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Denna standard ersätter SS-EN 15595:2009+A1:2011, utgåva 1.

The European Standard EN 15595:2018 has the status of a Swedish Standard. This document contains the official version of EN 15595:2018.

This standard supersedes the SS-EN 15595:2009+A1:2011, edition 1.

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EUROPEAN STANDARD

NORME EUROPÉENNE

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English Version

Railway applications - Braking - Wheel slide protection

Applications ferroviaires - Freinage - Anti-enrayeur

Bahnanwendungen - Bremse - Gleitschutz

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European foreword

This document (EN 15595:2018) 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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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

This document supersedes EN 15595:2009+A1:2011.

This document has been prepared under a standardization request given to CEN 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.

The rationale behind the changes between Revision 1 and this Revision of this standard is given in Annex H.

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Introduction

A Wheel Slide Protection (WSP) system is designed to make the best use of available adhesion and to improve adhesion 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 braking performance is optimized and the occurrence of wheelset damage is minimized.

The Wheel Rotation Monitoring (WRM) system is designed to detect locked wheels and to give immediate information in this case.

Trains fitted with WSP systems may consist of single vehicles, locomotive and trailing vehicles or may be high speed trains, multiple units, commuter trains, Light Rail Vehicles (LRV) and Tram Trains of any track gauge, etc.

Such trains will be equipped with friction brakes and may also be equipped with additional braking systems, e.g. dynamic brakes, wheel/rail adhesion independent brakes, and may also be fitted with adhesion improving systems, e.g. sanding.

This European Standard is not intended to be used to determine the stopping performance of a WSP equipped train under all environmental conditions.

1 Scope

This document specifies the criteria for system acceptance and type approval of a wheel slide protection (WSP) system. It also specifies criteria for the implementation of WSP to specific vehicle applications and specific operating conditions, as well as requirements for wheel rotation monitoring (WRM). This includes the design, testing and quality assessment of the WSP and WRM systems and their components.

This European Standard does not apply to vehicles on rubber tyred wheels or vehicles equipped with hydraulic brakes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 14478:2017, *Railway applications - Braking - Generic vocabulary*

EN 15663, *Railway applications - Vehicle reference masses*

EN 16834:—[1], *Railway applications - Braking - Brake performance*

EN 45545 (all parts), *Railway applications - Fire protection on railway vehicles*

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: Rolling stock and on-board equipment*

EN 50126-1, *Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Generic RAMS Process*

EN 50128, *Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems*

EN 50129, *Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling*

EN 50155, *Railway applications - Rolling stock - Electronic equipment*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

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

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)*

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

[1] Under preparation. Stage at time pf publication: FprEN 16834:2018.

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14478:2017 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
adhesion profile
predefined set of data representing the adhesion characteristics of a section of running line

3.2
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

3.3
supplementary reservoir
pressure reservoir used for determination of relative air consumption during WSP testing

3.4
crush laden
vehicle load condition based on the design mass under exceptional payload in accordance with EN 15663

3.5
dry rail
conditions where 100 % of the brake force of the vehicle can be applied with no axle sliding more than 2 %

3.6
dry rail stopping distance
actual measured stopping distance in dry rail conditions

3.7
low adhesion
conditions where the wheel/rail adhesion is in the range 0,08 to 0,05

3.8
very low adhesion
conditions where the wheel/rail adhesion is in the range 0,05 to 0,03

3.9
extremely low adhesion
conditions where the wheel/rail adhesion is below 0,03

3.10
reference speed
signal generated and generally used by the WSP or WRM to determine an approximation to the true train speed

3.11
nominal initial train speed
specified speed at start of braking during brake tests

Note 1 to entry: True train speed can slightly differ.

Note 2 to entry: This may be known as target speed.

3.12
uncoupled test
method of brake testing where the vehicle (or single unit) under test is uncoupled from the rear of the test train and brakes separately, also referred to as a slip test

3.13
brake to stop test
brake test starting from a nominal initial speed going to a stop, performed with either an individual vehicle (locomotive, coach) or a train set as the tested unit

3.14
absolute wheel slide
difference between true train speed and circumferential speed

3.15
relative wheel slide
absolute wheel slide divided by true train speed

3.16
undesired brake force reduction
reduction in brake force not justified by behaviour of wheelsets

3.17
brake blending curve
curve describing the characteristics of blending of dynamic and pneumatic brakes as function of speed

3.18
WSP controller
device having 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 force

3.19
WSP actuator
device used by the WSP controller to control the brake force

3.20
WSP dump valve
WSP actuator to control the brake cylinder pressure

3.21
speed sensor
device used to generate an individual wheelset or wheel speed signal to a WSP controller

3.22
service interface
access point for diagnostic information and maintenance test

3.23
validation
process of analysis followed by a judgment based on evidence to determine whether an item (e.g. process, documentation, software or application) fits the user needs, in particular with respect to safety and quality and with emphasis on the suitability of its operation in accordance to its purpose in its intended environment

3.24
verification
process of examination followed by a judgment based on evidence that output items (process, documentation, software or application) of a specific development phase fulfils the requirements of that phase with respect to completeness, correctness and consistency

Note 1 to entry: Verification is mostly based on document reviews (design, implementation, test documents, etc.).

