

<b>STN</b>	<b>Železnice Aerodynamika</b> <b>Časť 5: Požiadavky a postupy posudzovania na aerodynamiku v tuneloch</b>	<b>STN EN 14067-5</b>  28 0340
------------	--	--

Railway applications - Aerodynamics - Part 5: Requirements and assessment procedures for aerodynamics in tunnels

Táto norma obsahuje anglickú verziu európskej normy.  
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 04/22

Obsahuje: EN 14067-5:2021

Oznámením tejto normy sa ruší  
STN EN 14067-5+A1 (28 0340) z mája 2011

EUROPEAN STANDARD

**EN 14067-5**

NORME EUROPÉENNE

EUROPÄISCHE NORM

December 2021

ICS 45.060.01; 93.060

Supersedes EN 14067-5:2006+A1:2010

English Version

## Railway applications - Aerodynamics - Part 5: Requirements and assessment procedures for aerodynamics in tunnels

Applications ferroviaires - Aérodynamique - Partie 5:  
Exigences et procédures d'essai pour l'aérodynamique  
en tunnel

Bahnanwendungen - Aerodynamik - Teil 5:  
Anforderungen und Prüfverfahren für Aerodynamik im  
Tunnel

This European Standard was approved by CEN on 22 November 2021.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

**EN 14067-5:2021 (E)**

<b>Contents</b>	<b>Page</b>
European foreword.....	5
<b>1 Scope.....</b>	<b>6</b>
<b>2 Normative references.....</b>	<b>6</b>
<b>3 Terms and definitions .....</b>	<b>6</b>
<b>4 Symbols and abbreviations .....</b>	<b>8</b>
<b>5 Requirements on locomotives and passenger rolling stock.....</b>	<b>14</b>
<b>5.1 Limitation of pressure variations inside tunnels.....</b>	<b>14</b>
5.1.1 General.....	14
5.1.2 Requirements.....	14
5.1.3 Full conformity assessment.....	16
5.1.4 Simplified conformity assessment.....	16
<b>5.2 Limitation of pressure gradient entering a tunnel (relative to micro-pressure wave generation).....</b>	<b>18</b>
5.2.1 General.....	18
5.2.2 Requirements.....	18
5.2.3 Simplified conformity assessment.....	20
<b>5.3 Resistance to aerodynamic loading.....</b>	<b>20</b>
5.3.1 General.....	20
5.3.2 Requirements.....	21
5.3.3 Exceptional load assessment.....	27
5.3.4 Fatigue load assessment.....	28
5.3.5 Assessment in case of modification.....	28
<b>6 Requirements on infrastructure .....</b>	<b>29</b>
<b>6.1 Limitation of pressure variations inside tunnels to meet the medical health criterion.....</b>	<b>29</b>
6.1.1 General.....	29
6.1.2 Requirements.....	29
6.1.3 Full conformity assessment.....	31
6.1.4 Simplified conformity assessment.....	31
<b>6.2 Limitation of pressure gradient entering a tunnel (relative to micro-pressure wave generation).....</b>	<b>32</b>
6.2.1 General.....	32
6.2.2 Reference case.....	32
6.2.3 Requirements.....	32
6.2.4 Assessment.....	32
<b>6.3 Further aspects of tunnel design .....</b>	<b>33</b>
6.3.1 General.....	33
6.3.2 Aural pressure comfort.....	33
6.3.3 Pressure loading on installations.....	34
6.3.4 Induced airflows.....	35
6.3.5 Aerodynamic drag.....	35
6.3.6 Contact forces of pantograph to catenary .....	35
6.3.7 Ventilation .....	35
6.3.8 Workers' safety.....	35
6.3.9 Loads on vehicles in mixed traffic operation .....	36
<b>6.4 Additional aspects for underground stations.....</b>	<b>36</b>

6.4.1	Pressure changes.....	36
6.4.2	Induced airflows .....	36
6.4.3	Specific case for loads on platform barrier systems due to trains passing .....	37
7	Methods and test procedures.....	37
7.1	General .....	37
7.2	Methods to determine pressure variations in tunnels .....	39
7.2.1	General .....	39
7.2.2	Full-scale measurements at fixed locations in a tunnel.....	40
7.2.3	Instrumentation.....	41
7.2.4	Full-scale measurements on the exterior of the train.....	43
7.2.5	Predictive formulae .....	44
7.2.6	Assessment by numerical simulation.....	44
7.2.7	Reduced scale measurements at fixed locations in a tunnel .....	45
7.3	Assessment of maximum pressure changes (vehicle reference case).....	46
7.3.1	General .....	46
7.3.2	Transformation of measurement values by a factor (approach 1) .....	46
7.3.3	Transformation of measurement values based on A.3.3 (approach 2) .....	47
7.3.4	Transformation by simulation (approach 3).....	47
7.3.5	Assessment of the pressure time history.....	48
7.3.6	Assessment quantities and comparison.....	52
7.4	Assessment of maximum pressure changes (infrastructure reference case) .....	52
7.4.1	General .....	52
7.4.2	Assessment method .....	52
7.5	Assessment of the pressure gradient of a train entering a tunnel (vehicle reference case, with respect to micro-pressure wave generation) .....	54
7.5.1	General .....	54
7.5.2	Assessment by simulations .....	54
7.5.3	Assessment by moving model rig tests .....	55
7.6	Assessment of the micro-pressure wave (infrastructure reference case) .....	55
7.6.1	General .....	55
7.6.2	Assessment by numerical simulations.....	56
7.6.3	Assessment by moving model rig tests .....	58
7.7	Assessment of aerodynamic loads.....	59
7.7.1	Assessment of load due to strong wind .....	59
7.7.2	Assessment of open air passings for fatigue load assessments .....	60
7.7.3	Assessment of transient loads in tunnels .....	61
7.7.4	Assessment of fatigue loads .....	64
7.7.5	Determination of the damage-equivalent load amplitude for scenario .....	66
7.7.6	Documentation .....	67
7.7.7	Simplified load cases .....	68
7.8	Assessment of pressure sealing.....	69
7.8.1	General .....	69
7.8.2	Dynamic pressure tightness .....	70
7.8.3	Equivalent leakage area .....	70
7.8.4	Test methods.....	71
7.8.5	Dynamic tests.....	73
Annex A (informative)	Predictive formulae.....	75
A.1	General .....	75
A.2	SNCF approach.....	75
A.2.1	Entry of the nose of the train .....	75

