SLOVENSKI STANDARD
SIST EN 15595:2009+A1:2011

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Železniške naprave - Zavore - Preprečevanje zdrsa koles

Railway applications - Braking - Wheel slide protection

Bahnanwendungen - Bremse - Gleitschutz

Applications ferroviaires - Freinage - Anti-enrayeur

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ICS:

45.040	Materiali in deli za železniško tehniko	Materials and components for railway engineering

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Railway applications - Braking - Wheel slide protection

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Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword

This document (EN 15595:2009+A1:2011) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2011, and conflicting national standards shall be withdrawn at the latest by November 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1, approved by CEN on 2011-04-03.

This document supersedes EN 15595:2009.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

A1 This document has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2008/57/EC.

For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document. A1

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

The objectives of fitting WSP systems to trains are to assist in achieving the following:

1) minimum extension in stopping distance compared to stopping on clean dry rails (i.e. good adhesion conditions);

2) minimum level of wheelset damage due to wheel slide or wheel ‘lock-up’;

3) minimum level of track damage;

4) for pneumatic brake systems, minimum increase in air consumption compared to a “non WSP” stop.

The particular priority of these above objectives may vary for different classes of applications or even for a particular application.

Trains fitted with WSP systems may consist of single vehicles, locomotive and trailing vehicles or may be high speed trains, multiple units, commuter trains, wagons, etc.

Such trains will be equipped with a friction brake and may also be equipped with dynamic brakes, magnetic track brakes and/or eddy current brakes and may also be fitted with adhesion improving systems e.g. sanding.

This standard covers both the system acceptance requirements as well as the application specific requirements for WSP Systems.

Each manufacturer is responsible for taking every necessary step to make sure that the quality of workmanship and construction is such as to ensure accordance with good engineering practice.

1 Scope

This European Standard specifies the minimum criteria for system acceptance/type approval of a new wheel slide protection system and implementation of accepted WSP to specific vehicle applications and route requirements, as well as requirements for wheel rotation monitoring (WRM).. This includes the design, testing and quality assessment of the WSP system and its components.

This European Standard is applicable to wheel slide protection systems for pneumatic braking systems without taking the type of vehicles and track-gauge into consideration. The general principles of this standard can also apply as a reference for other types of braking systems and other kinds of railway vehicles. The system is designed to control the sliding of wheels of railway vehicles during braking under degraded adhesion conditions to prevent wheel damage and to minimize the extension of the stopping distance under degraded adhesion conditions by optimizing the available adhesion between wheel and rail.

This European Standard does not apply to the following categories of vehicles:

1) tramways;

2) light railways;

3) metros on steel wheels;

4) metros on rubber tyred wheels.

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.

EN 14478:2005, *Railway Applications — Braking — Generic Vocabulary*

EN 50121-3-1, *Railway applications — Electromagnetic compatibility — Part 3-1: Rolling stock — Train and complete vehicle*

EN 50121-3-2, *Railway applications — Electromagnetic compatibility — Part 3-2: Rolling stock — Apparatus*

EN 50125-1, *Railway applications — Environmental conditions for equipment — Part 1: Equipment on board rolling stock*

EN 50126-1, *Railway applications — The specification and demonstration of reliability, availability, maintainability and safety (RAMS) — Part 1: Basic requirements and generic process*

EN 50128, *Railway applications — Communications, Signalling and Processing Systems — Software for Railway Control and Protection Systems*

EN 50155:2007, *Railway applications — Electronic equipment used on rolling stock*

EN 60529:1991, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 61373, *Railway applications — Rolling stock equipment — Shock and vibration tests (IEC 61373:1999)*

EN ISO 228-2, *Pipe threads where pressure-tight joints are not made on the threads — Part 2: Verification by means of limit gauges (ISO 228-2:1987)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

ISO 8573-1, *Compressed air — Part 1: Contaminants and purity classes*

3 Terms and definitions, symbols, and abbreviations

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 14478:2005 and the following more specific definitions apply.