3.25
designed deceleration
maximum deceleration which is provided by the brake system of the vehicle, in a normal manner on level track and which is defined by calculation

3.26
slide test
test performed under degraded adhesion conditions

3.27
dry rail test
test performed where the adhesion conditions will support the maximum brake force

3.28
drag test
test to simulate braking on a falling gradient, performed with an auxiliary tractive unit to achieve a constant speed with a constant brake application

3.29
brake test
test where the brakes are applied to achieve a deceleration

3.30
tare laden
vehicle load condition based on the design mass in working order in accordance with EN 15663

Note 1 to entry: This can have to include additional test equipment and personnel.

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

g	acceleration due to gravity, in m/s^2
v_{nom}	nominal initial train speed, in km/h
v_{ref}	WSP vehicle reference speed, in km/h
v_t	true train speed, in km/h
μ	adhesion coefficient
ρ	coefficient of inertia of rotating masses
τ	initial adhesion coefficient
AR	auxiliary reservoir
BP	brake pipe
BSR	brake supply reservoir; may also be referred to as an auxiliary reservoir
EB	emergency brake
ER	(fr: événement redouté) anticipated event – used in safety analysis
MMI	Man Machine Interface
MTB	magnetic track brake
Nl	normal litre
RAMS	reliability, availability, maintainability and safety
VIT	Vehicle Implementation Test
WRM	wheel rotation monitoring system (sometimes called DNRA, detection of non-rotating axle)
WSP	wheel slide protection

5 Requirements

5.1 Functional requirements

5.1.1 Objectives of wheel slide protection

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

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

— minimum level of wheelset damage due to wheel slide or wheel lock;

— minimum level of track damage;

— for pneumatic brake systems, minimum increase in air consumption compared to a dry rail stop with no WSP activity.

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

The objectives are deemed to be fulfilled, if the requirements of this standard are met.

5.1.2 General functional requirements

One independent WSP/WRM system shall control no more than eight axles.

In the case of tractive units that are capable of running alone, any single fault of the WSP system shall not result in a loss of brake force on more than 50 % of the braked axles. This may be achieved by multiple WSP systems or an independent braking system that cannot be influenced by WSP.

The circumferential speed of the wheelsets is calculated on the basis of information provided by sensors, and monitored by regulators or automatic control systems (WSP controller).

The WSP controller may use additional information (e.g. signals from pressure sensors) about the status of the train for WSP control.

The WSP controller transmits commands to the WSP actuators (e.g. WSP dump valves) to reduce, hold or restore brake force, either totally or partially.

The WSP shall not reduce the brake force below a low speed threshold. This threshold shall not be higher than 5 km/h and not lower than 0,5 km/h. If the brake force is already reduced when the train speed falls below this threshold, the WSP system shall restore the brake force to the demanded value.

When starting the train the WSP shall be available for operation before the speed achieves 6 km/h. For freight applications where power supply is not provided at low speed, this threshold may be increased up to 15 km/h.

The WSP system shall remain operative whilst there is brake force present (i.e. until the brakes are fully released).

The WSP shall not be capable of increasing the brake force above that demanded by the braking system.

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

All speed thresholds defined in this standard shall be related to nominal mean wheel diameter if the true wheel diameter is not known.

5.1.3 Control of the brake force

5.1.3.1 Requirements for pneumatic actuation of the friction brake

WSP-actuators (e.g. WSP dump valves or other pneumatic control devices - integrated brake valve) are used to modify brake force.

The WSP-system shall not allow a direct connection between supply and exhaust.

5.1.3.2 Dynamic brake

Dynamic brakes shall have either WSP control in accordance with this standard or means to switch them off in the event of sliding.

If the dynamic brake is used for emergency brake applications a WSP control of the dynamic brake shall be provided.

If the dynamic brake is commanded by an independent control command, separate from the regular train wide control command, the maximum slide criteria, as defined in 5.4.3.1, shall at least be met.

The dynamic brake may be equipped with its own WSP. As long as the friction brake is not activated the slide can be controlled by the WSP of the dynamic brake alone.

A WSP strategy shall be adopted for the two systems if dynamic brake and friction brake are coordinated by a blending function or operated independently to fulfil the requirements of this standard.

5.1.4 Wheel slide protection watchdog (safety timer)

For safety reasons, a monitoring function is provided to avoid an excessive reduction of braking effort.

This WSP watchdog function shall be provided for WSP systems capable of acting during emergency braking, and shall be independent from the WSP control algorithm and processor.

