

# DIN EN 15595:2021-07 (E)

## Railway applications - Braking - Wheel slide protection (includes Corrigendum :2021)

---

| <b>Contents</b>         |   | <b>Page</b> |
|-------------------------|---|-------------|
| European foreword ..... |   | 6           |
| Introduction .....      |   | 7           |
| 1                       | Scope .....   | 8           |
| 2                       | Normative references .....                              | 8           |
| 3                       | Terms and definitions .....                             | 9           |
| 4                       | Symbols and abbreviations .....                         | 12          |
| 5                       | Requirements .....                                      | 12          |
| 5.1                     | Functional requirements .....                           | 12          |
| 5.1.1                   | Objectives of wheel slide protection .....              | 12          |
| 5.1.2                   | General functional requirements .....                   | 13          |
| 5.1.3                   | Control of the brake force .....                        | 13          |
| 5.1.4                   | Wheel slide protection watchdog (safety timer) .....    | 14          |
| 5.1.5                   | Air supply .....  | 14          |
| 5.1.6                   | Wheel diameter differences .....                        | 14          |
| 5.1.7                   | Wheel rotation monitoring (WRM) .....                   | 14          |
| 5.1.8                   | Diagnostics .....                                       | 15          |
| 5.2                     | Design requirements .....                               | 16          |
| 5.2.1                   | Environmental specification .....                       | 16          |
| 5.2.2                   | Fire behaviour .....                                    | 16          |
| 5.2.3                   | RAMS .....  | 17          |
| 5.2.4                   | Mechanical construction .....                           | 17          |
| 5.2.5                   | Power management .....                                  | 17          |
| 5.2.6                   | Software .....  | 18          |
| 5.2.7                   | Electronic control unit Input/Output (I/O) .....        | 18          |
| 5.2.8                   | Sensor - axle speed acquisition .....                   | 18          |
| 5.2.9                   | Actuator - modification of brake force .....            | 18          |
| 5.3                     | Installation recommendations .....                      | 19          |
| 5.3.1                   | General installation requirements .....                 | 19          |
| 5.3.2                   | Air system .....  | 19          |
| 5.3.3                   | Power supply and electrical system .....                | 19          |
| 5.4                     | Performance requirements for WSP .....                  | 20          |
| 5.4.1                   | Performance .....                                       | 20          |
| 5.4.2                   | Stopping distance and adhesion improvement .....        | 21          |
| 5.4.3                   | Wheelset slide limits .....                             | 21          |
| 5.4.4                   | Track damage .....                                      | 22          |
| 5.4.5                   | Maximum deceleration .....                              | 22          |
| 5.4.6                   | Air consumption .....                                   | 23          |
| 5.4.7                   | Output based on speed information provided by WSP ..... | 23          |
| 6                       | Range of tests .....                                    | 24          |
| 6.1                     | General .....   | 24          |
| 6.1.1                   | Test classifications .....                              | 24          |
| 6.1.2                   | Assessor .....  | 24          |
| 6.2                     | Type Test .....   | 24          |
| 6.2.1                   | General .....   | 24          |

|  |  |    |
|--|--|----|
| 6.2.2  | Test requirements .....  | 24 |
| 6.2.3  | Individual component Type Test .....   | 24 |
| 6.3  | Vehicle Implementation Test .....  | 25 |
| 6.3.1  | General .....  | 25 |
| 6.3.2  | Test requirements .....  | 26 |
| 6.3.3  | Conformity of previous vehicle tests .....   | 26 |
| 6.4  | List of tests .....  | 26 |
| 6.4.1  | Standard tests .....   | 26 |
| 6.4.2  | Drag tests .....   | 26 |
| 6.4.3  | Test methods for speeds from 160 up to 200 km/h .....  | 27 |
| 6.4.4  | Test methods for speeds > 200 km/h .....   | 27 |
| 6.4.5  | Supplementary higher deceleration tests .....  | 27 |
| 6.4.6  | Supplementary approval tests for WSP acting in vehicles with brakes that are independent of adhesion ..... | 27 |
| 6.4.7  | Supplementary approval tests involving tractive units and trainsets having dynamic brakes .....            | 27 |
| 6.4.8  | Testing of wheel rotation monitoring (WRM) .....   | 28 |
| 6.5  | Re-testing .....   | 34 |
| 6.5.1  | General .....  | 34 |
| 6.5.2  | Hardware .....   | 34 |
| 6.5.3  | Software .....   | 35 |
| 7  | Test methods .....   | 35 |
| 7.1  | General .....  | 35 |
| 7.2  | Measurement .....  | 36 |
| 7.3  | Tests on vehicle .....   | 37 |
| 7.3.1  | General .....  | 37 |
| 7.3.2  | Generation of degraded adhesion .....  | 38 |
| 7.3.3  | Environmental conditions .....   | 38 |
| 7.4  | Test in simulation environment .....   | 39 |
| 7.4.1  | General .....  | 39 |
| 7.4.2  | Tests on simulation rig .....  | 39 |
| 7.4.3  | Additional specific simulator tests .....  | 40 |
| 7.4.4  | Optional tests .....   | 40 |
| 8  | Evaluation of test .....   | 40 |
| 8.1  | Correcting the stopping distances .....  | 40 |
| 8.2  | Number and validity of dry tests .....   | 40 |
| 8.3  | Evaluation of slide test .....   | 40 |
| 8.3.1  | General .....  | 40 |
| 8.3.2  | Evaluation of stopping performance .....   | 41 |
| 8.3.3  | Evaluation of test validity .....  | 42 |
| 8.3.4  | Evaluation of relative air consumption .....   | 51 |
| 9  | Documentation of tests .....   | 52 |
| 9.1  | Test Specification .....   | 52 |
| 9.2  | Test report .....  | 53 |
| 10   | Routine test and inspection .....  | 54 |
| 11   | Designation, identification and marking .....  | 54 |
| Annex A (normative) Tables linking the WSP / WRM Requirements to Tests and Test Criteria ..... |  | 55 |
| Annex B (normative) Minimum requirements for a WSP simulator .....                             |  | 75 |
| B.1  | General .....  | 75 |
| B.1.1  | General .....  | 75 |
| B.1.2  | Use of the simulator model .....   | 75 |
| B.2  | Adhesion model .....   | 81 |
| B.2.1  | General .....  | 81 |
| B.2.2  | Constant adhesion condition .....  | 81 |