3.1.1 Wheel slide protection (WSP) terms

3.1.1.1
adhesion profile
predefined set of data representing the adhesion characteristics of a section of running line

3.1.1.2
relative air consumption
ratio of the total volume of air consumed during a braking stop with WSP activity against that which would be consumed during a stop with no WSP activity

3.1.1.3
auxiliary reservoir
protected and dedicated source of pressure energy for local brake actuation and also known as a Brake Supply Reservoir

3.1.1.4
supplementary reservoir
pressure reservoir used for determination of relative air consumption

3.1.1.5
crush laden
vehicle load condition in excess of the normal fully laden condition that may arise during exceptional operating circumstances

3.1.1.6
low adhesion
conditions where the wheel/rail adhesion is insufficient to sustain the required braking rate

3.1.1.7
true train speed
v_t
actual current train speed, also commonly referred to as “ground speed”

3.1.1.8
wheel lock
extreme example of wheel slide where the wheel set ceases to rotate during braking, whilst the vehicle is in motion

3.1.1.9
wheel slide
condition where a wheel set rotational speed is lower than that corresponding to the true train speed

3.1.1.10
circumferential speed
rotational speed of wheel set times radius of wheel

NOTE For vehicles with independent wheels all requirements described for wheelsets apply to the individual wheels.

3.1.1.11
reference speed
v_{ref}
signal generated and generally used by the WSP or WRM (wheel rotation monitoring system) to determine an approximation to the true train speed

3.1.1.12
duty cycle
percentage of time which the WSP and brake control element is active compared with the total operational time

3.1.1.13
nominal train speed
v
specified speed at start of braking during brake tests

NOTE Real speed may slightly differ.

3.1.1.14
uncoupled test
slip test
method of brake testing where the vehicle under test is uncoupled from the rear of the test train and brakes separately

3.1.1.15
absolute wheel slide
difference between true train speed and circumferential speed

3.1.1.16
relative wheel slide
absolute wheel slide divided by true train speed

3.1.1.17
undesired venting
reduction in braking force not justified by behaviour of wheelsets

3.1.1.18
drag braking test
test with auxiliary tractive unit performed as a braking with constant brake application and constant speed

3.1.1.19
dynamic brake blending curve
curve describing the characteristics of blending of dynamic brake as function of speed

3.1.2 Components

3.1.2.1
WSP rack/controller
device having the power supply interface with the vehicle control supply and the electronic hardware and software to receive the signals from the speed sensors and provide the outputs to the WSP brake control elements, for example dump valves enabling the modulation of the brake cylinder pressure

3.1.2.2
WSP dump valve
device used to control the amount of air within the brake cylinder in relation to the adhesion level perceived by the WSP controller

3.1.2.3
speed sensor
device used to generate an individual wheelset or wheel speed signal to a WSP controller

3.1.2.4
service interface
access point for diagnostic information and maintenance test

3.2 Symbols

v	nominal train speed (km/h)
v_{ref}	WSP vehicle reference speed (km/h)
v_t	true train speed (km/h)
λ	braked weight percentage (%)
τ	adhesion coefficient
σ	coefficient of inertia of rotating masses

3.3 Abbreviations

AR	auxiliary reservoir
BP	brake pipe
BSR	brake supply reservoir; for an air brake system with distributor valve, referred to as auxiliary reservoir
DNRA	detection of non-rotating axle (same as WRM)
EB	emergency brake
ER	anticipated event – used in safety analysis
FS	full service brake
G	brake mode G: brake mode used for freight trains with specified brake application time and brake release time.
MRP	main reservoir pipe
Nl	normal litre
P	brake mode: brake mode for passenger and freight trains with specified brake application time and brake release time and specified brake mass percentage
P(SS)	brake mode P(SS): brake mode for passenger and freight trains with specified brake application time and brake release time and specified brake mass percentage equipped with a self adjusting load-proportional brake system
R	brake mode R: brake mode for passenger trains and fast freight trains with specified brake application time and brake release time as for braking mode P and specified minimum brake mass percentage
RAMS	reliability, availability, maintainability and safety
WRM	wheel rotation monitoring system (sometimes called DNRA)
WSP	wheel slide protection

4 Requirements

4.1 General

4.1.1 General requirements

A WSP system is designed to make the best use and improve available adhesion for all operating conditions by a controlled reduction and restoration of the brake force to prevent wheel sets from locking and uncontrolled sliding due to low adhesion. Thus the stopping distance is optimized and the extension of stopping distance and the occurrence of wheelset damage minimized. The WSP device shall not alter the functional characteristics and performance of the brakes.

The design of the WSP system, its components and vehicle shall be such that the WSP system and its operation (in all modes) shall not have a detrimental effect on the constituent parts of the vehicle, bogie, train or track.

An additional WRM system shall detect locked wheels, which shall be indicated to the driver, where fitted.

4.1.2 Service life

This standard gives no rigid specification for service life performance.