A continuous brake effort release demanded by the WSP shall not exceed 10 s. After this time, the WSP watchdog shall inhibit WSP intervention.

The WSP watchdog shall inhibit WSP intervention in the case where the brake effort is maintained constant or continuously reduced below the demanded level with no rise in brake effort for a period which shall not exceed 15 s. The watchdog function shall remain permanently active including during WSP tests, in order to restore the demanded brake force if sustained release or reduction of this brake force occurs because of WSP operation. Activation of this function other than during a test shall be indicated and recorded.

If the watchdog function is activated, it shall be reset only after the WSP controller stops demanding a reduction in brake force.

5.1.5 Air supply

As an option, the WSP should have the capability of being inhibited if the BSR pressure falls below a defined value.

For single-pipe systems, the WSP system shall ensure that WSP activity is inhibited if the auxiliary reservoir pressure is less than 300 mbar above the highest brake application pressure.

WSP shall be automatically re-enabled when the inhibit signal is removed.

5.1.6 Wheel diameter differences

When evaluating speeds on a given vehicle, the WSP and WRM system shall tolerate permitted differences of the wheel diameters, within the range from new to worn wheels, so as not to cause WSP or WRM activity because of these differences.

5.1.7 Wheel rotation monitoring (WRM)

5.1.7.1 General

These characteristics are additional to those in 5.1.1 to 5.1.6 for WSP equipment designed for high speeds. Where fitted, WRM supplements the WSP device with a “rotation monitor function” to continuously monitor wheelset rotation and to indicate rotation anomalies.

5.1.7.2 Functional characteristics

If a wheelset locks when the train starts up a “rotation monitor function” shall output a locked axle indication no later than 10 s after a train speed of 50 km/h has been attained.

During a run the “rotation monitor function” shall output a signal on detecting an abnormal difference in the speeds of the wheelsets for a period longer than 10 s. A difference is considered abnormal if it is at least X km/h + $Y \cdot v_{\text{ref}}$. X and Y parameters being defined case by case, but not exceeding 50 km/h + 0,3 $\cdot v_{\text{ref}}$.

5.1.7.3 System requirements

The “rotation monitor function” is implemented in the WRM and may additionally be implemented in the WSP controller.

Where trains are required to be equipped with independent rotation monitoring systems they may both (WSP and WRM) provide locked axle information to the train system.

For each monitored wheelset the WRM shall include at least one speed sensor circuit that is electrically independent from the WSP. WSP and WRM may exchange data for diagnostic purposes.

The electrical/electronic circuits for the WSP and the WRM including power supply from the battery and protecting circuits shall function independently of each other. Electrical interfaces shall be such that a failure of one system does not impair the other e.g. galvanic isolation.

WSP may act as the WRM system for axles other than those for which it provides the WSP-control.

5.1.7.4 Recommended features

It is recommended that the WRM also has the functionality to remove the brake force for the wheelset concerned (including dynamic brake of motor axles) if abnormal differences in the circumferential speed are observed. If the WRM also has WSP exhaust functionality then the WSP requirements on safety timer, dump valves and diagnostics for the reduction of brake force shall also apply to the WRM.

WRM may also take over the principal functions of the WSP if this is defective. In this case it shall comply with WSP requirements.

5.1.8 Diagnostics

5.1.8.1 Permanent self-diagnostic

When the WSP or WRM system is operating the availability and correct functioning of speed sensors shall be checked.

Open-circuit and short-circuit conditions of speed sensors shall be detected.

If sensors for additional signals are used in the WSP system a diagnosis of these sensors shall be implemented.

The availability of the electrical circuits of the WSP actuators (dump valves), the open-circuit and short-circuit conditions, shall be detected when commands are sent by the controller to the appropriate WSP actuator (dump valve).

Additional permanent diagnostic functions, inherent to the electronic system technology employed, shall be performed to monitor the correct operation and availability of the WSP. These are adapted to and defined on the basis of the specific architecture of each WSP.

The diagnostic monitoring shall not impair the braking functions during the running of the vehicle.

Information shall be provided to the train system to enable detection of simultaneous failure of WSP and WRM on any single axle.

5.1.8.2 Manually initiated test

It shall be possible to manually initiate a WSP test with the vehicle at standstill. Automatic or remote initiation of this test may also be allowed, provided that all the requirements for manual initiation are met.

The manually initiated WSP test shall be aborted when the WSP detects vehicle movement which shall be before the vehicle reaches 3 km/h.

The manually initiated WSP test includes tests for dormant faults that can be detected when the vehicle is stationary.

The manually initiated WSP test shall include tests of the WSP watchdog function.

The manually initiated WSP test shall include the test of each WSP actuator. In the case of more than one WSP actuator per WSP system the test should be done sequentially on these WSP actuators.

All states of the WSP actuator shall be tested including complete release of the brake force. The WSP actuators function can be checked by audibility of venting air, visibility or other means.