f) Method of inspection, testing and assessment.
- g) Type of defect or condition being considered and its history.
- h) Potential risk and consequences of failure, derailment and other irregularities.

- i) History of failures and safety incidents (for example obstructions, track buckles and embankment failure).
- j) Results of previous investigations.
- k) Protection and safety systems applied.

### **C.3 Special inspection**

The following list of events might influence the requirements for special inspection and assessment of the track and civil and electrical infrastructure:

- a) Abnormal high or low temperature.
- b) Construction, maintenance and renewal of track, civil and electrical infrastructure
  - 1) following preparatory work for maintenance (following material storage and placement),
  - 2) during the execution of the work,
  - 3) following temporary infrastructure restoration to a safe condition, and before the passage of trains, and
  - 4) before infrastructure handover for normal operations.
- c) Damage or suspected damage due to external impact from road traffic, derailed rolling stock or out-of-gauge loads, dragging equipment, and collisions.
- d) Derailment or pantograph hook-up.
- e) Natural events such as floods, fires, landslides and earthquakes.
- f) Reports received of potentially unsafe conditions.

## **Bibliography**

*SARA 001: SARA Safety Policy.*

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