4.2 WSP controller

4.2.1 Principle of operation

The speed of rotation of the wheelsets is calculated on the basis of information provided by sensors, and monitored by regulators or automatic control systems. These transmit commands to the WSP actuators to reduce, hold or restore braking force (where applicable), either totally or partially.

The WSP shall be available for operation on braking forces as soon as reference speed is greater than a threshold which is not higher than 6 km/h.

The WSP shall not alter the demanded braking force at reference speed less than a predefined threshold and if the brake force has been reduced by the WSP system then the brake force shall be raised to the demanded value.

This reference speed threshold shall not be higher than 3 km/h.

The WSP shall not be capable of applying a greater brake force than that demanded.

The WSP shall not alter the demanded braking force at standstill except during test.

WSP-actuators (e.g. WSP dump valves) are able to reduce braking force.

4.2.2 WSP watchdog (safety timer)

The independent monitoring or watchdog function shall be provided for all systems. The watchdog function shall remain permanently active including WSP tests, in order to restore the braking force required by the command if sustained release of the brake occurs. Actuation of this function other than during a test shall be indicated and recorded as a fault. If the watchdog function is activated, it shall be able to revert automatically to its stand-by position when the WSP resumes normal functioning.

The reliability of the watchdog device shall conform to ER1 in 4.2.3.4.

An independent monitoring or watchdog function, independent from the control algorithm and processor, shall support the automatic control system. The function shall prevent triggering of the actuator if total release of the brake, friction or dynamic brake (or a combination of them during blending), continues uninterrupted for a set

period which shall not be more than 10 s. Also after 10 s the monitoring system shall prevent an incorrect brake force step being sustained as a result of a command fault. The watchdog function shall remain active during WSP tests, in order to restore the braking force required by the command if sustained release of the brake occurs during the tests, or if undesired venting continues on completion thereof.

4.2.3 Reliability, availability, maintainability and safety (RAMS)

4.2.3.1 General

The WSP shall be capable of initiating tests to detect a number of malfunctions, or faults. When the system is functioning the availability of speed sensors and the electrical circuits of the actuators (dump valves), particularly the open-circuit and short-circuit conditions, shall be detected. The reception of every command sent by the control system to the appropriate actuator (dump valve) shall also be monitored. The WSP shall initiate an automatic self-check when it starts up to ensure at least the electrical operational availability of the electronic control unit and the peripherals.

Independent from the above testing, continuous internal tests inherent to the electronic system technology employed shall be performed to monitor the proper functioning and availability of the WSP. This shall be adapted to and defined on the basis of the specific architecture of each WSP. The testing and monitoring during the running of the vehicle shall not impair the braking functions. This testing and/or monitoring shall not jeopardise securing the train when it is stationary.

Any faults detected shall be displayed as a fault code and stored in a fault memory. The WSP shall ensure that the fault codes remain stored in the memory in the event of a power supply failure. The fault codes shall be defined on the basis of a failure analysis and designed such that the smallest exchangeable unit can be identified.

Separate information on the availability status of the WSP shall be provided for the operational state, in addition to the codes for “Fault” and “OK” indications for maintenance.

Initialization and testing shall not generate incorrect information for those other functions which use the speed information provided by the WSP. The design of the WSP shall ensure that other functions than braking functions do not alter the proper function of the WSP.

It shall be possible to manually initiate a WSP self test with the vehicle at standstill. The test shall include those on the sensors, actuators and the operational availability of the electronic control unit, plus faults that exist when stationary. The test sequence also comprises tests of the watchdog plus the complete venting of the brake cylinders by actuating the release valves/actuators. It shall be possible to read off all faults detected during the test run. Deletion of the memorized fault shall be confirmed by a test and by an indication of the correct functioning of the WSP equipment. The manual test sequence shall be cancelled if the vehicle is above 3 km/h. The testing and monitoring shall not release more than 50 % of the brakes within a vehicle at the same time.

In addition, the above test may be initiated automatically when the vehicle is at standstill.

The WSP shall be equipped with a service interface.

If the reference speed signal is used by other functions, external to the WSP equipment, these other functions shall not affect the integrity of the reference signal or the WSP equipment.

4.2.3.2 Reliability

A reliability study shall be carried out on the WSP system in accordance with EN 50126-1.

4.2.3.3 Maintainability

The WSP shall be built to a modular design and modules with the same functions shall be interchangeable. Modules which are not functionally interchangeable shall not be able to be physically plugged into the incorrect location.

4.2.3.4 Safety

The WSP shall have a safety analysis performed for the following anticipated events (ER):

ER1: Unintended reduction or retention of a brake force on one control channel for a duration in excess of that specified in 4.5.