**EN 14067-5:2021 (E)**

<b>A.2.2</b>	<b>Entry of the body of the train</b> .....	<b>75</b>
<b>A.2.3</b>	<b>Entry of the rear of the train</b> .....	<b>76</b>
<b>A.3</b>	<b>TU Vienna approach</b> .....	<b>76</b>
<b>A.3.1</b>	<b>General</b> .....	<b>76</b>
<b>A.3.2</b>	<b>Symbols</b> .....	<b>76</b>
<b>A.3.3</b>	<b>Calculation of <math>\Delta p_N</math></b> .....	<b>77</b>
<b>A.3.4</b>	<b>Calculation of <math>\Delta p_{fr}</math></b> .....	<b>78</b>
<b>A.3.5</b>	<b>Calculation of <math>\Delta p_T</math></b> .....	<b>79</b>
<b>A.3.6</b>	<b>Calculation of the drag coefficient <math>C_{x,tu}</math></b> .....	<b>80</b>
<b>A.4</b>	<b>GB approach, ignoring changes in air density and the speed of sound</b> .....	<b>83</b>
<b>A.4.1</b>	<b>General</b> .....	<b>83</b>
<b>A.4.2</b>	<b>Calculation of <math>\Delta p_N</math></b> .....	<b>83</b>
<b>A.4.3</b>	<b>Calculation of <math>\Delta p_{fr}</math></b> .....	<b>84</b>
<b>A.4.4</b>	<b>Calculation of <math>\Delta p_T</math></b> .....	<b>84</b>
	<b>Annex B (informative) Pressure comfort criteria</b> .....	<b>85</b>
<b>B.1</b>	<b>General</b> .....	<b>85</b>
<b>B.2</b>	<b>Unsealed trains (generally <math>\tau_{dyn} &lt; 0,5</math> s)</b> .....	<b>85</b>
<b>B.3</b>	<b>Sealed trains (generally <math>\tau_{dyn} &gt; 0,5</math> s)</b> .....	<b>85</b>
	<b>Annex C (informative) Micro-pressure wave</b> .....	<b>86</b>
<b>C.1</b>	<b>General</b> .....	<b>86</b>
<b>C.2</b>	<b>Compression wave generation</b> .....	<b>86</b>
<b>C.3</b>	<b>Compression wave propagation</b> .....	<b>87</b>
<b>C.4</b>	<b>Micro-pressure wave radiation</b> .....	<b>87</b>
	<b>Annex D (informative) Pressure loading on unsealed crossing trains</b> .....	<b>89</b>
	<b>Annex E (informative) Validation cases for the assessment of aerodynamic loads</b> .....	<b>92</b>
<b>E.1</b>	<b>General</b> .....	<b>92</b>
<b>E.2</b>	<b>Validation procedure</b> .....	<b>92</b>
	<b>Bibliography</b> .....	<b>94</b>

## European foreword

This document (EN 14067-5:2021) 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 2022, and conflicting national standards shall be withdrawn at the latest by June 2022.

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 14067-5:2006+A1:2010.

EN 14067, *Railway applications — Aerodynamics*, consists of the following parts:

- *Part 1: Symbols and units;*
- *Part 3: Aerodynamics in tunnels;*
- *Part 4: Requirements and test procedures for aerodynamics on open track;*
- *Part 5: Requirements and test procedures for aerodynamics in tunnels;*
- *Part 6: Requirements and test procedures for cross wind assessment.*

The results of the EU-funded research project “AeroTRAIN” (Grant Agreement No. 233985) have been used.

The contents of the previous edition of EN 14067-5 have been integrated in this document; they have been re-structured and extended to support the Technical Specifications for the Interoperability of the Trans-European rail system. Requirements on conformity assessment for rolling stock were added.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## EN 14067-5:2021 (E)

### 1 Scope

This document establishes aerodynamic requirements, test procedures, assessment methods and acceptance criteria for operating rolling stock in tunnels. Aerodynamic pressure variations, loads, micro pressure wave generation and further aerodynamic aspects to be expected in tunnel operation are addressed in this document. Requirements for the aerodynamic design of rolling stock and tunnels of the heavy rail system are provided. The requirements apply to heavy rail systems only.

### 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 14067-4:2013+A1:2018, *Railway applications - Aerodynamics - Part 4: Requirements and test procedures for aerodynamics on open track*

EN 15273 series, *Railway applications — Gauges*

EN 17149-1:—,<sup>1</sup> *Railway applications — Strength assessment of railway vehicle structures — Part 1: General*

ISO 8756, *Air quality — Handling of temperature, pressure and humidity data*

**koniec náhľadu – text ďalej pokračuje v platenej verzii STN**