|   |   |            |
|---|---|------------|
| B.2.3   | Variable adhesion condition .....                         | 81         |
| B.2.4   | Adhesion conditioning factors .....                       | 82         |
| B.3   | Test and performance model .....                          | 82         |
| B.3.1   | General .....   | 82         |
| B.3.2   | Simulator performance .....                               | 82         |
| B.3.3   | Test requirements .....                                   | 82         |
| B.3.4   | Stopping performance .....                                | 82         |
| B.3.5   | Wheel damage .....  | 83         |
| B.3.6   | Air system .....  | 83         |
| B.3.7   | Pass/fail limits .....                                    | 83         |
| B.3.8   | Fault conditions .....                                    | 83         |
| B.3.9   | WSP outputs .....   | 84         |
| B.4   | Vehicle performance model .....                           | 84         |
| B.4.1   | General .....   | 84         |
| B.4.2   | Friction material .....                                   | 84         |
| B.4.3   | Pneumatic actuator/brake demand .....                     | 84         |
| B.4.4   | Body/Bogie/wheel dynamics .....                           | 84         |
| B.5   | Vehicle functional model .....                            | 85         |
| B.5.1   | General .....   | 85         |
| B.5.2   | Functional inputs .....                                   | 85         |
| B.6   | Simulator validation .....                                | 85         |
| B.6.1   | General .....   | 85         |
| B.6.2   | Validation of test benches .....                          | 85         |
| B.6.3   | Management .....  | 88         |
| <b>Annex C (informative) Example of customer specific simulator tests .....</b>   |   | <b>89</b>  |
| C.1   | Naturally occurring variable adhesion tests .....         | 89         |
| C.1.1   | General .....   | 89         |
| C.1.2   | Sequence .....  | 89         |
| C.1.3   | Measurement and pass/fail criteria .....                  | 91         |
| C.2   | Sustained low adhesion track condition (SLAC) Tests ..... | 92         |
| C.2.1   | Sequence .....  | 92         |
| C.2.2   | Measurement/pass fail criteria .....                      | 93         |
| C.2.3   | WSP speed reference (vref) .....                          | 93         |
| C.3   | Operating speeds above 160 km/h .....                     | 93         |
| C.3.1   | Criteria .....  | 93         |
| C.3.2   | Sequence .....  | 94         |
| C.3.3   | Measurement and pass/fail criteria .....                  | 94         |
| <b>Annex D (informative) Optional tests .....</b>   |   | <b>95</b>  |
| D.1   | Sander system tests -- Criteria .....                     | 95         |
| D.2   | Dynamic braking system tests -- Criteria .....            | 96         |
| D.3   | Peripheral output tests -- Criteria .....                 | 96         |
| <b>Annex E (informative) Typical diagram of a real WSP test .....</b>   |   | <b>98</b>  |
| <b>Annex F (informative) In-service monitoring .....</b>  |   | <b>100</b> |
| <b>Annex G (informative) Braking configurations .....</b>   |   | <b>101</b> |
| G.1   | Per bogie control .....                                   | 101        |
| G.2   | Per wagon control .....                                   | 101        |
| <b>Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC aimed to be covered .....</b> |   | <b>103</b> |
| <b>Bibliography .....</b>   |   | <b>105</b> |