ER2: Failure of any speed output used by a safety critical function (speed-dependent brake force application, electromagnetic track brake).

ER3: Loss of the function indicating a locked wheelset for equipment approved for v > 200 km/h.

The hourly probability of these anticipated events occurring shall be calculated by adequate numerical means, e.g. fault tree analysis.

4.2.3.5 Ambient temperature

The WSP system shall be able to operate within the temperature classes as specified by EN 50125-1 inside vehicles and inside cubicles.

NOTE EN 50155 applies for electronics.

4.2.3.6 Environmental specification and external appearance

The externally mounted WSP components shall withstand corrosion due to normal atmospheric pollutants and operate without restrictions under conditions as specified in EN 50125-1. The WSP control unit shall operate within the requirements of EN 50121-3-1 and EN 50121-3-2.

NOTE Further to EN 50121-3-2 for the WSP system, EN 50121-3-1 applies for the complete vehicle.

The design and installation of the dump valve shall be such as to protect the venting ports against snow and ice. When required by the purchaser the WSP components shall show conformity with this requirement by testing or by design documentation. Components that are mounted at the outside of the vehicle shall be to IP65.

The components of the WSP system shall be installed in a way so that the risk for persons who are working in the vehicle is minimized (for example injury caused by sharp edges).

4.2.4 Functional characteristics

4.2.4.1 Wheel diameter differences

The system shall tolerate permitted differences of the wheel diameter differences on a given vehicle when evaluating speed.

4.2.4.2 Special features of WSPs for dynamic and mixed braking systems

The characteristics according to 4.1.1 to 4.2.3 are also mandatory for WSP of dynamic brakes if applicable (except 4.2.2).

Wheel slide shall be kept within the tolerance range as specified for friction brake in Clause 6.4.3.2 in the case of tractive units where the dynamic brake can be used independently of the friction brake (particularly for drag

brake applications on steep gradients) to prevent damage to the wheel tread and to minimize the influence on speedometer variations.

The respective WSP shall become active immediately where the pneumatic brake force takes over in cases of failure of the dynamic brake or with mixed braking systems. Where separate WSPs are used for pneumatic and dynamic brakes, a strategy shall be used to ensure that the braking force to be transmitted is not unacceptably reduced (or increased) due to the regulating processes of mixed braking systems and there shall be a strategy to avoid conflicting actions, for example automatic inhibition of the dynamic brake.

It is recommended that for high-speed trains the wheelset rotation monitoring device totally suppresses the force of the dynamic brake if the threshold indicated in 4.2.4.3.2 is exceeded, independently from the WSP.

4.2.4.3 Special features of WSP systems for high speeds (v > 200 km/h)

4.2.4.3.1 General

These characteristics are additional to those in 4.1.1 to 4.2.3 for WSP equipment designed for high speeds.

Each WSP device shall be supplemented by a WRM to continuously monitor wheelset rotation and to indicate any rotation anomaly. The WSP device and WRM shall have outputs to provide indication of failure of these devices.

4.2.4.3.2 Functional characteristics

The electrical/electronic circuits for the WSP and the rotation monitor shall function independently of each other and of these devices on other vehicles. The functioning of the WSP and the rotation monitor, together with the continuity of the circuits of the speed sensors and the WSP dump valves, shall be automatically monitored while the vehicle is running.

The rotation monitor shall compare the speed of rotation of at least four wheelsets at all speeds.

The rotation monitor shall output a signal no later than 10 s after a speed of 50 km/h + 0,3 v_{ref} has been attained if a wheelset locks when the train starts up. Should the rotation monitor detect an abnormal difference in the speeds of rotation of the wheelsets during a run for a period longer than 10 s, that device shall output a signal. A difference is considered abnormal if it is $\geq$ X km/h + Y $\times$ v, X and Y parameters being defined case by case, but not exceeding 50 km/h + 0,3 v.

4.2.4.3.3 Recommended features

It is recommended that the rotation monitor also has the functionality to remove the brake force for the wheelset concerned if abnormal differences in the speed of rotation are observed, but in such a case the brake force shall not be removed for a longer period than 10 consecutive seconds.

It is also recommended that the rotation monitor takes over the principal functions of the WSP if this is defective.

4.3 Axle speed sensors

4.3.1 Integration

The WSP sensors shall be an integral part of the WSP system.

4.3.2 Electrical connection

The sensor shall be easy to disconnect for bogie or axle maintenance. The sensor should connect into a junction box or should be fitted with a plug.