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## RECOMMENDATION FOR USE

### NB-RAIL COORDINATION GROUP

Administrative Decision according to Interoperability Directive  
(EU) 2016/797 art. 30.6



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**RFU-RST-307**

Issue 01  
Date 09/11/2020

#### TITLE

SAFETY ASSESSMENT OF WHEEL SLIDE PROTECTION FOR EMU/DMU AND LOCOMOTIVES

#### ORIGINATOR

TÜV SÜD Nederland B.V.

#### SUBJECT RELATED TO

Regulation (EU) No. 1302/2014  
(LOC&PAS TSI) amended by Reg. (EU)  
2020/387 and earlier

AMENDMENT RECORD:

#### DESCRIPTION AND BACKGROUND EXPLANATION

##### References:

- [1] LOC&PAS TSI Reg. (EU) No. 1302/2014 (incl. Reg. (EU) 2020/387 and earlier)
- [2] EN 15595:2009+A1:2011

##### Background:

In EMUs/DMUs, the wheel slide protection system (WSP) is usually never deactivated in any conditions (in many locomotives, the WSP is typically deactivated when applying the “direct brake”, see also UIC 541-05:2005, 3.3.1). A systematic failure of the WSP, leading to the release of many or all brakes in the train, might therefore have catastrophic consequences. Systematic failures can be, for example, a wrong estimated speed or another inadequacy of the control algorithm. These failures might be overlooked in the tests required by [1], Appendix J-1, index 30 (= [2]).

The WSP requirements on vehicle (unit) level are described in LOC&PAS TSI [1], clauses 4.2.4.6.2 and 6.2.3.10:

*4.2.4.6.2 (6) The wheel slide protection system shall be designed according to the specification referenced in Appendix J-1, index 30, clause 4 [= [2], section 4]; the conformity assessment procedure is specified in clause 6.1.3.2.*

*6.2.3.10 and similar in 4.2.4.6.2 (7): If a unit is equipped with a WSP, a test of the unit in low adhesion conditions shall be carried out according to the specification referenced in Appendix J-1, index 93 [= [2], section 6.4], in order to validate the performance of the WSP system (maximum extension of the stopping distance compared to stopping distance on dry rail) when integrated in the unit.*

*4.2.4.6.2 (7) The relevant components of the wheel slide protection system shall be considered in the safety analysis of the emergency brake function required in clause 4.2.4.2.2.*



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The WSP requirements on Interoperability Constituent (IC) level are described in [1], clause 6.1.3.2 Wheel slide protection system (clause 5.3.5):

*“(1) The wheel slide protection system shall be verified according to the methodology defined in the specification referenced in Appendix J-1, index 72 [= [2], sections 5 and 6.2.3] [...].”*

#### Description of the situation:

The main question is how to deal with requirement 4.2.4.6.2 (7) in [1]:

*“The relevant components of the wheel slide protection system shall be considered in the safety analysis of the emergency brake function required in clause 4.2.4.2.2.”*

It can be assumed that this sentence refers to both the requirements no. 1 and no. 3 in [1] Table 3.

Section 4 of [2] can be assessed independently of a specific vehicle (subsystem), i.e. this is in fact a suitable basis for an assessment on IC level.

However, there are no suitable and clear requirements with respect to functional safety:

- EN 15595 ER1 is typically interpreted as being only related to section 4.2.2 of [2]. Therefore,
  - It only considers failures that lead to “sustained release of the brake” ([2], 4.2.2), i.e. significant reduction of the brake force for more than 10 seconds constantly (e.g. mechanical blocking of the refill valve in closed position or failure of both control and monitoring path).
  - Failures leading to too low (mean) brake force over an extended period of time are not considered at all in ER1, as long as the WSP dump valve is not constantly released, or the WSP refill valve is not constantly blocked. In particular, a failure of the control algorithm leading to significantly too low mean brake pressure is not considered in ER1, as long as the valves are opened/closed every couple of seconds for an infinitely short time. Thus finally, there is no relationship between the scenario to be considered by [1] Table 3 no. 1 and no. 3 and the requirements to be assessed on IC level.
  - ER1 considers single-channel failures (e.g. valve failures), but there is no requirement related to multi-channel failures, such as systematic faults (common cause HW failures, faults in algorithm SW or parameters).
- ER2 is not related to WSP, but general brake control. In addition, the effect of a failure of speed measurement and thus the required THR/TFFR and SIL depend on each specific application, a generic definition cannot guarantee suitability of the component for a specific vehicle type.
- ER3 is not related to braking distance at all.



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**In effect, the majority of functional safety aspects related to WSP systems is out of scope of EN 15595 and therefore out of scope of the assessment on IC level.**

[1] Appendix J-1 index 72 refers to section 5 of [2], which describes the test and simulations necessary for each specific vehicle type (in fact, those tests are typically performed for each vehicle type). Even though some verification by simulations is foreseen, it is common understanding that simulations and generic vehicle tests are not sufficient to prove the suitability of HW and SW of a WSP, so that a lot of tests have to be performed for each particular vehicle type. Thus, fulfilling section 5 of [2] does neither guarantee that the WSP (generic HW and SW) is in fact suitable for a certain specific vehicle type, nor does it give any indication regarding (functional) safety.

Since functional safety of the WSP is not sufficiently considered in the assessment on IC level, and functional safety requirements are not defined or harmonised anywhere, it is necessary to agree on how to understand and assess the requirement [1] 4.2.4.6.2 (7) in particular with respect to functional safety.

### RFU PROPOSAL

Item 4.2.4.6.2 (7) can not be assessed at IC level alone and therefore interface conditions shall be stated in the IC Certificate. In order to fulfil LOC&PAS TSI requirement 4.2.4.6.2 (7) and 4.2.4.2.2 for EMU/DMU and locomotives, the following assessment on subsystem level shall be carried out for wheel slide protection (WSP) systems:

- There must be evidence that there is no single hardware (HW) failure that leads to more than 50% loss of brake force of the vehicle. This proof shall be an FMEA and a fault tree analysis (FTA), which must refer to the actual architecture of the WSP and brake system of the particular vehicle type.
- There must be evidence that there is no software (SW) fault that could lead to more than 50% loss of brake force of the vehicle. In order to proof absence of those systematic failures, the manufacturer shall demonstrate by reference to the HW and SW architecture of the WSP for the particular vehicle type, that even in case of SW failures (e.g. due to the algorithm or parameters not fitting to any imaginable scenario not covered by tests) at least 50% of the brake force will still be applied in average (mean value over vehicle and any period of time). This guaranteed minimum brake force shall be considered in terms of enlargement of braking distance in LOC&PAS TSI Table 3 no. 3.
- If the failure rate (FR) for single point failures of the WSP leading to “stopping distance is longer than the one in normal mode” (LOC&PAS TSI Table 3 no. 3) is stated (which is not mandatory according to LOC&PAS TSI but necessary in order to parameterize an ETCS with the “gamma model”), it shall consider the safety integrity of the WSP control algorithm. For instance, if the WSP algorithm



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has been developed according to SIL1 requirements of EN 50126 and EN 50657, the FR of this failure cannot be claimed to be less than  $1e-6/h$ , even if the HW FR is lower.

Note: This evidence needs typically to be provided by the manufacturer of the WSP since the architecture definition, parameterisation and vehicle specific SW development is typically done by the manufacturer of the WSP.

Note: For units designed and assessed for general operation, it is useful if the WSP system has also been certified according to UIC 541-05, 3<sup>rd</sup> issue, March 2016.

#### THIS RFU WAS AGREED ON

PLENARY MEETING 060

#### THIS RFU ENTERS INTO FORCE ON

09/11/2020 (DATE OF PUBLICATION)

FROM THIS DATE ON THIS RFU CAN BE APPLIED INSTEAD OF THE PREVIOUS MANDATORY VERSION.

#### RFU APPLICATION IS MANDATORY STARTING FROM

09/11/2020

RFUs SHALL BE APPLIED BY ALL NOBOS. PLEASE REFER TO RFU-STR-702, CHAPTER 3 OF THE SECTION "DESCRIPTION AND BACKGROUND EXPLANATION", FOR THE LEGAL BASIS SUPPORTING THIS OBLIGATION.

#### ERA COMMENTS

PLE 060 – 04/11/2020: NO COMMENTS